THE AUSTRALIAN LEARNING FACTORY: LEAN OR MEAN?

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ABSTRACT

The competitive pressure experienced by manufacturers in the automotive industry in Australia and overseas has prompted the emergence of the 'learning factory' concept, which has been described as a new paradigm. This 'learning factory' or 'world-class performance' paradigm has evolved from a focus on Total Quality Management and lean production in the late 1980s, learning and the learning organisation in the early 1990s to world-class performance in the late 1990s and early 2000s. In this context, levels of 'world-class performance' can be achieved by developing into an organisation that includes both lean production and learning organisational characteristics.

However, one of the most contentious points within the research literature about the learning factory, lean production and the learning organisation involves the claims by their proponents that each of these models offers a kind of emancipation or empowerment for lower level workers, thus enriching the working lives of employees, and improving job satisfaction, worker morale and productivity; on the other hand, critics claim that each of the models provides management with the potential for increased scrutiny and strict management control of the workforce, sometimes termed 'management by fear'.

This thesis, based on a detailed exploration of four automotive component manufacturers located in Adelaide, Australia, investigates whether the learning factory in Australia is 'lean or mean' by developing and testing a comprehensive model of the learning factory which incorporates the human aspects of lean production, and the learning organisation.

The data used in this thesis were drawn from a parent study undertaken by a research team (which included the author) to investigate continuous improvement and problem-solving in different organisations in Australian automotive components manufacturing. This parent study was designed to extend understanding of the management of knowledge creation and application, and to examine how learning structures and processes impact on productivity and performance in these organisations. The study used questionnaires, semi-structured interviews, on-site observations and analysis of company documents and records to gather information on plant performance, management practices, continuous improvement and problem-

solving activities. This thesis is an in-depth study of both the qualitative and quantitative data relating to four of the sixteen plants included in the Parent study. The research design made extensive provision for triangulation of data, which enables the author to evaluate a number of issues from different viewpoints.

The significant findings in this thesis are as follows. Firstly, if the plants involved in the study are representative of Australian manufacturers, there are examples of learning factories in Australia capable of achieving world-class performance. Secondly, the learning factory model whether implemented in Australia or elsewhere in the world is not inherently 'mean' but often is, as a result of the way in which it is implemented. Finally, the example of a learning factory identified in the study expends considerable resources addressing the 'human aspects' of the learning factory in a way that is consistent with the research model developed and tested in this thesis.

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DECLARATION BY THE CANDIDATE

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give my consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.



Deborah Mason

Chapter 1
Introduction

With only a comparatively small domestic market, the survival and growth of manufacturing organisations in Australia depend on not only safeguarding their share of the domestic market but also gaining a competitive position in the international market. Competitive pressures and shareholder expectations are forcing Australian organisations to do more with less, or face the prospect of not 'doing' at all. In response to fierce competition from international competitors, Australian academics and practitioners alike are focussing on identifying how organisations can achieve world-class standards of production, not just to outperform competitors but in an attempt to ensure survival in a constantly changing environment. Much of the research published in this area during the 1980s and 1990s concentrated on the phenomenal growth of the manufacturing sector in Japan in the post World War II era (Adler and Cole, 1993, Stainer, 1995, Womack and Jones, 1996). Japanese manufacturing organisations, in many cases, managed to outperform Western organisations, not just on the international market but also in their competitors domestic markets (Delbridge, 1995, Oliver et al., 1994, Oliver et al., 1996b, Womack and Jones, 1996).

Lean production

The term 'lean production' was coined by Womack, Jones & Roos (1991) following a five-year research project into productivity and management practices in the world motor industry. The main conclusion of the study was that the Japanese model of production organisation was systematically related to superior productivity and quality in the order of 2:1 in comparison with Western production methods. In particular, the production and management practices of Toyota (also commonly called the Toyota Production System) provide an exemplar of lean production in its purest form.

Oliver et al. (1994) suggest that the core characteristics of lean production include:

- Team-based work organisation which involves flexible, multi-skilled operators taking a high degree of responsibility for work within their areas;
- active shopfloor problem-solving structures, central to *kaizen* or continuous improvement activities;
- lean manufacturing operations that force problems into the open to be corrected, are manifested by low inventories; the management of quality by prevention rather than

detection and subsequent correction; small numbers of indirect workers; and small batch just-in-time production;

- the use of high commitment human resource policies which foster a sense of shared destiny;
- close, shared destiny relationships with suppliers;
- cross-functional development teams; and
- retailing and distribution channels designed to permit make-to-order relationships with customers.

The Australian automotive manufacturing industry

Australia produced 343,000 passenger cars in 1999, representing less than 2.5% of total passenger cars built worldwide (2001). Australia's production volume is considerably less than that of the market leaders, Japan, the United States, Germany, France and Spain and only marginally higher than Argentina, Austria, the Czech Republic, Malaysia, the Netherlands, Portugal, Romania, South Africa, Sweden, Taiwan and Turkey. Although exports of road vehicles increased from $92,608,000 in 1977-78 to $769,000,000 in 1991-92, the majority of the vehicles produced locally were still sold on the domestic market (Truett and Truett, 1997).

In a paper that investigated the factors that affected the trade balance of the Australian motor vehicle industry, Truett and Truett (1997) argued that the performance of the Australian automotive industry had clearly not been satisfactory, as after nearly a century of tariff protection and other government assistance, the industry had failed to achieve an internationally competitive domestic industry. As the domestic market is fairly mature in Australia and unlikely to generate any significant levels of growth, Truett and Truett (1997) concluded that it was unlikely that the Australian motor vehicle industry would develop into a substantial exporter in the near future and cast doubt on the industry's ability to even maintain viability in the domestic market, unless it redoubled its efforts to strive for and attain international levels of competitiveness.

The picture painted by Garnaut (1997) is not quite as gloomy. Although he acknowledged that the performance of the Australian automotive industry over the previous decade was not something to be proud of and was written off by many as hopelessly inefficient sixteen years ago, he argued that the best firms in the industry, those that had embraced regionalisation and globalisation of production, were now close to international levels of performance. This suggests that some, if not all, Australian manufacturers have been

able to at least partially overcome the barriers to achieving internationally competitive practices.

Meanwhile, three of the four major car companies operating in Australia - Ford Motor Co. of Australia Limited - Toyota Motor Corp. Australia Limited and Mitsubishi Motors Australia Limited, were struggling to maintain market share, and given the current climate, have speculated publicly on their continued presence in Australia after the 2005 tariff cut takes effect. As demonstrated by the recent collapse of Ansett Australia, should even one of the car companies fail or relocate offshore, the impact on the Australian economy and the Australian psyche would be far-reaching. Rather than seeking answers outside the industry to explain or excuse the industry's performance, perhaps now is the time for a thorough investigation into those factors that can be controlled at an organisational level that may facilitate achievement of international levels of performance.

In the 1990s all of the firms operating motor vehicle assembly plants in Australia were foreign-controlled and, except for the Ford facility in Sydney, all of the assembly plants were located in Melbourne and Adelaide (Truett and Truett, 1997). At that time, there were approximately 500 firms supplying materials and components to the vehicle producers. The majority of these firms were also foreign controlled and concentrated in Melbourne and Adelaide.

Lean production in Australia

Manufacturers in Australia are increasingly adopting lean production models in an attempt to catch up with the rest of the world, with varying degrees of success (Chapman and Hyland, 1997, Mandal et al., 1999, Kayis, 1998, Sohal and Eggleston, 1994, Sohal, 1996, Sohal and Gordon, 2001). In a study designed to investigate the uptake of 'lean production' by Australian companies, Sohal and Eggleston (1994) reported that lean production methods had been or were being adopted by a majority of manufacturing companies. In fact, they suggested that for the manufacturing sector to survive in the world economy, it appeared to be inevitable that all Australian manufacturing companies must adopt lean manufacturing as a working philosophy.

Bamber & Dale (2000) suggest that the implementation of lean production often requires a change in attitudes and behaviour not only for managers but also for employees. For implementation to be successful, managers need to consider employees as being intelligent and willing, and in turn, employees need to respond by demonstrating initiative and commitment. Although lean production relies heavily on the input and involvement of both shop floor employees and management, there is perhaps an understandable tendency by

practitioners and consultants to concentrate on the technical aspects of lean production (Forza, 1996).

In a study of successful implementation at Trico, Sohal (1996) identified some key lessons, which included: the acceptance of the need to change existing attitudes, behaviours and practices, with full and ongoing support from top management; the need for a champion to drive the change programme, and the realisation by everyone that it will take a long time;

the need to involve employees as much as possible in planning, implementation and evaluation of changes: and the development of an environment of openness and trust through communication and sharing of information.

Scope and objectives of the study

The 'Learning Factory' has been a research project funded under the Australian Research Council SPIRT program, and is an investigation of the links between organisational learning and performance. The project builds on previous international research by Dr. Rick Delbridge of Cardiff University. The project was designed to explore the management of innovation, the implementation of improvements and the interface between systems, processes and technology in automotive components manufacturing, and to identify sources of knowledge available to manufacturers and explore processes by which employees, suppliers and customers contribute to, and benefit from, internal process improvements. The links between organisational learning and performance were to be examined over two years through a combination of qualitative and quantitative research into the processes and management of improvement activities.

While the other results of the Learning Factory project will focus on the more technical aspects of lean production, and the comparative performance of Australian manufacturers through investigation of quantitative and qualitative data collected during this parent project, this thesis focuses on how a sample of South Australian automotive component manufacturers are managing the human aspects of lean production. All of the participants in the Learning Factory project are or have implemented components of the lean production model in an effort to improve both quality and production. This study aims to evaluate the progress of four automotive component manufacturers located in South Australia to determine how they are managing the less technical, human aspects of the introduction of these practices.

Specifically, this study addresses the following questions:

1. What is meant by the term 'lean production' in the research literature and how is that definition interpreted in practice?

2. As the Learning Factory concept encompasses both the 'learning organisation' and the 'lean production' models, are these two models as described in the research literature compatible?
3. Is it possible to identify, from a review of research literature from the related fields of psychology, management and education, any additional factors that may influence an employee's decision to fully participate, in the way expected by the lean production, learning organisation and leaning factory models?
4. Do the characteristics of the Australian organisations in this study conform to the model of the learning factory proposed in this study?
5. How are lower level employees reacting to the introduction of lean production, learning organisation and/or learning factory models?

Structure of the thesis

Chapter 2 is an investigation of the lean production model and its application in the West, to clearly identify and articulate all of the components of the model and to determine why the implementation efforts of so many Western organisations have failed to produce the expected performance improvements. The chapter concludes by comparing and contrasting the elements of lean production and the learning organisation in an attempt to address the call by researchers for organisations to take the next step and become 'learning factories' by combining lean production with the learning organisation model.

Chapter 3 discusses those characteristics of a lean production or learning factory organisation identified in the previous chapter as implicit in either or both models, but poorly defined in the literature as components of the model. The chapter commences with a discussion about how learning occurs in and by organisations. This is followed by a section which addresses issues of employee involvement, participation and empowerment. The chapter concludes with a discussion of some of the factors commonly cited within the literature as potential facilitators or inhibitors of employee involvement in the improvement process.

Drawing on the literature presented in the previous two chapters, Chapter 4 attempts to develop a comprehensive model of the 'Learning Factory', which incorporates the human aspects of combining lean production and the learning organisation model.

Chapter 5 provides detail of the research methods and data collection procedures used by the parent study from which the data for this study were drawn. The chapter then introduces each the four plants selected for inclusion in this study and concludes by discussing the methods used to evaluate the data provided by the four participating plants.

Chapter 6 reports on the significant results of the study. This chapter presents both qualitative and quantitative data (where available) as they relate to each of the components of the model proposed in Chapter 4.

Chapter 7 reviews the significant findings of the study in relation to each of the research questions and presents the conclusions of the study. The chapter concludes with suggestions for further research.

Chapter 2

Lean production and the learning factory

Lean production has been the subject of vast amounts of research over the past two decades and is often promoted as the only or best way that a manufacturing organisation can improve both quality and productivity, if it is to maintain a competitive position in the world market. The purpose of this chapter is to investigate the lean production model and its application in the West, firstly, to clearly identify and articulate all of the components of the model, and secondly, to explore possible reasons why the implementation efforts of so many Western organisations have failed to produce the expected performance improvements.

This chapter commences with a discussion of the origins of lean production, the Toyota production system, and this is followed by a detailed description of the lean production model proposed by the authors of *The Machine That Changed The World* (Womack et al., 1991). The next section analyses the criticism the model has attracted, and the literature reporting the varied experience of Western producers who have implemented lean production, and contrasts the implementation experiences of successful Japanese transplants against those portrayed in the literature as lean production failures, to identify possible explanations for the performance differential. The chapter concludes with an investigation of the future direction of lean production proposed in the literature.

The Toyota production system

The Toyota Production System was developed by the Toyota Corporation in Japan over a period of twenty years. In the early 1950s Toyota was a fledging company struggling to survive, and although the founding family was determined to begin full-scale car and commercial truck manufacturing, the obstacles they faced were considerable. Japan's domestic market was very small and demanded a wide range of vehicles. New labour laws introduced by the Americans in the post-war period had enabled workers to negotiate extremely favourable employment conditions, investment capital was scarce and they planned to enter a market populated by well-established high-volume producers well prepared to defend their established markets (Womack et al., 1991).

Limited capital resources made the replication of mass-production systems such as the one operating at Ford's Rouge plant in Detroit impossible for the Japanese firm, Toyota was forced to adapt the mass production system to suit the economic and cultural conditions of Japan's post-war society.

In the late 1940s Taiichi Ohno, Toyota's chief production engineer, was grappling with the problem of producing approximately 300 stamped metal parts with a minimum of press lines. By a process of experimentation, Ohno was able to develop a method for quick die changes and eliminate the need for die-change specialists, reducing press downtime from several days to three minutes, and thus enabling Toyota to produce all 300 parts in short runs using significantly fewer machines than Western producers. Almost as a by-product of this process, Ohno discovered that it cost less per part to produce small batches of stampings than to run large batches, as making small batches eliminated the need to carry large inventories of finished parts and as errors were identified almost immediately. This was the beginning of 'just-in-time' (JIT) and push-pull production (Womack et al., 1991).

In a plant operating the Toyota Production system, each step in the production process is synchronised so that each piece of the line only produces the output as and when required by the next step in the process. Workstations are arranged wherever possible in accordance with the physical flow of production process to minimise material handling between steps. In this way, surplus work-in-progress inventory can be minimised or eliminated, requiring less storage space around the line (Womack et al., 1991).

To make the short run batch method work, Ohno needed an extremely skilled and highly motivated workforce. If workers failed to anticipate problems or did not deal with problems quickly and effectively, production in the whole factory would cease. Worker commitment was gained in the late 1940s following an industrial dispute. Although a quarter of the workforce was laid off, the remaining employees received two guarantees - the first was lifetime employment and the second was pay for seniority rather than by specific job specification and with bonuses tied to company profits (Womack et al., 1991).

Under these conditions, employees become a lifelong investment, and in some respects, a partner with a shared interest in the ongoing profitability of the company, rather than a short-term variable cost. If the company was to gain maximum benefit from their human resources, it made sense to continually enhance and upgrade workers' skills and to encourage those workers to share their knowledge and experience (Womack et al., 1991).

Employees in a mass production system are assigned one or two simple repetitious tasks on the line and operate independently of everyone else on the line. They just do their jobs, over and over again. In contrast, Toyota's workforce was organised into teams. Each team was responsible for a set of assembly steps and members were expected to work together. The team was made responsible for all of the housekeeping activities, minor plant repair and quality checking on their piece of the line, eliminating the need for an army of support staff. Team leaders were expected to work on assembly in addition to their duties as team coordinators and fill in for any absent workers. After the teams were operating

smoothly, time was set aside periodically for the team, in collaboration with industrial engineers, to discuss ways to improve the process (Womack et al., 1991).

Following visits to mass producers in the West, the engineers from Toyota were determined to eliminate or at least minimise 'rework' which they viewed as a wasteful and non-value adding activity. In the mass production system, errors are not corrected until the product reaches the end of the line. Errors are often compounded as the product moves along the line, the result being costly and time-consuming 'rework' to rectify the fault(s). In the Toyota Production System, every employee on the line is able to halt production if a problem occurs that they are not able to fix themselves. When the line stops, the whole team works on the problem, seeking a solution that will not only rectify the problem and get the line moving again but also to understand why the fault occurred and prevent it from reoccurring (Womack et al., 1991).

By this stage, Toyota had a factory layout and a work team-based organisation that supported and facilitated the physical flow through the production process on demand, minimal work-in-progress inventory between workstations, minimal rework of finished products and a committed and skilled workforce. They turned their attention to their supply chain. The relationship between mass producers and their supply base observed by Toyota at Ford and GM could only be characterised as adversarial. Independent supplier firms competed against each other to supply parts. Contracts were awarded on the basis of price, quality and delivery reliability, with car manufacturers often switching from one supplier to another on short notice. Suppliers produced to specification, and had little or no opportunity to improve their product. The short-term nature of supply contracts hindered their ability to make capital investments in new or improved production technology, and the competition between suppliers prevented information sharing (Womack et al., 1991).

The system of bank enterprise groups in Japan, or *keiretsu*, which help to regulate alliances between Toyota and their suppliers, enabled Toyota to counteract these problems by organising suppliers into functional tiers with different responsibilities assigned to each tier. The first tier suppliers were responsible for the design and supply of component systems directly to the assembly plant. Toyota would provide the supplier with performance specifications for a component system, and the supplier would design a prototype. First tier suppliers were not told how to make the systems or what they should consist of, providing the system met the car maker's performance specifications. These suppliers were also responsible for managing the relationship between themselves and the second tier, suppliers who were assigned the task of producing individual component parts. Thus the assembler was responsible for the car design and performance specification of the component systems, first tier suppliers were responsible for designing and assembling component systems, and

second tier suppliers were responsible for manufacturing individual component parts (Womack et al., 1991).

Toyota wanted to develop a relationship with their suppliers that encompassed a sense of shared destiny, which was necessarily long-term. Toyota trained each first tier supplier in their new production methods and encouraged communication suppliers to enable them to seek and share methods of improving production. When demand produced higher than normal workloads for their suppliers, Toyota offered their suppliers the use of their own personnel. Intercompany transfers of senior (non-production) employees were common (Womack et al., 1991).

The close relationship between Toyota and its suppliers enabled the company to extend the just-in-time inventory system to their supply chain, with suppliers producing only that quantity of component systems required to supply the immediate demand of the assembly plant (Womack et al., 1991).

The lean production model

In the outline by Oliver et al. (1994) of the 'lean production model', they suggested that its important features are: team-based work organisation; continuous improvement; lean manufacturing operations which include just-in-time inventory systems, problem-solving, and synchronised work processes; high commitment human resource practices; supplier relations; cross-functional development teams; and customer relations.

Team-based work organisation

A high percentage of production workers are organised into teams, which under the management of a team leader, are responsible for a discrete sub-process or specific section of the line. Unlike production workers in a traditional mass production setting, lean teams are responsible for routine preventative maintenance, housekeeping activities, collection of simple statistical data relating to quality and production and performing quality certifications on their output, thus reducing or eliminating the need for specialist staff to support the line (Karlsson and Ahlstrom, 1996).

When a problem occurs on the line, team members have the authority to stop the line and are expected to identify and if possible, rectify the problem themselves (Womack et al., 1991). All workers in the team are required to work together and their performance is evaluated on the basis of team rather than individual outputs (Forza, 1996). The teams have

substantive influence over work allocation and work methods within their work area, but have very little influence over work pace which is determined by the pull system (Pil and MacDuffie, 1999).

Team leaders are considered as members of the shop floor teams, and although they have some managerial responsibilities for immediate production activities, they are expected to assist team members when problems arise and fill in for any absentees (Kenney and Florida, 1995).

Kaizen – continuous improvement

Kaizen, or 'continuous improvement' as it is termed in the West, has been defined as "a company-wide process of focussed and continuous incremental innovation" (Bessant and Francis, 1999). *Kaizen* is based on a belief in people's inherent desire for quality and worth, and should involve everyone in the Organisation from top managers to workers on the shop floor (Burger, 1997). Continuous improvement is process orientated and lasting improvements can only be achieved if innovations are combined with an ongoing effort to maintain and improve standard performance levels.

Lean production in its purest form uses two central mechanisms, suggestion schemes and quality circles, to harness workers' knowledge and ideas to achieve process improvements (Kenney and Florida, 1995).

Suggestion schemes have been described by some researchers as a tool for stimulating innovation and creativity of employees (Carrier, 1998). In large organisations, suggestion schemes offer some form of reward, either monetary or symbolic, to encourage employees to submit suggestions about how work processes could be improved. The suggestions are either given directly to a supervisor or placed in a special suggestion box to be collected on a regular basis, and assessed. Those suggestions that are feasible, likely to save the company money, and enable the company to improve its productivity or employee working conditions, or reduce industrial accidents, are accepted for implementation (Carrier, 1998).

Quality circles are small groups of workers who regularly meet off-line to work together to either solve existing process problems, or to seek process improvements (Kenney and Florida, 1995). Although participation in quality circles is voluntary, contribution to continuous improvement activities is a factor in the remuneration of production workers in a number of ways. For example, improvement activities have the potential to improve team performance, and ultimately organisational performance, both of which are the basis of bonuses received by workers (Pil and MacDuffie, 1999).

Lean manufacturing operations

The Toyota Production System evolved from a determination to eliminate waste, or *muda*, defined as everything that does not add value to the product, from the production system (Karlsson and Ahlstrom, 1996). Lean production attempts to eliminate waste by reducing inventory of work-in-progress and finished product (just-in-time), minimising down-time on the line using preventative maintenance, reducing re-work by identifying and eliminating faults where they occur on the line (quality management aimed at zero defects), by arranging the physical flows of production to reduce material handling between steps in the production process, strict process control and discipline, and by synchronising cycle time across the production process to eliminate under-utilisation or overburdening people and machines (*heijunka*).

Just-in-time inventory systems procure, hold or produce only those materials or components that are immediately required for the next step in the production process. Buffers are dramatically reduced across the factory floor, making production imbalances and other problems highly visible. As each step in the production process is reliant on the previous step to provide their inputs, delivered to the workstation just as they need them, problems must be fixed quickly for production to continue. To be able to achieve high productivity, it is essential that the production process is smooth, and that all parts and products are fault free as they flow throughout the process; in other words, zero defects (Karlsson and Ahlstrom, 1996). This is achieved by implementing strict process control and discipline using precise documentation to ensure each cycle through the process is performed in an identical manner. As and when problems occur, production workers are required to identify the source of the problem and correct the error as it occurs. From a lean production perspective, the most crucial element of any solution selected to address a production problem is to ensure that the problem does not re-occur.

Under lean production all work is highly specified as to content, sequence, timing and outcome (Spear and Bowen, 1999). The specifications designed by Toyota are exact and apply to activities of all employees regardless of their functional speciality and position in the hierarchy. As all workers follow a well-defined sequence of steps for each particular job, it is instantly obvious when they deviate from the standard. The reduction of variability leads to improvements in safety and a reduction in work related injuries, higher quality standards, better inventory control, and makes job rotation easier for workers as there are detailed instructions on how to perform each and every activity on the line (Adler, 1993).

Heijunka addresses two types of waste, *muri* and *mura*. *Muri* translates as overburden or the placing of excessive demands on workers or production equipment, which may reduce

their productive life, and *mura,* the irregular or inconsistent use of a person or machine. *Heijunka* seeks to achieve 'uniform plant loading' where the workload of both operators and production machines are balanced to their capacity or capability, and all of the steps in the production process are synchronised (Hampson, 1999). If all the components of the production system are working at the same pace, work-in-progress inventory can be minimised, and idle time is virtually eliminated.

High commitment human resource practices

Pil and MacDuffie (1999) suggested that, although life-time employment, company-based or enterprise unionism and seniority based wages form the three pillars of Japanese employment, work organisation and skill development are also important features of the Japanese production system, and include team-based production methods, worker participation in problem-solving, job rotation, a small number of job classifications, few distinctions between employees and management, and high levels of training.

In Japan, lifetime employment, a condition won by employees through industrial action is only made available to 'core' employees. Fluctuating demands in production are managed by using part-time, temporary or casual workers, enabling companies to protect the jobs of their core employees from instability in the market. As a result, Japanese companies view core employees as a long-term investment rather than a short-term variable cost, and place considerable emphasis on skill development to ensure the maximum return possible on that investment. The remuneration system, particularly seniority-based wages, often preclude employees from moving from one company to another, as with each move they start again at the bottom.

In the Japanese production systems, production workers can directly affect their level of remuneration as the companies pay bonuses based on individual differences in seniority, skill and contribution to continuous improvement and problem-solving (Pil and MacDuffie, 1999). Workers also receive another component which is related to the team's performance (Hampson, 1999), encouraging team members to work together to improve performance.

A feature of lean production is the extensive use of job rotation. Production workers rotate between tasks within their own team as well as between teams. The objects of job rotation include training workers in multiple tasks, increasing the skills and flexibility of the workforce; reducing boredom or stress for workers by varying tasks and work pace; and educating workers about the entire production process and the potential impact(s) of problems at one work station flowing through the production process (Pil and MacDuffie, 1999, Hampson, 1999, Womack, 1996, Kenney and Florida, 1995).

Employees are carefully selected and socialised during an extensive orientation process, over a period of months (Mestre et al., 1997). Prior work experience is not viewed as a requirement, the emphasis during the recruitment process is on the potential to learn, work values, work ethic and personality (Yang, 1994).

New employee intakes typically occur once a year, and the orientation process consists of new employees rotating through all areas of production, to provide the employees with knowledge of the company, an appreciation of customer requirements, and knowledge of product and technology. By grouping the new employees into teams for the duration of the orientation process, the company attempts to assist the new employees to develop relationships with co-workers and to adopt company values and attitudes (Mestre et al., 1997).

Supplier relations

The common saying, that a chain is only as strong as its weakest link, provides us with an easily understood rationale for the close cooperative ties between lean automobile producers and their suppliers. The relationship between lean producers and suppliers is necessary to ensure smooth production through low cost, high quality, just-in-time deliveries of components. Relationships are viewed as long-term, and lean producers and suppliers share the responsibility for product design and manufacturability.

Close relationships are developed over time using a variety of mechanisms that include reciprocal ownership arrangements, providing training and assistance to suppliers through supplier groups and the intercompany transfer of management and other staff.

Inter-company transfers of staff maintains trust, provides an avenue to share production and organisational knowledge, and fosters communication between assemblers and suppliers (Pil and MacDuffie, 1999).

Cross-functional development teams

Womack et al. (1991) concluded that there were four basic differences in the methods used to design and develop new products employed by mass and lean producers: leadership, teamwork, communication and simultaneous development.

The job of *shusa* or project leader carries a great deal of power over the development process. At the beginning of a development project the *shusa* assembles a small cross-functional team that is assigned to the project team for the life of the project.

The team members, drawn from various functional departments including marketing, product planning, engineering and factory operations, retain their ties to their own

departments but are under the control of the *shusa* during the project. The team members are seen as representative of their functional departments and it is their responsibility to resolve any inter-departmental conflict and to negotiate necessary trade-offs regarding the allocation of resources and departmental priorities.

Customer relations

The relationships with the customer(s) are managed just as carefully as the supplier relationships. Although not common in the West, in Japan the carmaker and the distributor often have reciprocal ownership arrangements, which foster a sense of shared destiny. The distributor is viewed as the direct link between the carmaker and the end consumer, whose knowledge of consumer tastes and demand is captured by including representatives from the distributor on product development teams (Womack et al., 1991). The just-in-time inventory system is extended to the sale and distribution channels, with the manufacturer producing only those cars the distributor has ordered.

Critics of lean production

Womack et al. (1991) suggested that the greatest obstacle in the path of a lean world is the resistance of large mass-production companies like General Motors, Renault, Volkswagen, and Fiat. Although Japanese production methods have been the subject of academic debate for over twenty years, the diffusion of lean production in Western economies has been slow and fraught with difficulties.

The implementation of a new production system involves a significant investment of an organisation's capital and human resources over a very long period of time, with little hope of return on the investment in the short-term. Before an organisation is likely to take this course of action, it first must believe that the change is necessary and that the results will achieve the desired outcomes.

The Machine that Changed the World (Womack et al., 1991) claimed that Japanese automotive manufacturers were more efficient than Western producers in the order of 2:1. While some academics supported the investigation of lean production as a new manufacturing model, a considerable number of academics in the West either attempted to discount the findings of the original study (Williams et al., 1992, Rinehart, 1999), or to qualify the Japanese success in terms of the economic, cultural and social features that they claimed were unique to Japan (Oliver et al., 1996, Ackroyd et al., 1988).

Critics of *The Machine That Changed The World*

Many explanations for the success of Japanese companies in the world market have been put forward, including corporate paternalism, unfair trading practices, relationships between firms and the economic and social structures in Japan (Oliver et al., 1996). Others, such as Williams, Haslam, Williams, Cutler, Adcroft and Johal (1992) have questioned the validity of the study which first brought lean production to prominence. Williams et al. (1992) described lean production as a myth designed to appeal to Western public policy makers, who, rather than embracing lean production, should be regulating the entry of Japanese transplants to protect domestic producers.

In support of these statements, they argued that the study undertaken by the International Motor Vehicle Program (IMVP), from which Womack et al. (1991) drew their data, did not provide corroborating evidence for the crucial assertions in the book, specifically that the performance ratio of 2:1 argued by Womack et al., (1991) is not empirically sustainable. Using their own calculations on the raw data reported in IMVP reports, Williams et al. (1992) argued that although the Japanese companies did out-perform Western mass producers consistently between 1969 and 1988, the ratio as stated by Womack et al. (1991) is a significant overstatement of the performance differential (Williams et al., 1992). A second criticism was that Womack et al. (1991) failed to explain how the Japanese take labour out and control labour costs, which they theorised to be the cause of the performance differential.

In his critique of lean production, Rinehart (1999) made several valid points regarding the robustness of some of the conclusions drawn by the study undertaken by the IMVP. The measure the IMVP used for employee involvement did not address quality, quantity or content of the involvement. Plants were asked what percentages of employees were in teams, but as 'team' was very broadly defined, there was no measure of team design, structure or level of autonomy. The measure of employee training, and job rotation, were similarly criticised - the measure for training focussed on the number of hours rather than the content of training, and the job rotation measure did not take into account complexity of the job, skills demanded or the extent of the rotation (Rinehart, 1999).

In closing, Rinehart (1999) stressed that evidence was accumulating that lean production had failed miserably to live up to its promise, because like it or not, under a lean production model, companies had to be nice to their workers, and American companies being studied were not necessarily nice to their employees.

Critics of lean production – It won't work here

In arguing that Western manufacturers would not be able to emulate the success of the Japanese with lean production, Cusumano (1994) and Katayama and Bennett (1996) both attributed the development and success of lean production in Japan to timing and the uniqueness of the culture in Japan. When the IMVP was conducting its study, the Japanese economy was booming with high domestic demand, a bull stock market and low interest rates, and it was to these factors, rather than the use of lean production techniques, that both authors attributed the Japanese success in international markets. As a result, they argued, it would be very difficult for Western producers to succeed by emulating the Japanese (Cusumano, 1994, Katayama and Bennett, 1996). Cusumano (1994) suggested in closing that changing economic conditions in Japan were now forcing Japanese companies to become more like everyone else in the world, and focus more on profit in the short-term.

In a study of the Mazda assembly plant in Flat Rock, Michigan, Babson (1993) focussed on the failure of the emancipatory potential of lean production to materialise, due in part to the attitudes and beliefs of American workers who view lean as mean, but also due to the adversarial relationship between the organisation and labour unions (Babson, 1993).

The experience of production workers in Japanese transplants in the UK has been one of exploitation and control (Delbridge, 1995), as the adoption of lean production practices had given managers the opportunity to intensify work, increase surveillance, heighten responsibility and accountability and to use peer pressure to control employee behaviour. This conclusion was supported by Danford (1998) who asserted that under lean production, shopfloor employees may end up working harder, with reduced buffers and breaks, and may experience multi-tasking rather than multi-skilling.

In a paper that examined what it was like to work in lean production plants in the US and Canada, Lewchuk and Robertson (1997) found that motor vehicle workers were not empowered, and were subject to increased monitoring. The majority of workers found it difficult to modify their jobs, vary their work pace or leave their workstation. .

Hampson (1999) pointed out that the more resources that are removed from a production system, the more fragile the system becomes, making the contribution of shopfloor workers essential. However, the Westernised version of lean production has been described as management by stress, management by blame and management by fear. Under these conditions (real or perceived), the contribution made by shopfloor workers is unlikely to exceed mere compliance.

Soderquist & Motwani (1999) suggested that the implementation of lean production in several Western organisations resulted in 'mean' rather than 'lean', and was characterised by

the elimination of jobs, diverting revenues from customers and extracting profits from suppliers.

Bamber & Dale (2000) suggested that implementation of lean production in a traditional manufacturing environment requires a change in attitudes and behaviour for managers and employees alike. Managers must view shop-floor employees as intelligent, willing and able to be involved in continuous improvement and problem-solving, and the employees must respond by demonstrating initiative and commitment. However, the study found that one of the main causes of failure to successfully implement lean production was the threat of redundancy, where employees feared that by contributing to the lean production processes, they would improve themselves right out of a job..

Proponents of lean production – it will work anywhere

Krafcik (1988), one of the researchers who worked on the original IMVP study, stated that several U.S. plants following a lean production policy had been able to achieve similar performance levels to some Japanese plants, as lean plants are more capable of simultaneously achieving high levels of productivity, quality and mix complexity. Although the adoption of lean production policies is a high-risk strategy, Krafcik (1988) suggested that the risk can largely be neutralised by developing a well-trained, flexible workforce, product design that emphasises ease of manufacture and a supportive, high-performance supplier base.

In 1991, using a research design which closely followed the IMVP study, Oliver, Delbridge, Jones and Lowe conducted a study into the performance and management practices of eighteen auto components plants - nine in the U.K. and nine in Japan (Oliver et al., 1994). The findings of the study replicated some but not all of the findings of the IMVP. Firstly, the study indicated that it is possible for organisations to perform at high levels according to a range of performance measures. This finding contradicted the prevailing assumption of manufacturers that a strategy design to improve quality will necessarily increase costs. Secondly, the performance differential between Japanese and European auto components manufacturers mirrored the 2:1 differential Womack et al. (1991) reported for car assemblers. Finally, although most of the theorised cause and effect relationships in the lean production model were found to be in the expected direction, none other than process discipline and control was statistically significant (Oliver et al., 1994).

A follow-up study by Oliver, Delbridge and Lowe, which commenced in 1994, investigated 71 plants in Germany, Italy, France, Spain, Japan, Mexico, the U.S. and the U.K. Although the highest concentration of world-class plants (defined in terms of simultaneous high performance on the main measures of total factor productivity and quality) was found in

Japan, the study identified some plants in the U.S., France and Spain that were also world-class.

Oliver et al. (1994) concluded that lean production principles only partially explain high performance since process discipline and control, rather than the softer aspects of lean production, such as team-working and operator responsibility, appeared to have a clear link with performance.

In a comparison of the work practices and performance of Japanese plants against Japanese owned transplants and Big Three plants in the U.S., Pil and MacDuffie (1999) found that, although there were no statistical differences between the (quality) performance of the transplants and the Japanese plants, the performance of the U.S. owned plants (in terms of quality and total factor productivity) was considerably worse.

Kenney & Florida (1995) concluded that Japanese management systems (lean production) have been transferred to and are operating in the U.S. successfully, although they caution that lean production will work in the U.S., it is by no means natural and requires active effort to resist the prevailing environment and attitudes to complete the transfer successfully (Kenney and Florida, 1995).

The Western experience with lean production

The preceding discussion of lean production and experiences of organisations adopting the approach in the West presents two diametrically opposed viewpoints. One is that lean production is applicable universally (albeit with some modification) and the way of the future, the other is the opposing view that lean production will not and cannot work outside of Japan.

Non-transplant studies

In a study that compared empowerment in lean plants and traditionally organised plants in Canada and the U.S.A., Lewchuk and Robertson (1997) concluded that there was little evidence that lean production empowered workers, and that although company documents paid lip service to empowerment the true focus of the implementation efforts was process control. The study investigated the lean production implementation efforts of CAMI, a joint venture of General Motors and Suzuki, Chrysler Mini-van plant, a General Motors plant and a Ford plant. Of these four plants Lewchuk and Robertson (1997) suggested that CAMI and General Motors are the furthest along in implementing lean production. None of

the plants had adopted the human resource policies associated with lean production in Japan; there are no age- or merit-based pay systems, or profit sharing or bonus schemes; job rotation is only found at CAMI; and teams were not very common. Lewchuk and Robertson (1997) argue against other researchers, such as Pil & MacDuffie (1999), who suggest that the absence of these human resource policies means these plants are not really lean. They suggested that Oliver et al. (1994) have provided sufficient evidence to conclude that it is strict process control and discipline that 'makes a plant lean' rather than human resource policies.

In an analysis of operations management literature, Forza (1996) attempted to develop a reference framework for the study of work organisation and lean production practices. Lean production processes identified by Forza (1996, p. 50 - 51) included: rolling production plans, detail schedule adherence, equipment layout, design for manufacture, links with customers for quality, process control, links with suppliers for quality, maintenance, functional integration and coordination of decision-making, and reduction of set up times. Work organisation practices in lean production included: a commitment to continuous quality improvement, small problem-solving teams, employee suggestions (realisation and feedback), supervisors who encourage teamwork, interactions between management, technicians, supervisors and workers, feedback about quality performance, decentralisation of authority, worker autonomy, multifunctional employees, worker responsibility for statistical process control, worker responsibility for preventative maintenance, and the documentation on production procedures.

The conclusions drawn from the empirical data collected to test the framework were that lean production plants seemed to: make more use of teams for problem-solving; take employee suggestions more seriously; rely more heavily on quality feedback; document production procedures more carefully; and to have employees perform a greater variety of tasks. However, hierarchy, encouragement of teamwork, the integration between management, engineers and workers, decentralisation of authority and worker autonomy, were not differentiating characteristics of lean production.

What about transplants?

A significant number of studies investigating Japanese transplants argue that, although some organisations have experienced difficulty achieving the expected outcomes, others have not only succeeded in terms of productivity and quality but also have engaged the interest and cooperation of their employees.

Kenney and Florida (1995) suggested that the transfer of Japanese management style is far more complicated than has been assumed. While Japanese automotive manufacturers

have made a great effort to transfer the Japanese management style, Kenney and Florida (1995) suggested that the process has been complicated by the fact that some of the plants are joint ventures with U.S. companies hampered by existing adversarial employee relations and a prior commitment to the Taylorist management system with U.S management staff often attempting to re-establish class lines characterised by the old hierarchy.

Despite the view that teams play a less important role in North America (Lewchuk and Robertson, 1997), all of the transplants included in the study viewed 'teams' as the most fundamental building block of the Japanese production system. Production teams meet regularly to discuss production improvements and to redesign tasks.

Team leaders are members of the shop-floor work-groups rather than off-line supervisors, although they do have managerial responsibility for immediate production activities. Workers are encouraged to use initiative through the (admittedly limited) delegation of authority and responsibility to shop floor workers, with work teams often designing and developing standardised task descriptions themselves. All of the transplants rotate production workers, use the minimum number of job classifications possible, and remove or limit the status barriers between different types of workers. Suggestion schemes and quality circles are used to harness workers' knowledge and ideas. Whether the transplants are unionised or non-unionised, they all have made a commitment to their employees to guarantee job security by restricting layoffs, in return for employee commitment to the organisation (Kenney and Florida, 1995).

Kenney and Florida (1995) found that although shop floor workers have experienced very few problems adapting to the Japanese management practices, middle managers were having great difficulty in accepting the system, which generally involves taking orders from foreign nationals, and taking on a role which requires them to support and assist rather than control shop floor workers.

Pil and MacDuffie (1999) offered insights into how lean production practices associated with superior performance can be implemented outside of Japan. The transplants had undertaken extensive transfer of the operating practices and principles of lean production, albeit with some adaptation, necessary to cater to the external environment. For example, the compensation system and the responsibilities assigned to teams more closely resembled those of Big Three plants than plants in Japan, and the transplants had less automated assembly equipment that their parent companies.

Organisational characteristics of transplants in the study, which differed from the Big Three, included: employment security expressed in formal agreements at unionised plants, and pledged by management at non-union plants; extensive use of work teams, but with less influence over performance evaluations and settlement of grievances or complaints than in

Japanese plants; a moderate level of employee suggestions with a relatively high implementation rate; very selective recruitment based on a willingness to work in teams and learn new skills; higher levels of training for experienced workers; minimal status differentials; few first tier suppliers; low inventory levels; and no inspection of incoming parts.

Despite the concessions made by the transplants to the environment in which they operate, Pil and MacDuffie (1999) found that overall productivity levels at the transplants were quite close to the productivity levels found in Japan, and in terms of quality, there was no statistical difference between the performance of the transplants and their Japanese counterparts.

Lean production in Australia – has it worked here?

The results of a study by Sohal and Eggleston (1994) indicated that lean production had been adopted or was being implemented by a large majority of Australian manufacturers, and suggested that it was perhaps inevitable that Australian companies would adopt lean production as a working philosophy if they were to survive.

In an empirical study designed to investigate the uptake of continuous improvement strategies in Australian manufacturing, Chapman and Hyland (1997) found that, where continuous improvement was being implemented, it was generally linked to quality improvement and cost reduction strategies, and although employee involvement is widely recognised in the literature as a critical factor in continuous improvement, many organisations struggle with the concept.

Sohal (1996) found that the major difficulties experienced during the implementation of lean production principles at Trico Australia involved the attitudes and expectations of shopfloor workers. The management had to convince operators that, just because they had done things the same way for the past twenty years, it was not necessarily the best or only way. The organisation also faced the issue of maintaining discipline on the floor while addressing the fears of operators as the changes began to take place.

Sohal (1996) attributed the Trico's success to a committed management team, competitive pressure arising from changing customer requirements, effective communication and collaboration and the provision of adequate training for all employees.

While the studies reported in this section are limited in their scope, they suggest that it is possible for Western manufacturers to implement lean production successfully provided the implementation effort acknowledges and adequately addresses the concerns and reactions of the employees.

So what is the problem?

From a review of the literature, is seems as though there are as many versions or interpretations of lean production as there are lean producers, which prompts the question when discussing lean production as to whether participants in the discussion are really talking about the same concept(s).

Conceptual confusion

There appears to be a tendency by researchers and practitioners to assume that all Japanese owned transplants or joint ventures are equally skilled at operating the Toyota production system and are therefore 'lean'. However this is not necessarily the case. To ensure the anonymity of the participants in the IMVP study, the data were presented in an aggregated form for each country (Williams et al., 1992). Although the aggregated data indicated that Japanese participants outperformed Western producers, as Williams et al. (1992) pointed out, some but not all Japanese producers were performing at world-class levels. One possible explanation for the performance differentials described in the literature may be the relative skill levels of each of the parent companies.

Another possible explanation may be that the terms used in describing 'lean production' can mean different things to different people, and as a result the interpretation and definition of the lean production model may lead to conceptual confusion.

One example highlighted in the literature is the concept of teams and team working. The way in which a Western manager interprets the term 'team' may be significantly different to the 'teams' envisioned by Japanese manufacturers (Danford, 1998).

Western managers have often interpreted standardised work routines as a tool to limit and control the actions of shop floor workers (Jones, 2000, Oliver et al., 1996b, Delbridge, 1995, Lewchuk and Robertson, 1997). However, the Japanese production model views them as a mechanism for the transfer of best practice from one work station, employee or line to another. Standardisation is also a pre-condition for achieving process improvements, as one cannot identify the source of a problem or suggest improvements in a process that one does not fully understand (Adler & Cole, 1993, p. 92). By focussing on standard operating procedures, a number of researchers have suggested that worker empowerment is little more than a myth in a lean production setting (Lewchuk and Robertson, 1997, Landsbergis et al., 1999, Delbridge, 1995). Lean production does require each operator to follow the same

sequence through a task each and every time, and this sequence cannot be changed on an *ad hoc* basis. However, in many cases, the employee who performs the task has had considerable input into the original task design (Pil and MacDuffie, 1999), and has the opportunity to suggest amendments or improvements to the procedures via team meetings, by submitting a suggestion, or by participation in a quality circle or a cross-functional problem-solving or development team.

There also appears to be considerable confusion regarding the role of management in lean production. In the Toyota production system, managers are viewed as functional specialists and experts (that is, as resources) who are to be made available to support, coach and mentor, rather than control, the production employees (Spear and Bowen, 1999). Often this is not how other managers view themselves. Kenney & Florida (1995) found middle management attitudes to and prejudices about shop floor workers could be a serious problem. Bamber and Dale (2000) reported that many of the organisations experiencing problems with the implementation of lean production had managers who viewed workers as a problem that needed to be fixed or controlled rather than as partners in the production process and, as a result, the process of implementing and managing lean production was modified to enable managers to maintain or regain control.

Incomplete or incompetent implementation

Hackman and Wageman (1995) suggested that 'learning and continuous improvement' is one of the four principles of Total Quality Management (TQM) and attributed TQM failures to either incomplete or incompetent implementation (or the failure to correct anti-learning habits). Perhaps the performance differential is a function of the scope and content of an organisation's lean production practices. A number of studies have suggested that Western managers are not implementing the lean production model in its entirety, but selecting those components that are more visible or easier to implement (Oliver et al., 1994, Dervitsiotis, 2001, Krafcik, 1988, Kenney and Florida, 1995, Hill, 1991, Lewis, 2000). As Dervitsiotis (2001) pointed out, often the properties of the whole cannot be derived from the parts, and it is possible that one of the reasons that organisations using all or most of the components of the lean production model have been able to demonstrate world-class performance is due more to the interaction between the components, rather than the implementation of any of the components themselves. One example may be the removal of status barriers, which of itself would have little or no impact on productivity in a manufacturing environment. However, if the removal of the barriers is associated with a move to a more egalitarian attitude on the part of the organisation, where each employee,

regardless of position or level of compensation, is respected and valued for the contribution they make to the production process, shop floor employees may be more prepared to fully participate and contribute, resulting in productivity and quality improvements sought by the organisation.

The missing element – employee involvement in learning

One critical issue raised in the literature relates to the difficulty that a number of organisations have in gaining the acceptance and cooperation of shopfloor employees. Acceptance of change and employee involvement does not happen by itself, and requires the organisation to put in place policies and practices that encourage employees to interact with each other and across departmental boundaries to participate fully in the change process. However, although the literature about lean production, continuous improvement and total quality management stresses employee involvement as an essential component, very rarely does it provide any information on how an organisation would go about engaging their employees in the process.

According to Krafcik (1988), a 'true' lean manufacturer encourages the full development and integration of existing technology, policies and human resources and this requires a change in attitude and behaviour for managers and employees alike (Forza, 1996, Bamber and Dale, 2000). Employee involvement in a lean production plant manifests itself through the commitment of each worker to continuous improvement (Forza, 1996), which, to be successful, requires the organisation to make a conscious effort to manage and accelerate the learning curve by involving as many employees as possible (Lewis, 2000, Lillrank et al., 2001).

Adler and Cole (1993) put forward the argument that lean production does not take organisational learning as a given. However, they argue that to be successful, lean production requires managers to consciously work to create an environment that encourages learning by employees. Continuous improvement presupposes a learning environment as employees are required to constantly seek opportunities to improve processes. However, learning is not usually given much more than a brief mention, if it is mentioned at all, by authors providing a description or critique of the lean production model (Cusumano, 1988, Oliver et al., 1996, Womack et al., 1991). And yet, the basic premise of lean production is continuous or incremental improvement of processes and the identification and elimination of waste using a problem-solving methodology. Production workers and white-collar staff are organised into teams and provided with the tools and training to enable them to contribute to the process of operating as a lean manufacturer (Adler, 1993, Adler and Cole, 1993).

The new frontier: the learning factory

McAdam, Leitch and Harrison (1998) noted that, while the underlying assumptions and definitions of total quality (quality being a component lean production) and the learning organisation are different, recently there has been a convergence of the two notions. They suggested that this convergence offers opportunities for both organisations and employees by satisfying the need for increased synergy in response to business pressures and also to the demands of employees for greater emancipation.

Based on a study of Chaparral Steel in Midlothian, Texas, Leonard-Barton (1992) argued that operating factories as 'learning laboratories' would be the next production frontier. Leonard-Barton (1992, p. 23) defined a learning laboratory as follows:

> *. . .a learning laboratory is an organization dedicated to knowledge creation, collection and control. Contribution to knowledge is a key criterion for all activities, albeit not the only one. In a learning laboratory, tremendous amounts of knowledge and skill are embedded in physical equipment and processes and embodied in people. More important, however, are the non-technical aspects, the managerial practices and underlying values that constantly renew and support the knowledge bases.*

In Leonard-Barton's (1992) view, the distinguishing activities of a learning laboratory include: problem-solving in current operations, internal knowledge integration across functions and projects, innovation and experimentation to build for the future, openness to and integration of external information flows, independent problem-solving, experimentation and positive risk taking, egalitarianism and respect for the individual, supportive managerial system (for example, performance rewards, hiring practices and career paths), apprenticeships and education, and resources for alliances and networks (Leonard-Barton, 1992).

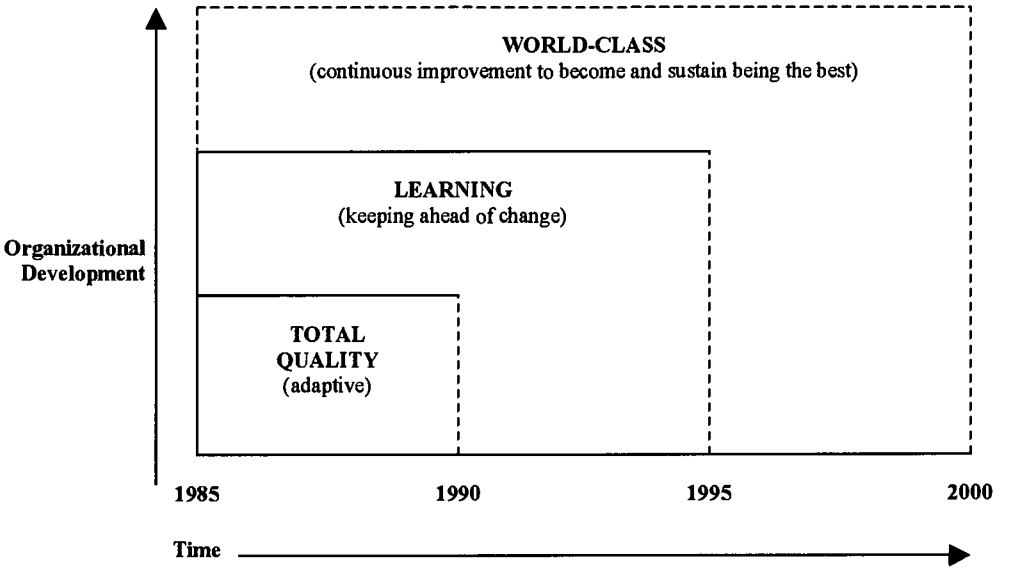
In 1995, Nonaka & Takeuchi introduced the idea of a 'learning factory', which has innovation as its central motif. The learning factory generates, codifies and applies knowledge to improve its products and technologies, and achieves continuous improvement through problem-solving knowledge workers for whom the expenditure of 'mental' rather than manual labour is central to their role. Benefits are derived from improvement derived from external sources of information and the learning factory is embedded in an innovation network of collaborators with whom there is information exchange and shared learning

Hodgett, Luthans and Lee (1994) suggested that organisational design has entered a new paradigm with new boundaries and new ways of behaving. They suggest that this new paradigm supersedes the old, in which the organisation had to accept higher costs if it was to drive quality up, long production runs were the only way to minimise costs, the top-down

approach to strategy formulation and planning was a key and increased productivity was best achieved by reducing the time in sequential work-flow tasks. The old rules are being replaced by new rules as organisations attempt to stay ahead of the competition through adaptation, keeping up with change and finally through continuous improvement and innovation.

The new paradigm has evolved over time (see Figure 1). The process of evolution began with organisations implementing a total quality philosophy, which Hodgett et al. (1994) describe as an organisational strategy that drives an ongoing, continuous process that requires radical changes in organisational design and day-to-day operations to enable the organisation to adapt or respond to changes in the environment.

Figure 1: The evolution of new paradigm organisations



(Hodgett, Luthans & Lee, 1994, p. 10)

The next phase was the introduction of organisational learning, as organisations attempted to implement the learning organisation model, thus enabling organisations to anticipate and plan for change rather than merely reacting to it. Hodgett et al. (1994) suggested that world-class organisations are those that have gone beyond the learning organisation stage to become organisations that are innovative and are recognised as the best in their fields, or better than their competitors around the world in several strategically important areas.

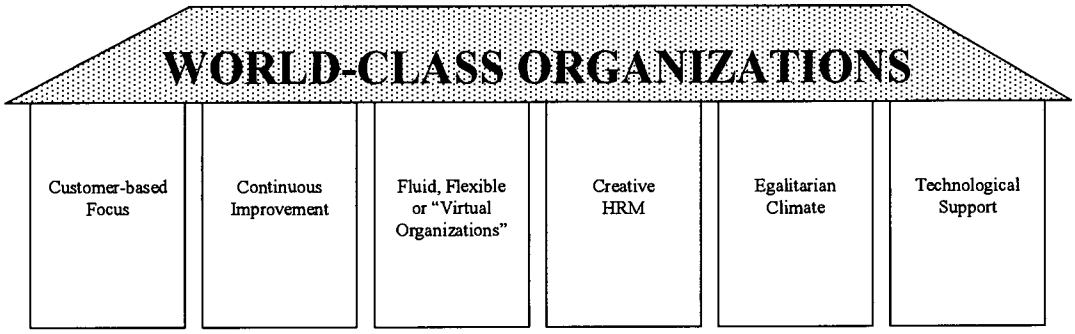
Hodgett et al. (1994, p. 14) proposed that world-class organisations would:

> . . . *include both the total quality and learning organizational characteristics and more. To become world-class, an organization must excel in most of the dimensions that are important in both total quality and learning organizations.*

These authors pointed out that, while many organisations are exceptional in one or more areas of performance, world-class manufacturing, world-class quality management or world-class purchasing systems do not necessarily make the whole organisation world-class.

To become world-class, organisations need to develop the six major pillars that are necessary to support world-class stature (see Figure 2). The six pillars are: customer-based focus; continuous improvement; fluid, flexible or virtual organisations; creative human resource management practices; an egalitarian climate and technological support.

Figure 2: The major pillars of world-class organisations



(Hodgett, Luthans & Lee, 1994, p. 13)

Customer-based focus includes a shared vision for customer service; a shared ownership of the customer service tasks and solutions; organisational structure, processes and jobs designed to serve the customer; empowered teams for generating new ideas and approaches to improve customer service; information systems designed to monitor and predict the changing needs of the customer; management systems that ensure prompt translation of the customers' requirements to organisational actions; and compensation systems designed to reward employees for excellent service to customers.

Continuous improvement on a global scale includes rapid improvement prototyping; benchmarking / best-in-class; business process reengineering; empowerment for employees; corporate strategies for knowledge asset expansion; outsourcing, rightsizing; and innovation-based reward systems for employees.

Fluid, flexible or virtual organisation includes modular organisation; matrix organisation; multi-functional teams; simultaneous processing of ideas; multiple skilled workers; empowered teams; cross-training; job rotation; and innovative approaches to cycle time reduction.

Creative human resource management includes shared ownership of problems and solutions; entrepreneurship; constant training; experimentation, and failure-based promotion;

employee involvement/suggestion schemes; multi-functional teams; empowered teams; effective recognition/reward systems; and gain sharing.

An egalitarian climate consists of shared vision/information; holistic view of employees; open communication; business ethics, community citizenship; environment-friendly systems; mentoring, coaching and a buddy system; employee involvement/participation; and sponsored community, wellness and family programs.

Technological support includes modern information/telecommunications systems; technology-human interface; distributed information/database systems; shared ownership of information; pushing decision-making down to the lowest level possible; and continuous technical training.

The learning organisation

During the 1990s, as many organisations were facing rapid change in the market-place and the effects of globalisation, there was a growing awareness of the potential improvements an organisation could achieve in terms of flexibility and responsiveness, by harvesting the skills, experience and learning of organisational members (West, 1994, Leitch et al., 1996, Pedler, 1995, Gardiner and Whiting, 1997). As a result there was a surge of interest in the concept of the learning organisation.

Pedler, Burgoyne and Boydell (1991, p. 1) have defined the learning organisation as "an organisation that facilitates the learning of all its members and continuously transforms itself".

While it is generally acknowledged that all organisations learn, unless the learning is managed there is a risk that the learning may result in counter-productive or disruptive behaviours Levitt & March, 1988; West, 1994); for example, if reporting errors or mistakes results in the employee being censored, the resultant learning may be that mistakes should be covered up. The basic assumptions of the learning organisation model are that learning can be of value to the organisation and that the quality and quantity of learning can be increased if they are managed deliberately rather than being left to chance (Gephart, Marsick, Van Buren & Spiro, 1996; West, 1994)..

Garvin (1993) suggests that a learning organisation is an organisation that is good at facilitating and managing organisational learning by engaging in systematic problem-solving and experimentation with new approaches, learning from its own experience and past history, and learning from the experiences and best practices of others.

Gephart et al. (1996, p. 38) suggested that the essential features of a learning organisation include: continuous learning at the systems level; knowledge generation and

sharing; critical, systematic thinking; a culture of learning; and a spirit of flexibility and experimentation. In their view, the learning organisation is a set of inter-related systems (organisational structures, processes and systems) that facilitate learning. Leadership and management provide critical support for the learning and development of employees at all levels of the organisation. An organisational culture of openness and trust supports and rewards learning by promoting inquiry, dialogue, risk-taking and experimentation without assigning blame. The communication and knowledge systems facilitate the creation, transfer and retention of new knowledge. A learning organisation has a structure that facilitates work and learning across internal and external boundaries. Performance support and measurement systems provide indicators of the organisation's progress, track the development and contribution of individuals, identify areas for improvement and provide rewards that promote learning (Gephart et al., 1996).

Garavan, Gunnigle and Morley (2000) adopt Burgoyne's (1992) definition of a learning organisation, that it "continually transforms itself in a process reciprocally linked to the development of all its members".

They suggest that it is clear from the literature that a learning organisation has a core set of strategic building blocks, which include: clarity of mission and vision; shared leadership and involvement; a culture that encourages experimentation; an ability to transfer knowledge across organisational boundaries; the facilitation of teamwork and cooperation; strong support and foundations in terms of appropriate organisational designs; and a foundation of employee skills and competencies.

In Hill's (1996) view, learning organisations: are customer focussed; have a high proportion of people who enjoy well-honed self-development and learning-to-learn skills; continually question and challenge the norm; are creative, prepared to experiment and are action-orientated; allow people to make mistakes without apportioning blame; use detection and correction activities as a learning experience and as a mechanism to transform their accepted values and practices; have a vision of how they want to be, communicate that vision effectively to their people and then work towards a common and shared purpose; have built learning opportunities for all into their strategies; provide and sustain total environments (in terms of culture, recognition and conditions) that positively encourage their people to seek learning and self-development opportunities; seek ways of transferring and encoding the individual learning of their people into a cohesive and beneficial whole; and communicate freely and openly with their customers, their suppliers and all other stakeholders and frequently their competitors.

Drawing on the literature presented above, then, we might summarise by saying that learning organisations: engage in systematic problem-solving and experimentation with new

approaches; learn from their own experience and past history; learn from the experiences and best practices of others; continuously learn at the systems level; generate and share knowledge; have a customer focus; continually question and challenge the norm; are action-orientated, creative and prepared to experiment; allow people to make mistakes without apportioning blame; use detection and correction activities as a learning experience and as a mechanism to transform their accepted values and practices; and communicate freely and openly with their customers, their suppliers and all other stakeholders.

The supporting characteristics or features of the learning organisation include: clarity of mission and vision; shared leadership and involvement; an organisational culture of openness and trust; communication and knowledge systems; a supportive organisational structure; performance support and measurement systems; the foundation of employee skills and competencies and teamwork and cooperation

It is interesting to note that most of the studies mentioned above tend to focus on the characteristics or action imperatives of the learning organisation while paying scant attention to the contribution of the individuals who are actually involved in the learning process. As Confessore and Kops (1998, p. 366) noted, the learning organisation is "an environment in which organisational learning is structured so that teamwork, collaboration, creativity and knowledge processes have a collective meaning and value". As with the implementation of lean production, it may well be that the contextual or structural elements of the learning organisation are easier to implement and manage than the softer 'people' issues or elements.

Armstrong (2000, p. 359) pointed out that the view of the learning organisation as a people-friendly model is not universally shared, suggesting that if an organisation attempts to implement the learning organisation model without taking into account the development, values and spiritual beliefs of the organisational members, the learning organisation becomes:

> ... *naught but a Hawthorne light bulb with a dimmer switch, intended to stimulate productivity regardless of its chameleonic brilliance. It is a Machiavellian subterfuge. It is a pimp, and the employees, the hapless prostitutes.*

Not unlike lean production, the learning organisation has the potential to be exploitative if the cultural or human elements of the implementation effort involve more rhetoric than substance.

Are lean production and the learning organisation compatible?

As indicated by Table 1, there are parallels for each of the lean production characteristics in the learning organisations model, except for JIT inventory systems, process

control and discipline and synchronised work processes, and often it is these components of the lean production model which are cited as the features of the model which cause lean to be 'mean' (Babson, 1993, Delbridge, 1995, Lewchuk and Robertson, 1997).

Table 1: A comparison of the learning organisation and lean production

Characteristics of the Lean Production	**Corresponding Characteristics of the Learning Organisation**[1]
Team-based work organisation	The facilitation of team-work and cooperation
Continuous improvement and problem-solving	Systematic problem-solving Experimenting with new approaches Learning from their own experiences and past history Learning from the experiences and best practices of others Continuously learn at the systems level Generate and share knowledge Continually question and challenge the norm Use detection and correction activities as a learning experience and as a mechanism to transform their accepted values and practices
Employee involvement programs o Quality circles o Suggestion schemes	Experimenting with new approaches Learning from their own experiences and past history Action-orientated, creative and prepared to experiment
Just-in-time inventory systems	
Process control and discipline	Performance support and measurement systems
Synchronised work processes	
High commitment human resource practices	A foundation of employee skills and competencies
Supplier relations	Extension of the learning culture to include suppliers and other significant stakeholders
Cross-functional development teams	The facilitation of team-work and cooperation Experimenting with new approaches Learning from their own experiences and past history Learning from the experiences and best practices of others Ability to transfer knowledge across organisational boundaries
Customer relations	Extension of the learning culture to include customers and other significant stakeholders

However, while it is true that JIT reduces or eliminates buffers between work stations, synchronised work processes force employees to maintain a constant rate of production to ensure a smooth flow throughout the production process, and process control and discipline on the shop floor force employees to perform each task in exactly the same way every time, one of the underlying principles of lean production is *heijunka*, which seeks to balance the

[1] Garavan, Gunnigle & Morley (2000); Garvin, (1993); Pedler, Boydell &Burgoyne, J. (1989).

workload of machines and workers to their capacity or capability. Thus, in a 'true' lean producer, no units of production, neither men nor machines, are overburdened by excessive demands. Work processes may be highly structured with no tolerance for variation, but lean producers do build slack into their organisation to enable workers to participate in the learning process: it just occurs off-line so as not to interrupt or interfere with the production process. While there are direct parallels for all of the activities or actions of the learning organisation in the lean production model, the supporting characteristics of the learning organisation (clarity of mission and vision, shared leadership and involvement, an organisational culture of openness and trust, communication and knowledge systems, organisational structure, and technical support) do not appear to directly correspond with any of the components of the lean production model.

However, it could be argued that without these characteristics a lean producer would be unlikely to achieve the desired productivity improvements. The mission and vision are closely related to the organisation's sense of identity and purpose or "who we are, what we do, and where we are headed" (Thompson & Strickland, 1995, p. 4) and as such, should guide the decisions and actions of organisational members.

Leadership, which is defined by Kreitner and Kinicki (1995, p. 428) as "a social influence process in which the leader seeks the voluntary participation of subordinates in an effort to reach organizational objectives", is often assumed to be the role of managers in organisational settings. However, based on that definition, not all leaders are managers, and not all managers are leaders. Leadership is not just about position in the organisational hierarchy, or wielding power and authority, and describes many of the behaviours and aptitudes valued by lean producers. New employees are selected not for their existing skills but for their potential to learn and to work collaboratively, and although promotion is partially based on seniority, the suitability of the employee seeking promotion is also assessed on their contribution to the improvement process and their ability to coach, mentor, lead and encourage fellow workers.

Although employee involvement and learning by individuals, teams and the organisation as a whole appear to be essential in both the lean production and the learning factory models, in most cases, the research literature on lean production and the learning organisation fails to clearly articulate the importance of engaging employees' support and ongoing involvement in the process, much less how an organisation might go about it.

Summary

This chapter commenced with a comprehensive review of the history and development of lean production in an attempt to gain a better understanding of how and why the various

components were introduced to the model. This is followed by a discussion of how each of these components has been interpreted and implemented by Western manufacturers. Although lean production does, and will in all probability, continue to have its critics, the fact remains that lean production has been implemented with varying degrees of success in a large number of manufacturers outside of Japan, and as the global market becomes more and more competitive this is a trend which is likely to continue.

The competitive pressure experienced by manufacturers in the automotive industry has also prompted the emergence of the 'learning factory' concept, which has been described as a new paradigm. This 'learning factory' or 'world-class performance' paradigm has evolved from a focus on TQM and lean production in the late 1980's, learning and the learning organisation in the early 1990's to world-class performance in the late 1990's and early 2000's. In this context levels of 'world-class performance' can be achieved by developing into an organisation that includes both lean production and learning organisational characteristics.

The literature reviewed in this chapter does appear to support some of the claims of those proposing the emergence of this new paradigm, at least to the extent that it is possible for the two models to co-exist in a single organisation, thus creating the potential to radically improve the 'bottom line', even if they are not considered to be entirely compatible. Interestingly, one of the most contentious points within the research literature involves the claim by their proponents that each of these models, lean production, the learning organisation and the learning factory, offer a kind of emancipation or empowerment for lower level workers, thus enriching the working lives of employees, improving job satisfaction, worker morale and productivity. The arguments are particularly interesting when you consider that the models provide very little in the way of any guidance as to managing the human aspects of implementation.

If a more comprehensive model of the learning factory is to be developed, the gaps or omissions in the learning factory model need to be investigated and if and where appropriate, incorporated into the model. The next chapter will address these issues by investigating the research literature on organisational learning, employee involvement, participation and empowerment, motivation, trust and organisational culture and climate.

Chapter 3

The human aspects of the learning factory

The proponents of the Toyota Production System have made claims that the introduction of lean production has the potential not only to significantly improve performance in terms of productivity and quality, but also to provide employees with the opportunity for more enriched and meaningful work in a collaborative, secure and virtually egalitarian environment. Evidence has also been collected to support the opposing view, that lean production is 'mean' and will not work in Western cultures. Both sides of the debate put forward convincing arguments, largely based on case studies of Japanese-owned and Western transplants in Australia, Europe, the USA and Canada. One of the questions posed in the previous chapter was: is either position correct? The tentative answer to that question is that both are probably correct. A review of the literature, both pro and anti lean production, seems to suggest that although lean production does have the potential to meet or exceed the claims made by some researchers, there is also the potential to be 'mean' if the implementation process is handled poorly and fails to secure the commitment and cooperation of the workforce.

If, as suggested by the previous chapter, a 'true' lean manufacturer encourages the full development and integration of existing technology, policies and human resources and requires the organisation to make a conscious effort to manage and accelerate the learning curve by involving as many employees as possible (Lewis, 2000, Lillrank et al., 2001), then employee involvement and learning in organisations must necessarily be important, if often over-looked, components of lean production.

This chapter commences with a discussion of what learning is and how it occurs in organisations. This is followed by an examination of what researchers mean by employee involvement or empowerment in an organisational setting, and why employees would want to participate in an improvement process. The last section investigates the factors that the literature suggests may facilitate or encourage employees to become involved, such as motivation, organisational culture and climate and trust in organisations.

Learning in and by organisations

Although organisational learning has been studied for a considerable period of time, there is still much debate as to the most appropriate definition of the concept (Dodgson, 1993,

Easterby-Smith, 1997, Garvin, 1993, Tsang, 1997). Perhaps this is not surprising when one considers the diversity of the disciplines studying the concept, which include Economics, Education, Psychology, Organisational Development, Management Science, Sociology, Organisational Theory, Strategy or Strategic Management, Production Management and Cultural Anthropology (Easterby-Smith, 1997).

Organisational learning is often defined as a process. Huysman (2000) suggested that organisational learning is the process through which an organisation constructs knowledge or reconstructs knowledge. Edmondson and Moingeon (1996, p. 12) proposed the following definition:

> *Organisational learning is the process in which an organisation's members actively use data to guide behaviour in a way as to promote the ongoing adaptation of the organisation.*

Although researchers have been known to use phrases such as team learning (Edmondson, 1996a, Edmondson, 1999, Kasl et al., 1997) and organisational learning (DiBella et al., 1996, Edmondson and Moingeon, 1996, Nicolini and Meznar, 1995, Shrivastava, 1983), there is considerable debate in the literature about where the learning actually occurs. As Argyris and Schon (1978, p.9) point out, researchers in the area of organisational learning face a dilemma:

> *There is something paradoxical here. Organizations are not merely collections of individuals, yet there are no organizations without such collections. Similarly, organizational learning is not merely individual learning, yet organizations learn only through the experience and actions of individuals. What, then, are we to make of organizational learning?*

In tackling this issue, some researchers argue that the process of learning essentially occurs within the individual members of the team or organisation (Simon, 1991), on the basis that organisations do not have the necessary physiology to learn by the same mechanisms as a human.

> *What organisations do when they learn is necessarily different from what individuals do when they learn. Specifically, we believe that organisational learning is not essentially a cognitive activity, because at the very least, organisations lack the typical wherewithal for undertaking cognition.*
>
> (Cook & Yanow, 1993, p. 378)

Luthans, Rubach and Marsnik (1995) also suggested that organisational learning poses a dilemma. If organisations are more than a mere collection of individuals, organisational learning cannot merely be the sum of individual learning, but as organisations cannot learn independently of the individuals that compose the organisation, organisational learning must be based on individual learning.

This argument is clearly supported by Kim (1993, p. 37).

> *The importance of individual learning for organizational learning is at once obvious and subtle – obvious because all organizations are composed of individuals; subtle because organizations can learn independent of any specific individual but not independent of all individuals.*

Others however argue that an organisation is an entity or a living being in much the same way as nations, work teams or people, and can learn in its own right (Huber, 1998) by constructing and institutionalising knowledge (Huysman, 2000).

Yet other researchers take the position that learning within organisations arises from both individuals and organisations (Popper and Lipshitz, 2000, Ulrich et al., 1993). Individual learning occurs as the people within the organisation acquire tacit knowledge about their environment and organisational learning occurs when the learning is embedded into the systems and culture of the organisation, and thus becomes available to other organisational members (Ulrich et al., 1993).

Popper and Lipshitz (2000) suggested that treating organisations as if they were human beings results in conceptual confusion, as there are two distinct concepts or points of view within the field of organisational learning - 'learning in organisations' and 'learning by organisations'. If organisational learning is conceived as learning in organisations, the question then becomes: How does the learning of individuals become organisational? Alternatively, if organisational learning is conceived as learning by organisations, we have the problem of determining what organisational learning is and how it occurs (Popper and Lipshitz, 2000).

Recognised authorities in the field of organisational learning and the learning organisation, such as Argyris and Schon (1978), Kim (1993) and Senge (1990), have addressed this issue by fusing learning in organisations and learning by organisations (Popper and Lipshitz, 2000). Argyris & Schon (1978) proposed shared individual-level theories of action, and Kim (1993) and Senge (1990) suggested the use of shared mental models to study organisational learning. These authors posit that organisational learning occurs when interventions and evaluations of the organisational members are embedded in the organisation's theory-in-use or shared mental models (Argyris and Schon, 1978, Kim, 1993, Senge, 1990).

However, hypothetical constructs, such as an organisation's theory-in-use or shared mental models, are notoriously difficult to define, let alone measure. In a discussion of the nature of intelligence, Western (1996) alluded to the use of circular arguments by some psychologists to define hypothetical constructs, using as an example a statement made by Boring in 1923 that 'intelligence is what intelligence tests measure'. This often leads to a debate similar to the classic 'what came first – the chicken or the egg?'. First we develop hypotheses regarding the existence of an abstract construct based on pre-existing theory, which by definition, has no single external referent sufficient to validate its existence (Gregory, 1996), thus forcing us to develop proxies to measure the construct. The developer of any instrument designed to test a hypothetical construct must demonstrate that the test possesses construct validity (that the test does in fact measure a close approximation of the construct) before the instrument will be accepted for general use. Two commonly used methods of establishing construct validity include the correlation of the test with other related and unrelated tests and measures, and undertaking research to determine whether intervention effects on test scores are consistent with the theory. Therefore it is assumed that the test does measure what the researcher intended, if the test produces similar results to other tests that were designed to measure a similar construct, or produces results that support the relationships predicted by the underlying theory. Both of these methods assume that the prevailing theories provide an accurate depiction of the construct under investigation, and as a result, over time the construct does indeed become what the construct test measures, at least until new developments in technology or human knowledge enable us to develop more concrete or absolute measures.

As the measurement of hypothetical constructs involves inferring the existence and nature of abstract entities or objects that cannot be definitively proven empirically, Popper and Lipshitz (2000) suggest an alternative strategy for investigating organisational learning, one which studies the concrete structural and procedural arrangements through which individuals within the organisation learn and which result in observable changes in the organisation's pattern of activities. The organisational learning mechanisms outlined by Popper and Lipshitz (2000) include the structures and procedures that enable the organisation (through the actions of the organisation's members) to collect, analyse, store, disseminate and systematically use information that is relevant to performance.

While Popper and Lipshitz's (2000) model provides a useful distinction between learning in organisations and learning by organisations, Nevis, DiBella and Gould (1995) offer some insight into the stages of learning in and by organisations. They make the assumption that the organisational learning process has three identifiable stages - knowledge acquisition (the development or creation of skills, insights or relationships); knowledge

sharing (the dissemination of what has been learned); and knowledge utilization (generalising and integrating the knowledge so that it is available to organisational members in new situations). Knowledge acquisition would correlate with Popper and Lipshitz's (2000) 'learning in organisations', while 'learning by organisations' or the process of institutionalising learning would involve knowledge sharing and knowledge utilization.

Huysman (2000) described three phases that occur during the process of institutionalising organisational knowledge - externalisation (individual knowledge is communicated), objectifying (the new knowledge is codified and disseminated to organisational members) and internalising (the new organisational knowledge is accepted and internalised by organisational members).

Table 2 demonstrates the model of organisational learning discussed in this chapter, where learning in organisations is performed by individuals (organisational members) and represents knowledge acquisition, and learning by organisations consists of knowledge sharing through externalising and objectifying the learning, and knowledge utilization where the knowledge is available to and accepted by organisational members as the current norm.

Table 2: The phases of organisational learning

Popper and Lipshitz	**Nevis, DiBella and Gould**	**Huysman**
Learning in organisations	Knowledge acquisition	
Learning by organisations	Knowledge sharing	Externalising Objectifying
	Knowledge utilisation	Internalising

Learning in organisations: knowledge acquisition

Defining learning has proved difficult. Some researchers have suggested that the term learning defies definition because it is put to multiple uses (Smith, 1982). Learning has been used to describe a product (the acquisition and mastery of what is already known about), a process (the extension and clarification of meaning of one's experience) and as a function (an organised, intentional process of testing ideas relevant to problems). There appears to be general agreement that learning is cognitive, involves change and is reflected in a change in behaviour as the result of the learning experience (Knowles, 1984).

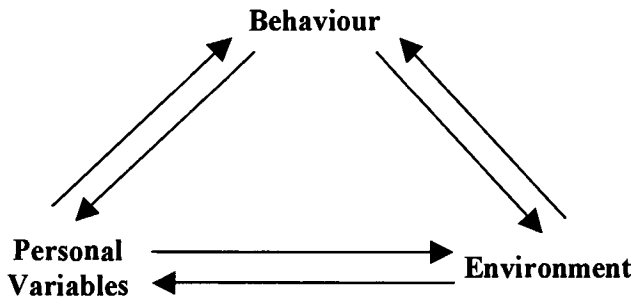
Individual learning

The andragogical model of adult learning developed by Knowles (1984) explains when adults will learn. The model assumes that adults have a self-concept of being responsible for their own decisions and need to know why they need to learn something before they will be prepared to undertake learning. He suggests that adults will only become ready to learn those things that they need to know in order to cope with their real life situations.

In one well known psychological model of learning, Bandura developed a model of reciprocal determinism to explain how humans learn. This model suggests that individuals learn through the interactions of the environment, behaviour and the person. As illustrated by Figure 3, although behaviour is partly determined by the environment, the environment is also a function of behaviour; personal variables include biological or physical characteristics and internal factors such as cognition, memory and anticipation.

When an individual is subjected to an event in their environment, their personal variables influence, first, whether they pay attention to the stimulus and bring it into their awareness, and secondly, how they perceive and interpret the environmental stimulus. Their response to the stimuli is a function of both personal variables and the environment, which results in some form of action or behaviour. The behaviour, in turn, influences not only the environment but also the personal variables as the individual perceives the outcome of their behaviour and gives the experience meaning.

Figure 3: Bandura's model of reciprocal determinism



(Adapted from Feist & Feist, 1998, p. 300)

Learning is essentially a process of interpreting events or actions of the self and others and attributing meaning to those events. Williams (2001, p. 77) described sense-making as the process whereby individuals make sense of their perceptions and suggested that it is

grounded in identity construction. We each have a concept of self, which has developed over time through social interactions. Although this self-concept can enable us to maintain a positive image of ourselves, it can sometimes prevent us from accurately interpreting and assimilating new information.

Rogers (1951) made a distinction between the self as we perceive it and the organismic self. The need to protect the self-concept arises from experiences that are incongruent with our perception of self. This incongruence occurs as our self-concept, or the ways we perceive ourselves to be, is not necessarily an accurate or complete representation or perception of who and what we are. The organismic or true self, rather than our self-concept, is the source of our behaviour and, when our perceptions of self are not accurate, that behavior, and the reactions or responses to that behaviour by people around us, may be in conflict with or directly contradict our image of ourselves.

When this conflict between actual (true self) behavior and self-concept occurs, the individual can react in one of two ways: he or she can assimilate the experience into the self (learning from the experience which Rogers describes as a reorganization and enhancement of the self), or he or she can seek to protect the existing sense of self by resisting assimilation of the experience through denial or distortion.

The greater the distance between the self-concept and the true self, the more likely that individual's behaviour will be inconsistent with the individual's sense of self. These experiences, which involve behaviour or actions that are not aligned, or even in direct contradiction with the person's perception of self, cause vulnerability, anxiety and threat. When faced with anxiety or a threat to their self-concept, an individual will seek to protect the self-concept by distorting or misinterpreting the experience or by refusing to admit or perceive an experience into awareness.

Maslow (1972) argued that growth takes place only when the next step forward is subjectively more delightful, more joyous, more intrinsically satisfying than the gratification received from maintaining the *status quo*. In his view, the goal of learning is self-actualization, and growth toward this goal is determined by the relationship of two sets of forces operating within the individual:

> *One set clings to safety and defensiveness out of fear, tending to regress backward, hanging on to the past . . .*
>
> *The other set of forces impels him forward toward wholeness to Self and uniqueness of Self, toward full functioning of all his capacities . . .*
>
> *We grow forward when the delights of growth and anxieties of safety are greater than the anxieties of growth and delights of safety . . .*
>
> (Maslow, 1972, pp. 44-45)

Maslow placed special emphasis on the role of safety in learning (Knowles, 1984). He argued that growth would only occur to the extent that the individual is not crippled by fear, to the extent that he or she feels safe enough to dare. The individual must be safe and self-accepting enough to be able to choose growth experiences rather than be frightened by them. The environment, for example parents, teachers, therapists, bosses or peers, can enable or support the individual by gratifying her or his basic need for safety, belongingness, love and respect. Thus, the individual feels free from threat, autonomous and interested enough to choose the unknown, and by making the growth choice more attractive and less dangerous (Maslow, 1972).

Both learning and psychological research acknowledge low self-esteem poses a potential problem for individuals in a learning situation. However, recent research (Miller and Neese, 1997, Mussweiler et al., 2000) has indicated that some individuals with very high levels of esteem strenuously resist change, perceiving themselves as better than others or perfect, and therefore deeming it unnecessary.

Self-esteem or self-regard has been defined as the distance between the self-concept, or the way we perceive ourselves, and the ideal-self, the self we would like to be. In cases of either high or low self-esteem, the need to maintain or protect the concept of self by rejecting or distorting their experiences would be high, albeit for different reasons. Thus it may be more difficult to introduce and reap the benefits of learning if organisational members have either very high or very low self-esteem.

Humans tend to be learning all the time, whether they are aware that learning is occurring or not (Williams, 2001). Williams suggested that a good deal of individual learning occurs without the conscious intervention of the individual, and that the same applies to the learning of social units, such as work groups, teams, departments and divisions within organisations. This learning, termed emergent learning, is relatively unplanned and takes place through an incremental process during everyday social interactions. He suggested that emergent learning is rarely managed in an organisational setting, and is a function of the historical context and is reflected in the culture and climate of the organisation. Thus, as pointed out by Levitt and March (1988), learning does not necessarily lead to intelligent behaviour and there is no guarantee that organisational members will learn what the organisation had intended when designing either formal or informal learning opportunities. The same processes that can produce experiential learning can produce superstitious learning, erroneous attributions or competence traps.

If organisations wish to manage learning, they need to take into account that adults will only engage in formal learning when they, as individuals, are motivated to learn, for

example, when they perceive learning as necessary or desirable, and relevant to them and their circumstances (Maslow, 1972, Knowles, 1984), rather than just when the organisation deems learning to be appropriate. Hackman and Wageman (1995) discussed three different sources of human motivation at work: intrinsic motivation where the individual acts purely for the joy of growing, learning and developing one's 'self'; task motivation, where the individual seeks the pleasure arising from doing something well and seeing it work; and social motivation, where individuals seek the approval of peers and the recognition from others of their efforts. The outcomes of all three sources of motivation can be altered by the individual's perceptions of the organisational setting. People inherently want to learn and grow, and to seek love, belongingness and acceptance (Maslow, 1971, Rogers, 1980), but in an organisational setting these inclinations can be fragile and can be easily undermined by systems that create fear, mistrust or defensiveness (Hackman and Wageman, 1995). In a situation characterised by fear, mistrust and defensiveness, the individual continues to learn, but the learning tends to be orientated more towards adapting to their surroundings or defending themselves physically or psychologically, rather than growth and development.

Mental models, schemas and individual sense-making

In the organisational literature, the terms schema and mental model tend to be used interchangeably. Harris (1994) suggests that schemas are dynamic, cognitive knowledge structures used by individuals to encode and represent information. Schemas help to reduce the amount of information processing required as a result of social interaction by providing ready-made theories based on past experience to make sense of incoming information and guide behaviour in response to that information.

Taylor and Crocker (1981) identified seven functions of schemas; they provide a structure against which experience is mapped, direct information encoding and retrieval form memory, affect information processing efficiency and speed, guide filling gaps in the information available, provide templates for problem-solving, facilitate the evaluation of experience, and facilitate anticipations of the future, goal setting, planning and execution (cited in Harris, 1994, p.310).

Schema-based sense making enables an individual to 'fill in the gaps' when the information received is incomplete and thus allows the perceiver to draw conclusions and take what they perceive to be the appropriate response. This is done by evaluating the information against understandings that have been developed from previous experiences in the same or similar circumstances. Although schemas assist the individual to 'make sense' of the stimulus, there is the potential for attribution error or errors in assumptions.

Schemas can and are modified as a result of the information received. Over time, schemas are expanded to accommodate new information, becoming more complex, abstract and organised as more stimulus-relevant information is encountered. When an individual encounters information that conflicts with a schema, the information will either be ignored, cognitively recast to fit the current schema or accepted resulting in schema modification (Harris, 1994).

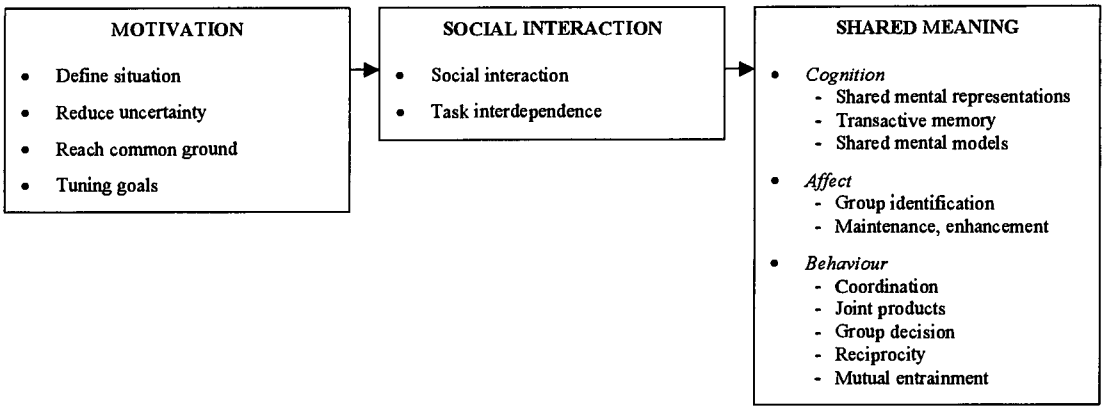
Mental models are defined as an individual's mental or cognitive representations and beliefs about a system and their interaction with that system (Wilson & Rutherford, 1989). The mental model includes beliefs about the individual's actions in regard to the system, beliefs about how the system works, and beliefs about the relationship between the individual's interactions with the system to important outcomes. As mental models are mental representations, they do not necessarily correctly represent reality and can suffer from all the biases and distortions normally associated with subjective perceptions. Mental models are dynamic, changing over time as the individual and their perception of the system changes. Mental models are specific, idiosyncratic, gained through experience and incredibly difficult to access and measure (Hinsz, 1995). Thus mental models are:

> *... a type of knowledge representation which is implicit, incomplete, imprecise, incoherent with normative knowledge in various domains, but it is a useful one, since it results in a powerful explicative and predictive tool for the interaction of subjects with the world, and a dependable source of knowledge, for it comes from the subjects' own perceptive and manipulative experience with this world.*
>
> (Barquero 1995, in Greca & Moreira, 2000, p. 3)

Thompson and Fine (1999, p. 287) described shared mental models as a "mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states". The shared mental model develops as members of the group, team or organisation engage in social interaction to construct working models or mental images that help them understand their world and allow them to draw inferences, make predictions and decide what actions to take.

The model of socially shared meaning in groups developed by Thompson and Fine (1999), as illustrated in Figure 4, consists of three central processes: motivation, social interaction and implicitly negotiated processing or shared meaning.

Figure 4: Socially shared meaning in groups



(Thompson & Fine, 1999, p. 296)

Motivation refers to the environmental factors that create a need to develop a shared meaning. Social interaction is the mechanism that creates the shared perception of reality or shared meaning for the individuals involved.

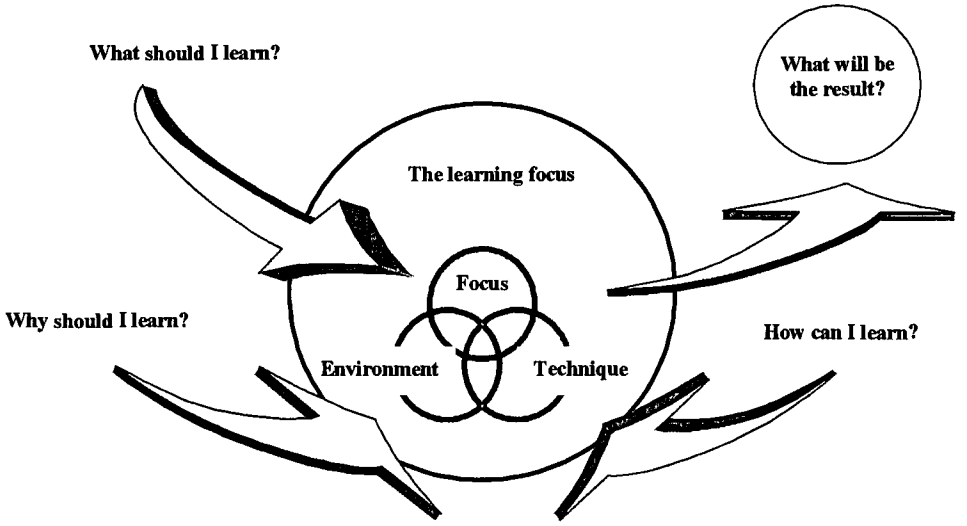
Types of learning in organisations

Learning by adults will result in a potential or actual change in behaviour, but adults will only learn if they see that the learning is relevant or necessary to them personally to cope with or adapt to the environment in which they find themselves, and if they feel the process is safe. In a model of learning by members of an organisation, Buckler (1996) described learning in organisations as a process that results in changed behaviour, where the focus is what the individual should learn (what), the environment which creates meaning that encourages or discourages learning (why), and the techniques employed that enable learning to be efficient (how).

In Buckler's (1996) view, learning occurs in stages - ignorance, where the individual is not aware of the need to learn; awareness, where the individual recognises that there may be a problem; understanding, where the individual recognises the problem and begins to seek a solution; commitment, where the individual makes the effort to experiment with a solution; enactment, where the individual takes action to make real improvements; and finally, reflection, where the theories on which action is based, the action taken and the outcomes of the action are evaluated.

Buckler (1996) believed that it is the role of management to create an environment that facilitates learning. He suggested that management should guide workers through the stages of learning, develop a clear vision for the organisation and encourage employees to share the vision, enable learning by providing opportunities and encouragement and by removing barriers to learning.

Figure 5: Learning as a process



(Buckler, 1996, p. 32)

The learning undertaken by individuals in an organisation can be either lower or higher level learning, and tacit or explicit. Lower level learning has been described in the literature as single-loop learning (Argyris and Schon, 1978) or adaptive learning (Senge, 1990). Learning at this level improves the organisation's capacity to achieve objectives and is often associated with routine or behavioural learning (Ulrich et al., 1993). Single-loop learning is typically described as the response of organisational members to changes in the environment. Organisational members attempt to maintain the *status quo* by detecting errors and taking corrective action within the existing organisational framework. This type of learning is related to how organisations do what they do.

Higher level learning, on the other hand, addresses why organisations do what they do. Double-loop learning (Argyris and Schon, 1978), or generative learning (Senge, 1990) involves gaining a deeper understanding of the issue or problem, as the organisational members engage in open inquiry into underlying assumptions, values and culture to design or re-design an abstract concept or theory which explains the experience. Issacs (1993) defines dialogue as the sustained collective inquiry into the processes, assumptions and certainties that compose everyday experience and suggests that this is the next step and represents triple-loop learning.

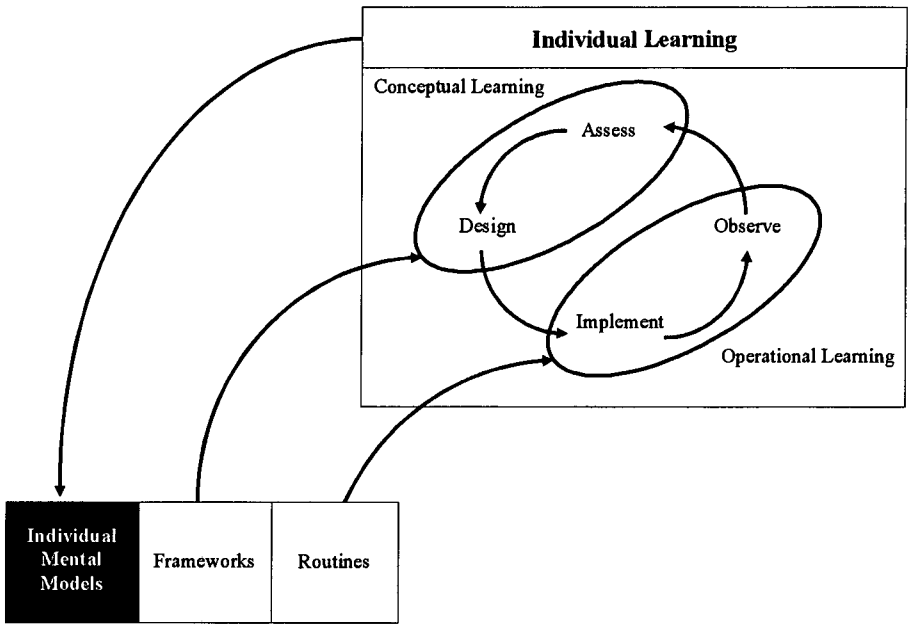
Explicit knowledge is knowledge that can be expressed in words or numbers and therefore can be shared. Tacit knowledge, on the other hand, is highly personal and difficult to articulate or communicate in a form that can be shared by others (Nonaka and Konno, 1998). Nonaka and Konno (1998) argued that tacit knowledge has two dimensions, the

technical dimension that includes personal skills and crafts (know-how) and the cognitive dimension, which consists of beliefs, ideals, values, schemata and mental models.

Kim's (1993) model of individual learning (see Figure 6) not only makes a distinction between acquiring know-how, which he terms operational learning (single-loop, or adaptive learning) and know-why, which is conceptual learning (double-loop or generative learning), but also acknowledges the interactions between existing mental models and learning.

The learning cycle in the model has four components: to observe a concrete experience; to assess, which is to reflect on observations of that experience; to design, which is forming abstract concepts to explain the experience; and implement, to test the concepts; which is followed by observing, assessing etc. as the individual continues to move through the cycle. Implementing and observing are the components of learning at the procedural level. The individual learns the steps in a particular process or task; assessing and design are conceptual and involve thinking about why things happen or are done in a particular way.

Figure 6: Simple model of individual learning



(Kim, 1993, p. 40)

Kim (1993) also introduced two types of individual mental models, routines and frameworks to the model. Operational learning is captured as a routine, which in turn, will influence the implementation and observation stages in the learning cycle. Frameworks consist of the individual's perceptions about the prevailing conditions, and the values and assumptions of the organisation.

By challenging the existing conditions, procedures or conceptions, conceptual learning can lead to new frameworks within the mental model. Kim's (1993, p. 40) model of individual learning is "a cycle of conceptual and operational learning that informs and is informed by mental models".

Learning by organisations: knowledge sharing and utilization

Confessore and Kops (1998) argued that a key characteristic of a learning organisation (an organisation that is good at organisational learning) is the ability of its members to learn from whatever resources are available and to add value to the organisation by converting that individual learning into organisational learning. One view is that the conversion occurs via the dissemination of the information to other members and embedding it into the organisation's theories-in-use or shared mental models (Argyris and Schon, 1978). Argote, Ingram, Levine and Moreland (2000) described knowledge transfer in organisations as the process through which one unit is affected by the experience of another. Collective learning and knowledge transfer is an interactive, ongoing and dynamic people-to-people process (O'Dell and Grayson, 1998), because social interactions and cognitive iterations are fundamental to the development of shared mental models (Williams, 2001). This is important for organisational learning because the collective knowledge of an organisation represents the prior learning of the organisation and resides not only in databases, files and manuals but also in the minds of the organisational members in the form of shared mental models (Bell DeTienne and Jackson, 2001, Kim, 1993).

Kim (1993) suggested that an organisation's active memory (the individual and shared mental models which may be explicit or may be implicit and tacit but widely recognised) determines what an organisation pays attention to, how it chooses to act and the way it chooses to interpret its experiences.

Much of the knowledge acquired by or potentially available to an organisation is tacit knowledge residing in the heads of the organisation's members. The ability to share tacit knowledge has been described as the critical factor in generating competitive advantage (West and Meyer, 1997). Although tacit knowledge is commonly described as knowledge that is difficult to articulate (Nonaka and Takeuchi, 1995), Leonard and Sensiper (1998) suggested that this difficulty is not always the reason why tacit knowledge remains tacit. They argued that tacit knowledge might remain tacit not because it is too difficult to articulate, but because we are either not aware that we possess the knowledge, or because making the knowledge explicit is not to our advantage.

West and Meyer (1997) suggested that there is a clear distinction between information and meaning. Information is collected about the environment and is then transformed as the individuals process the information and attribute meaning to the information. The creation of organisational knowledge occurs as organisational members communicate the meaning to others. Through a process of continued iterative, reciprocal communication, organisational members add to, enhance and/or improve on the meaning, eventually arriving at a shared perspective and mutual understanding. In their view, organisational knowledge is socially constructed, highly contextual (dependent upon the ways in which individuals interact in attempting to understand the environment) and dynamic. Organisational knowledge is therefore subject to changes in the environment, changes in the perceiving individuals, and changes in their interpersonal relationships (West & Meyer, 1997, p.36).

Kim (1993) identified three types of incomplete learning that affect organisational learning: situational learning, fragmented learning and opportunistic learning. He defines situational learning as the learning that occurs as an individual encounters a problem and devises a solution on the spot, without incorporating the learning into their own mental models or by storing or codifying what he or she has learnt for future use. Fragmented learning is where an individual does learn (the lesson is incorporated into their own mental models) but the learning is not shared with the rest of the organisation. Opportunistic learning occurs when, in order to seize an opportunity that cannot wait for the whole organisation to change, the actions taken are based on the mental models of an individual or a small group of individuals rather than on the organisation's shared mental model.

Employee involvement, employee participation and empowerment

Employees of high performance manufacturers are now expected to think, to learn and to act in many situations where previously they were merely expected to do what their supervisors told them to do, as Aktouf (1992, pp. 417 - 418) stated:

> *The era of the "right man at the right place" is over, and the time has come for the employee who knows (and is allowed) to think, to react, to modify, and so on. The time has come for the employee to do more than the job requires.*

Although previous research has shown that shop floor employees can make significant contributions to performance and continuous improvement activities (Delbridge et al., 1995, Delbridge, 2000, Harrison and Storey, 1996, MacDuffie, 1995, Oliver et al., 1996b), some researchers have also suggested that employee acceptance and involvement in many of the

new management practices and processes can be fraught with difficulty (Delbridge, 1995, Groebner and Merz, 1994).

It is questionable how much an organisation can expect from employees for their labour dollar, if in the past, those employees have been treated as mindless drones or 'passive cogs' in the production machine (Aktouf, 1992).

The scope and diversity of research in this area indicate that researchers do appear to believe there is a gap between the contribution an organisation can reasonably expect and the contribution necessary to achieve the desired productivity gains. Coye and Belohlav (1995) and Glew, O'Leary-Kelly, Griffin and Van Fleet (1995) use the terms employee involvement and employee participation interchangeably, and seem to be using these terms to describe the act of cooperation or participation, that is, the behaviour(s) of employees in response to an involvement program or scheme. If it is accepted that the terms 'employee involvement' or 'employee participation' refer to the self-directed actions of employees, employee empowerment may define the arena in which the employee has the power or permission to act autonomously.

This assumption is supported by the argument that when task-related decisions are delegated, (empowered) employees and groups achieve higher levels of productivity, quality and team member satisfaction (Margulies and Kleiner, 1995). Thus empowerment has been defined as "the process of passing authority and responsibility to individuals at lower levels in the hierarchy" (Paul, Niehoff & Turnley, 2000, p. 472).

From a management point of view, empowerment is seen to be "getting workers to do what needs to be done rather than doing what they're told" (Thorlakson & Murray, 1996, p. 67). However, empowerment in an organisational setting has also been defined as: "increased task motivation resulting from an individual's positive orientation to his or her work role" (Kirkman & Rosen, 1999, p. 58), "a psychological mindset, which comprises several dimensions: the fit between one's job and personal values; the belief that one has the necessary knowledge, skills, and so forth, to perform a job or task well; and the belief that one can make a difference with respect to organizational outcomes" (Connor, 1997, p. 506), and as such refer to cognitions, beliefs or values of the employees rather than the mechanisms which allow employees to act. Therefore empowerment is not merely a reflection of the context in which employees work, but also of a psychological or emotional state.

Contextual or structural empowerment

Koberg, Boss, Senjem and Goodman (1999) suggested group and organisational characteristics could affect empowerment. The results of their study indicated that status or

position in the hierarchy, leader approachability, group perception of group-worth and group effectiveness influence empowerment.

The structural components of Kirkman and Rosen's (1999) model of team empowerment included leader behaviour, production or service responsibilities, team-based human resources policies and the social structure. The study found support for each of the structural features. In Kirkman and Rosen's (1999, p. 71) view, if managers want to raise the level of empowerment in their organisations, they should take action to: ensure team leaders have appropriate training to enable them to encourage their subordinates to solve their own problems; increase the product or service responsibilities of employees; alter the human resource policies to support empowerment; and modify social structures to improve access to resources and information, and to establish communication and coordination across the organisation.

Paul et al. (2000) argued that employees must be provided with the right mix of information, knowledge, power and rewards if the organisation is to achieve empowerment. A study by Spreitzer (1996) found support for some key contextual factors associated with empowerment, which included clear goals, tasks and lines of responsibility, socio-political support and a participative climate.

Herrenkohl, Judson and Heffner (1999, p. 375) defined empowerment as "a set of dimensions that characterise an environment's interaction with persons in it so as to encourage their taking initiative to improve process and to take action". In their study, they considered four broad dimensions of empowerment: shared vision, which incorporates goal clarity, goal achievement and customer orientation; supportive organisational culture and governance, which includes responsibility, teams, risk-taking and customer focus; knowledge and learning, incorporating change, skills and problem-solving, trust and communication; and institutional recognition, incorporating recognition and knowledge of the reward system.

The study indicated that only responsibility to make decisions about how immediate work activities are carried out, and a fair reward and recognition system, were important features of structural empowerment. Although the finding was less definitive, the study found that clarity of goals is crucial for informed, relevant decision-making. However, there was no support found for the proposed dimension of knowledge and learning.

Psychological empowerment

A commonly cited definition of psychological empowerment is the one developed by Thomas and Velthouse (1990). They define empowerment as intrinsic task motivation and suggested that empowerment manifests itself in a set of four cognitions: meaning,

competence, self-determination and impact. These four cognitions reflect an individual's orientation to his or her work role.

Meaning is defined as the value the individual places on a work goal or purpose; competence is a similar concept to self-efficacy, or the individual's belief in his or her capability to perform a work activity with skill; self-determination is an individual's sense of having a choice about his or her actions in relation to a work activity; and impact is the degree to which the individual can influence the outcomes of the activity (Spreitzer, 1995).

Spreitzer (1995) suggested that perception is very important to empowerment, arguing that the way in which people actively perceive and interpret their environments may have more influence on behaviour than objective reality. If this is the case, organisations should not only provide the context to enable employee empowerment to take place, but also ensure employees are aware of its existence and believe that the context does enable them to be empowered.

Employee involvement approaches

From a review of the employee involvement/participation literature, Paul, Niehoff and Turnley (2000) identified three approaches to involvement - parallel suggestion involvement, job involvement and high involvement. In parallel suggestion involvement, employees are asked to contribute by offering ideas and suggestions to solve problems. With this approach, employees take no part in implementing their ideas, and Paul et al. argued that this approach tends to be temporary, expensive and difficult to maintain. Job involvement focuses on job enrichment, through the introduction of task variety, multi-skilling, autonomy and providing feedback. This approach involves high start-up costs and, as employee involvement and focus is limited to their own tasks or those of their work group, this approach may result in employees neglecting overall organisational performance. High involvement approaches are more complex than parallel suggestion and job involvement approaches.

Unwilling participants

One of the key principles of human motivation, organisational theory and human resource management is that people *want* to experience meaning in and from their work (Coch and French, 1948, Connor, 1997). Those employees who are able to find meaning in their work exhibit higher levels of intrinsic motivation and job satisfaction, and take fewer days off (Connor, 1997). A significant number of organisations are introducing new methods of organising work, which, on paper at least, offer employees the opportunity to have some

input into how their jobs are done. As a species, humans have a tendency to seek meaning and personal growth (Knowles, 1984; Maslow, 1968; Rogers, 1980). Thus gaining the cooperation and participation of employees should be easy, but in practice it has been very difficult (Margulies and Kleiner, 1995, Thorlakson and Murray, 1996, Connor, 1997, Lewchuk and Robertson, 1997).

Connor (1997) suggested that employee participation in TQM could be problematic, if managers fail to reduce or eliminate the 'them and us' relationship between management staff and the general workforce by creating a climate of trust and allowing employees the freedom to fail. Other issues identified by Connor (1997) included managers' egos and fear of losing control or power, the often limited scope or triviality of participation schemes, coercive climates and the tendency to focus on technical training rather than staff development.

O'Brien (1995) suggested that, although it is easy initially to 'harvest' tacit knowledge, it is also surprisingly easy to discourage employee contributions. The lack of consistency by management, poorly structured opportunities, non-collaborative or uncooperative technical staff and low trust between organisational members are cited as the most common reasons for the failure of programs designed to encourage employees to contribute knowledge to an improvement process. Thorlakson and Murray (1996) identified three potential problem areas that could constrain employee participation: peer-group pressure, management coercion or retribution, and re-entry adaptation (a feeling of dissatisfaction and/or de-motivation upon returning to normal activity after engaging in a participation activity).

Propensity to withhold effort

Shirking, social loafing and free riding are three concepts related to the level of effort expended by employees, and although these concepts are often studied independently of each other, Kidwell and Bennett (1993) argued that the propensity to withhold effort is the common denominator of each concept. They define the propensity to withhold effort as the likelihood that an individual will give less than full effort on a job-related task (Kidwell & Bennett, 1993, pp. 429 – 430). The decision of an employee to withhold effort will be influenced by: rational choice variables, normative conformity values and affective bonding variables.

In a study of unwilling participants, Lightfoot (1999) identified three different behaviour patterns. Some unwilling participants make unintentional misrepresentations, some make intentional misrepresentations and some are generally uncooperative. Unintentional misrepresentations can occur because the employee is attempting to articulate tacit knowledge without the necessary skills, or he or she assumes that the listener has a better understanding

of the knowledge than they actually do. Intentional misrepresentations are just that - the employee intentionally mis-states and misrepresents their knowledge in the hope of sabotaging the improvement effort. Uncooperative employees simply refuse to participate.

Lightfoot suggested that motivation is one way of gaining the acceptance and cooperation of unwilling employees. The most suitable motivation package will vary depending on which category the unwilling employee belongs to.

Motivation: incentives and rewards

Amabile (1993) suggested that motivating employees has always been a critical issue for managers in the workplace, and would become an even more important issue in the future. She argued that unmotivated employees:

> *... are likely to expend little effort in their jobs, avoid the workplace as much as possible, exit the organization if given the opportunity, and produce low quality work ...*

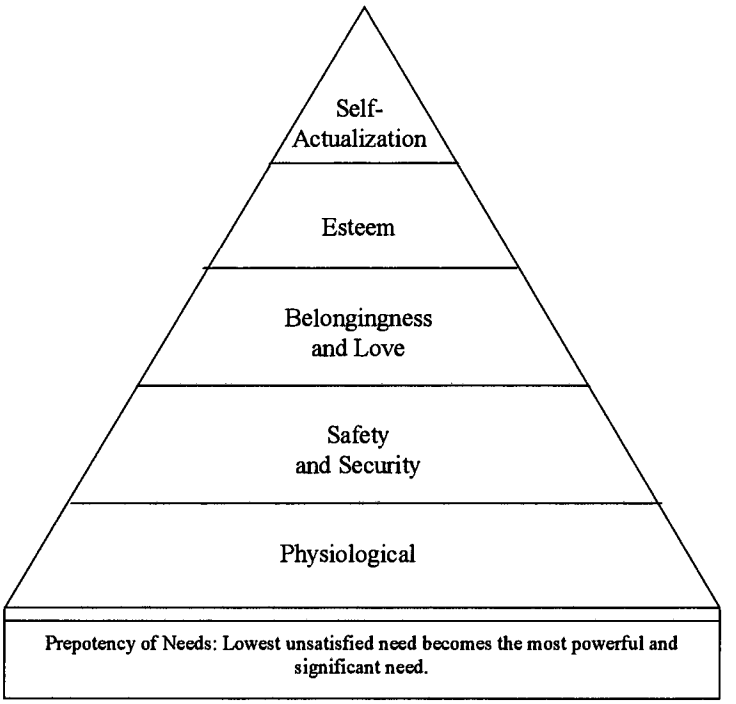
whereas,

> *... employees who feel motivated toward their work are likely to be persistent, creative, and productive, turning out high quality work that they willingly undertake.*
>
> (Amabile, 1993, p. 185)

Although motivation is a subject that has attracted a considerable amount of research, there is still no universally accepted or complete theory of human motivation. To gain a better understanding of the issues related to employee motivation, two early theories, Maslow's hierarchy of needs and Herzberg's two-factor theory of motivation, are presented to provide background, followed by a discussion of recent research in the area of employee motivation.

Maslow introduced a simple and easily understood concept of individual motivation based on a hierarchy of needs. The theory is based on five assumptions: motivation influences the whole person rather than any single part or function; motivation is generally complex; all of the actions of people are motivated by the desire to satisfy one need or another; all people are motivated by the same basic needs; and needs can be ranked from basic lower level needs up to higher level needs. The hierarchy, shown in Figure 7, arranges individual needs from the most basic lower level physiological needs up to high level needs such as esteem and self-actualisation.

Figure 7: Maslow's hierarchy of needs



(Gordon, 1996, p. 116)

Maslow argued that the actions of an individual would be driven by a desire to satisfy their lowest unsatisfied need in a given situation.

Gordon (1996) suggested that organisational conditions could satisfy each level of needs. Pay and employee benefit programs such as subsidised or company housing may satisfy physiological needs. Benefit plans, occupational health and safety, or the provision of child care may satisfy safety and security needs; work teams, coffee breaks or a social club may satisfy love and belongingness needs. Autonomy, responsibility and pay may satisfy esteem needs. A challenging job, job advancement, autonomy and authority may satisfy self-actualisation needs.

However, as the personal situations of individuals vary, the needs of individual workers are unlikely to be exactly the same, and as a result managers may need to use an array of mechanisms to motivate employees. For example, some employees may be focussed on financial needs to pay for food and housing, others may be more concerned with social interaction and fitting in. Yet others may be more concerned with esteem issues, such as seeking recognition and rewards for performing well or doing a good job. Maslow's theory incorporates intrinsic and extrinsic motivation, as the basic lower level needs, physiological and safety and security are satisfied largely by extrinsic means, and the higher level needs of belongingness and love, esteem and self-actualisation tend to be of a more intrinsic nature.

While the theory does provide a framework for organising what we know and understand about human behaviour and is intuitively appealing, Feist and Feist (1998) pointed out that, although Maslow's hierarchy of needs is often cited and discussed, the assumptions about motivation and the hierarchy of needs have not been empirically proven. Gordon (1996, p. 119) argued that the theory is too simplistic as workers may not have precisely five needs, or they may be acting to satisfy more than one need at a time, and the order of the needs presented in the hierarchy does not generalise across cultures.

In contrast, Herzberg argued that employees are more likely to be motivated by intrinsic aspects of the job rather than by extrinsic factors such as financial rewards. He argued that the key to motivating employees was the redesign of jobs to make employees' work more meaningful (Noe et al., 1997). In Herzberg's two-factor theory, the focus is how organisations can increase job satisfaction, rather than how organisations can motivate employees to exert greater effort. Organisational mechanisms are divided into two types of components, hygiene factors and motivators (see Table 3). Hygiene factors are the features of the job's context, and although they themselves do not motivate workers to exert more effort, the motivators are unlikely to influence employees if the hygiene factors are not present at an acceptable level. Motivators are features of the job content, including responsibility, esteem, autonomy and growth (Gordon, 1996).

The Herzberg two-factor model has featured in numerous empirical studies that have found support for the theory. However, Gordon (1996) suggested that the research support is limited as there are a number of problems, particularly the difficulty of classifying some work characteristics as either hygiene or motivational.

Table 3: Herzberg's motivation-hygiene theory

Hygiene Factors *The Environment*	Motivators *The Job*
Job Dissatisfaction ⟷ No Job Dissatisfaction	No Job Satisfaction ⟷ Job Satisfaction
- Pay - Status - Security - Working conditions - Fringe benefits - Policies and administrative practices - Interpersonal relations	- Meaningful and challenging work - Recognition for accomplishment - Feeling of achievement - Increased responsibility - Opportunities for growth and advancement - The job itself

(Gordon, 1996, p. 124)

Both Maslow's needs hierarchy and Hertzberg's two-factor theory are described in the literature as need satisfaction theories, and both have been criticised. Synder and Williams (1982, p. 257) go so far as to argue that the 'valid' criticisms of individual theories, and in particular, the Maslow and Hertzberg models of motivation, have resulted in broad skepticism about needs and need satisfaction in the literature and in practice. Rather than following the trend to discount the value of need satisfaction theory all together, Synder and Williams proposed an alternate need satisfaction theory, self-theory, which they argue may be less susceptible to the common criticisms. Self-theory is a psychological theory that attempts to deal with general contexts such as work organisations, and is based on the premise that human beings have a fundamental need to maintain or enhance the phenomenal self (Synder & Williams, 1982, p. 258).

A self-theory is a schema or implicit theory of the self, which develops as we learn from our experiences. The implicit theory is applied and tested in relevant situations to enable individuals to predict and control their environments. In Epstein's (1973, p. 407) view, our self-theory;

> ... *consists of concepts that are hierarchically organized and internally consistent, that assimilates knowledge, yet, itself, is an object of knowledge; that is dynamic, but must maintain a degree of stability; that is unified and differentiated at the same time; that is necessary for solving problems in the real world; and that is subject to sudden collapse, produce total disorganisation when this occurs.*

The self-theory is learned and therefore subject to errors, which can mean that our self-theory is not necessarily an accurate depiction of who we are. Synder and Williams (1982, p. 261) suggested that all behaviour is ultimately a function of the self-theory, and will

depend on whether objective situations are perceived as opportunities for, or threats to, the fundamental maintenance and enhancement of the self. They cite the example of a low-performing employee, who would normally be viewed as unmotivated. Synder and Williams (1982) argued that this employee is highly motivated; however the employee does not perceive high performance as the means to satisfy their need to maintain or enhance their sense of self. They suggested that the way to increase the performance of a low performing employee is to create a situation where the employee's need to maintain or enhance the self will be satisfied by performing at a higher level.

Organisational culture and climate

By summarising the research literature, Detert, Schroeder and Mauriel (2000, p. 851) derived a general definition of culture as an enduring, autonomous phenomenon that consists of some combination of artefacts, values, beliefs and underlying assumptions that organisational members share about appropriate behaviour. They suggested that culture is holistic, historically determined and socially constructed, and manifests itself in all aspects of the organisation.

Detert et al. (2000) outlined eight dimensions that they identified in the literature on organisational culture, namely: ideas about the basis of truth and rationality; ideas about the nature of time and time horizon; ideas about motivation; ideas about stability versus change, innovation and personal growth; ideas about orientation to work, task and co-workers; ideas about isolation versus collaboration and cooperation; ideas about control, coordination and responsibility; and ideas about orientation and focus.

Ahmed et al. (1999, p. S430) suggested that organisational culture might be taken to include all the institutionalised codes of behaviour and implicit beliefs, norms and values, and premises that underline and govern behaviour. In their view, culture has two components: explicit culture, which represents the typical pattern of behaviour and the artefacts that organisational members produce and abide by, and implicit culture, the values, benefits, norms and premises that determine the observed patterns of behaviour.

Slater and Narver (1995) suggested that the culture of an organisation exists as a shared mental model or cognitive schema, which governs the behaviour of organisational members.

Ahmed (1998) argued that the culture of an innovative organisation constantly guides and supports organisational members to seek innovation, and outlined a set of critical norms necessary to promote and implement innovation and learning. These include: a safe environment; challenge and belief in action; freedom and risk-taking; a dynamic and forward

looking orientation; an awareness of the external environment; trust and openness; organisational slack; debates; cross-functional interaction and freedom; supportive myths and stories; a real commitment and involvement by organisational leaders; appropriate awards and rewards; time set aside for innovation and training; identification with the organisation and corporate unity; and autonomy and flexibility built into the organisational structure (Ahmed, 1998, Ahmed et al., 1999).

There are several views on the relationship between culture and climate in the research literature, and as a result the two terms are often confused or used interchangeably (Denison, 1996, Hicks-Clarke and Iles, 2000). Some researchers view culture and climate as separate and distinct constructs. For example, Denison (1996) suggested that while culture refers to an evolved context of values and basic assumptions, which are rooted in history, collectively held and sufficiently complex to resist many attempts at direct manipulation, climate relates to the behavioural patterns and norms, which are considered to be relatively temporary, subject to direct control, and largely limited to aspects of the social environment that are consciously perceived by organisational members.

Others view climate as a component or subset of culture. Schneider, Gunnarson and Niles-Jolly (1994, p. 18) describe climate as the "feeling in the air", and suggest that climate is the employee's perceptions of the atmosphere that is created by their organisation's practices, procedures and rewards. Climate develops as employees interpret the events, actions and outcomes that arise from their interaction with organisational systems, and assign meaning to those events, actions and outcomes. Thus climate is a schema or theory about social interaction and behaviour, which is developed by organisational members, to enable them to predict and to some extent control the outcomes of future interactions.

Schneider, Brief and Guzzo (1996) described four dimensions of climate, which are the nature of interpersonal relationships, the nature of the hierarchy, the nature of the work, and the organisational focus and rewards. A climate which will encourage and foster employee involvement in change and learning will be one in which organisational members can trust one another and feel valued by the organisation. New members are socialised and supported as they find their way within the organisation. Decision-making is decentralised, there are few status distinctions and teamwork is valued over individual effort. Workers have challenging, flexible jobs and are provided with sufficient resources to complete tasks and engage in learning. Innovation and creativity are rewarded; the organisation has a clear focus on quality rather than quantity; and people are hired for their potential for learning and change rather than on the basis of existing skill sets (Schneider et al., 1996).

Fear in the workplace

Many organisations are now using team or group based work organisation in an attempt to improve organisational performance. Ideally, members of these work groups will contribute fully to complete the tasks set and seek ways to improve their performance not only as individuals, but also for the group as a whole. Often, rather than being formed naturally, people are placed within groups in an organisational setting. In any setting, let alone an artificially created group, fear arises as people enter a new group (Back, 1979). This fear is characterised by a mistrust of others due an unsafe and insecure feeling in a new environment (Back, 1979). For an organisational group to be effective, the members must move past the fear and learn to work, and learn, together.

In a study investigating team learning and performance, Edmondson (1996a) defined team learning as a process of using data to guide behaviour in such a way as to promote ongoing adaptation. She suggested that it is a process that involves individual cognition, one of acting, assessing and acting again. Team learning, so defined, requires behaviours such as asking questions to seek and attend to task relevant information, seeking feedback, discussing errors as a way of gaining understanding about performance gaps, experimenting with and implementing subsequent actions in response to the information obtained through these behaviours. However, she suggested that team members were only going to engage in learning behaviours if they perceived themselves to be in a psychologically safe environment. Edmondson (1996) described psychological safety as a shared cognition, or mental model of the team environment.

Trust in organisations

As more and more organisations begin to implement new methods of organising work which require the cooperation and a far greater contribution by lower level employees, managers are faced with the dilemma of how to ensure that the actions of employees will be in the best interests of the organisation while they no longer have complete knowledge or control (Spreitzer and Mishra, 1999). Traditional methods of management control tended to assume that lower level employees had only limited competence and required constant surveillance to ensure that they did the right thing. The introduction of teams, cross-functional collaboration and the de-layering of management levels resulting from downsizing have made it more difficult to monitor individual contributions to performance and are forcing managers to seek alternative methods of maintaining control. One method suggested by the research literature is to hire only individuals whose personal goals are aligned with those of

the organisation or socialise existing employees to the organisational goals, thus ensuring that the organisation will still benefit even when the employee acts out of self-interest. However, as socialisation can be a very long process and not all organisations have the opportunity to start up from scratch, trust has been advocated as an alternative to formal control (Spreitzer and Mishra, 1999).

Trust in employees implies that managers believe that employees will not take advantage of decision-making processes, are reliable and competent to make important decisions about their work activities (Spreitzer and Mishra, 1999). In the absence of trust, managers are unlikely to believe that employees are able to act in the best interests of the organisation and will attempt to limit their involvement while increasing surveillance and control.

However, trust goes both ways and can play a major role in an employee's decision to participate. If they do not feel trusted by management or are unable to trust management to keep the promises made to them in exchange for their cooperation and contribution to improvement processes, employees' cooperation and contribution are less likely to occur.

In 1967 Rotter developed a scale to measure the individual trait of 'propensity to trust'. He described this trait as a generalised trust of others, and defined it "as an expectancy held by an individual or a group that the word, promise, verbal or written statement of another individual or group can be relied on" (Rotter, 1980. p. 1) This trait theory assumes that some people are predisposed to either trust or distrust others.

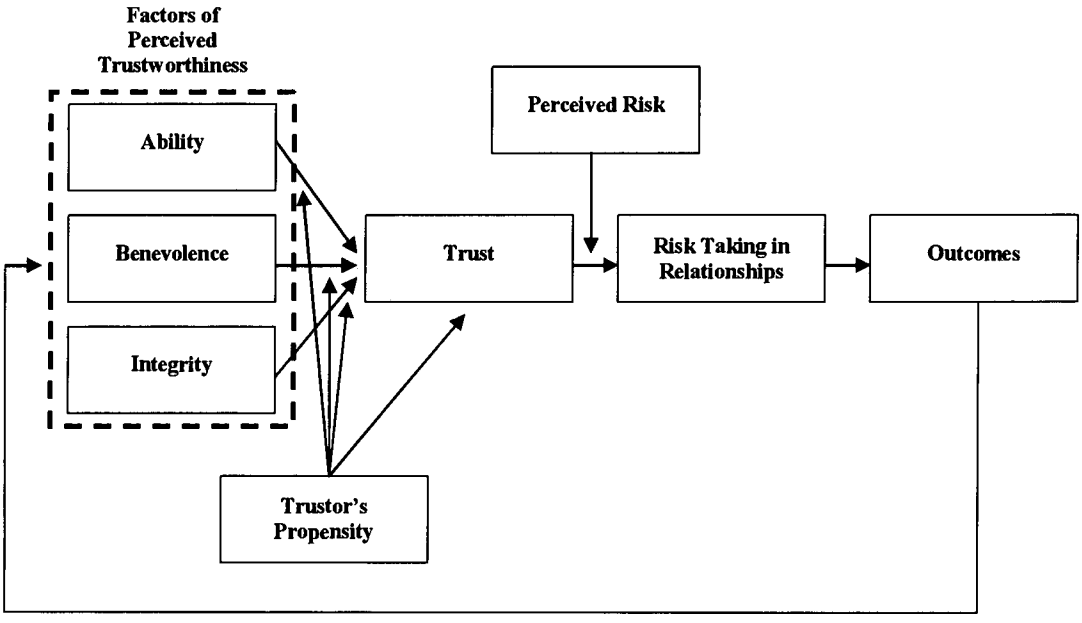
Mayer, Davis and Schoorman (1995, p. 712) define trust as:

> *... the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party.*

In their model of trust, Mayer et al. (1995) suggested that trusting behaviour depends on the characteristics of the trustor, the characteristics of the trustee and the perception of risk (see Figure 7).

The characteristics of the trustee include ability, benevolence and integrity and relate to the perceived trustworthiness of the trustee. Ability is the group of skills, competencies and characteristics of the trustee that would enable them to have an influence within some specific domain, situation or activity. Benevolence relates to whether the trustor believes the trustee wants to do 'good' to the trustor, and integrity is the trustor's belief that the trustee operates consistently within a set of principles that they find acceptable.

Figure 7: Mayer, Davis and Schoorman's (1995) model of trust



(Mayer et al., 1995, p. 715)

The risk perception or perceived risk involves the trustor's beliefs regarding the likelihood of losses or gains resulting from actions occurring in the trust relationship. The perceived risk can be affected by the prior relationship between the two parties and by factors outside the relationship, such as control mechanisms within an organisation, that may affect the decision to trust.

Jones and George (1998) described trust as an expression of confidence between parties in an exchange of some kind, that they will not be harmed, put at risk or be exploited by the actions of the other party, and suggested that trust is created over time. They described trust as a psychological construct, which is the outcome of the interaction of people's values, attitudes, moods and emotions. These authors argued that trust develops through three distinct stages: distrust, conditional trust and finally unconditional trust. To move from distrust to conditional trust, each person suspends belief that the other's values may be different from their own or that the other may not be trustworthy. Jones and George (1998) argued that this occurs because trusting another person and assuming that others share your values is easier for individuals than maintaining distrust. Unconditional trust starts when the individuals no longer have to suspend belief because shared values are now evident and structure the social situation. It appears that if trust is to develop in the group, the members must first suspend belief that the other members of the group have dissimilar values to themselves, and that they may not be trustworthy. Trust will evolve over time and thorough continued interactions, providing the trust is not violated.

A summary: managing the human aspects

From the preceding discussions which touch upon: learning in and by organisations; employee involvement, participation and empowerment; motivation; organisational culture and climate; trust in organisations; and mental models or schemata, it becomes readily evident that employees will only risk involvement and/or learning, not only when they perceive that it is safe to do so, but also when they perceive the involvement and/or learning to be necessary or desirable for them as individuals. It is the meaning that an individual or group of individuals assign to an event or situation, rather than the facts or objective reality, will determine their response, and therefore managing the human aspect of the learning factory involves much more than implementing structural or contextual changes and providing rewards and incentives for employees. It involves consciously managing the development and maintenance of the individual and shared mental models of employees at all levels of the organisation.

To manage and develop the human aspects of the learning factory, organisations would have to design and implement the contextual or structural components identified in the preceding sections: such as providing opportunities for growth and development and the systems to support the externalisation and objectification of knowledge; developing contextual or structural empowerment by introducing guidelines for desirable or appropriate team leader behaviour, devolved production responsibilities, team based human resource policies, and access to information and resources; and the introduction of a system of rewards and incentives that are targeted to the needs of the individuals employed by the organisation. The organisational culture should be supported by clear organisational goals and a formalised 'employee friendly' code of behaviour, which clearly defines roles and responsibilities and provides remedies for any breach.

Once these measures are in place, the difficulty will be in gaining the trust of employees and continually reinforcing the values and beliefs of the organisation so that they, as a group, are prepared to modify or update shared mental models about the organisation. If at any time, the actions of management are perceived to be inconsistent or counter to the stated values and beliefs, the employees will revert to negative mental models. The downside of managing the human aspects is that it involves a significant investment of time and money to develop employees at all levels of the organisation and will have no definite time line. Changing the shared mental models of a group of people takes as long as it takes, and is potentially characterised by the common phrase 'two steps forward and one step back'.

The next chapter attempts to bring together all of the components of the learning factory model by incorporating the structural components of the human aspects identified in the preceding sections of this chapter.

Chapter 4
Developing a research model

The second chapter of this thesis presented a review of the literature on lean production, compared the experience of lean production in Japanese-owned or controlled plants with those of Western manufacturers to clearly identify and describe all of the components of the model, and investigated the suggestion that the next new step for manufacturers seeking performance improvements is to combine lean production principles and the learning organisation model. A major conclusion of the literature review was that although employee participation, learning and commitment are assumed, neither model clearly articulates the importance of engaging employees' support and ongoing involvement in the process or how an organisation might go about it.

Thus Chapter 3 presented a review of recent research on learning in and by organisations, employee participation, employee involvement and employee empowerment to determine which factors influence an employee's decision to reject, accept or adapt to the improvement process, and to identify the mechanisms that an organisation may be able to use to engage the cooperation and contributions of its employees.

This chapter now attempts to bring together all of the components of the learning factory model and to develop a more comprehensive description by incorporating the human aspects identified in the previous chapter.

The learning factory

A learning factory is described in the literature as one that is able to outperform its competitors by using a learning organisation approach to implement and manage lean production techniques (Hodgett, Luthans & Lee, 1994, Nonaka & Kakeuchi, 1995). This implies that the successful implementation of a lean production model is a starting point rather than an end in and of itself, as the organisation learns, evolves and/or grows in response to changes in the internal and external environment. The literature suggests that this can be achieved by continually questioning and challenging the norm; allowing people to make mistakes without apportioning blame; and using detection and correction activities as a learning experience and as a mechanism to transform accepted values and practices.

A key requirement of the learning factory is to develop a common vision and purpose, shared by employees at all levels of the organisation. To this end, the learning factory is likely to have built learning opportunities for all into its strategies and provided an

environment (in terms of culture, recognition and conditions) that positively encourages its people to seek learning and self-development opportunities. Thus, a learning factory is likely to be characterised by clarity of mission and vision, shared leadership and involvement, an organisational culture of openness and trust, communication and knowledge systems, a solid foundation of employee skills and competencies, and a happy, productive workforce. The key question is – given that the learning factory concept has been proposed as the next evolutionary step facing the manufacturing industry and a potential source of competitive advantage, what must an organisation implement or change about the way it operates, if it is to become a learning factory?

As the learning factory concept is a combination of lean production and the learning organisation, lean production methods must necessarily be significant components of the learning factory model. The major operational components of the lean production model identified in the preceding chapters include: team-based work organisation; continuous improvement; lean manufacturing operations, which include process control and discipline, synchronised work processes, standardisation of tasks, and simplifying the physical flow along the production line; and the introduction of just-in-time inventory systems. Although often not selected for implementation by Western organisations in practice, close long-term relationships with both customer and supplier groups and the organisation's employees are also identified in the literature as important components of the model.

The learning organisation literature generally provides a description of what a learning organisation looks like, rather than specifically addressing the components underlying the model. For example, Hill (1996) describes an organisation with a culture of openness and trust where employees are able to experiment and take risks without the fear of reprisals, but does not specify what mechanisms were used by the organisation to develop the culture. However, if the success or failure of the learning factory is dependent on the willing contribution and learning of all organisational members, the mechanisms that can enable and encourage employees to participate are vital to the model.

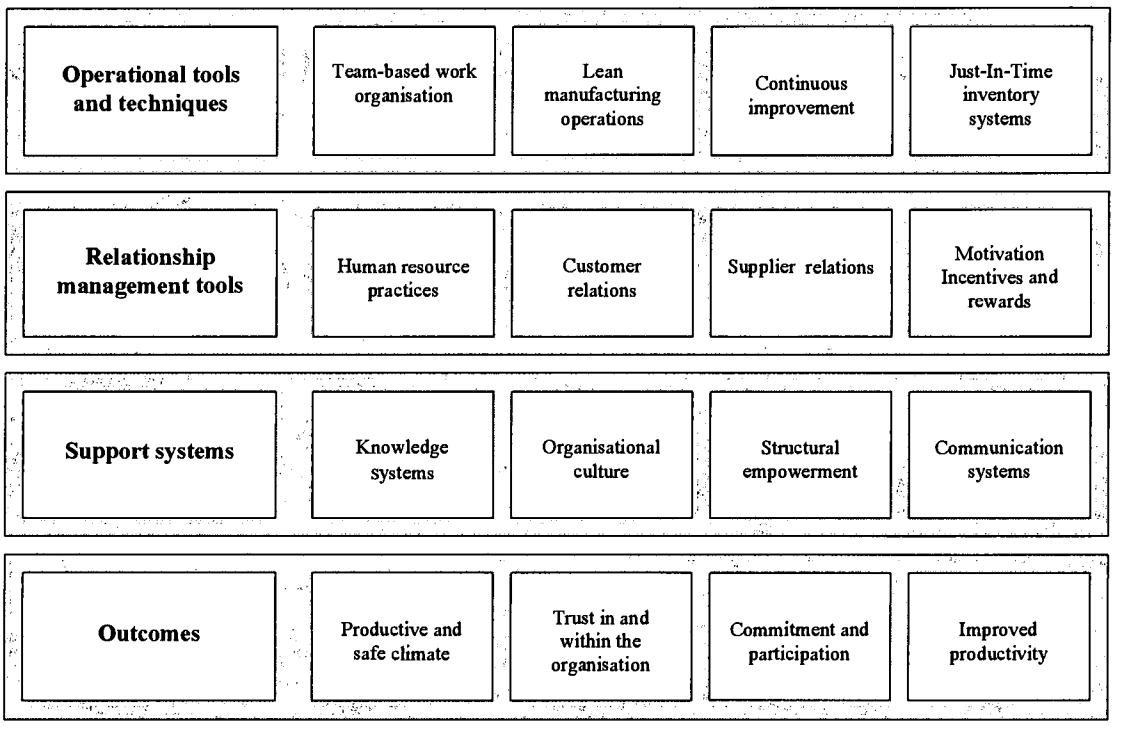
The literature on organisational learning, employee participation and empowerment provides ideas on the types of mechanisms an organisation can utilise to enable and encourage employees to fully participate in learning activities. Firstly, one recurring theme in the literature is the importance of eliminating fear and the need to protect the self-concept or self-theory of organisational members. The literature suggests that the use of mechanisms such as the provision of appropriate training (including self-development as well as professional development), access to knowledge and resources, leader availability and support may facilitate the learning and empowerment of employees. The decision of an individual to

participate will also be influenced by the culture and climate of the organisation, the level of trust in and within the organisation, and the attitudes and behaviour of organisational leaders.

Many of the components identified in the various models discussed in this and previous chapters complement each other, and in some cases, the models share common components. From a review of this material, twelve components (or groups of 'like' components) appear to be central or necessary to the success of a learning factory. These components are: team-based work organisation, lean manufacturing operations, continuous improvement, just-in-time inventory systems, human resource practices, supplier and customer relations, motivation systems, knowledge systems, communication systems, structural empowerment and organisational culture. And from further analysis of these components, similarities can be identified amongst the components enabling them to be grouped into three categories: operational tools and techniques, relationship management tools, and support systems.

The outcomes included in the model (refer to Figure 9) are those suggested by the research literature and include a productive and safe work climate, trust and openness, commitment and participation at all levels of the organisation, and improved productivity. As one of the criticisms of the literature presented in this study involves the failure to clearly articulate and define some of the essential components or conditions of each model discussed, the next two sections of this chapter incorporate a discussion of all of the components identified in previous chapters and included in this research model.

Figure 9: The learning factory model



Operational tools and techniques

The operational tools and techniques category consists of the structural systems, procedures and processes typically implemented in an organisation using a lean production model.

Team-based work organisation

In lean production, a high percentage of workers are organised into teams that are responsible for a discrete sub-process or specific section of the production line. The teams are responsible for routine maintenance, housekeeping activities, the collection and analysis of simple statistical data related to quality and performance and performing quality certification of their output. In a learning factory, team members would receive training and ongoing support to facilitate teamwork and cooperation.

Lean manufacturing operations

Lean manufacturing operations typically include minimising down-time on the line using preventative maintenance, reducing re-work by identifying and eliminating faults where they occur on the line (quality management aimed at zero defects), arranging the physical flows of production to reduce material handling between steps in the production process, strict process control and discipline, and synchronising cycle time across the production process.

Continuous improvement and problem-solving

Continuous improvement has been defined as a company-wide process of focussed and continuous incremental innovation (Bessant and Francis, 1999). Employees at all levels of the organisation would be free to experiment with new approaches (albeit with some restrictions), and to continually question and challenge the norm. Detection and correction activities would be used as a learning experience rather than as an indicator of poor discipline or sloppy workmanship. Training would be provided for all employees on the use and application of problem-solving tools and techniques, to enable them to generate and share knowledge in a consistent manner.

The most common employee involvement programs used by lean producers involve suggestion schemes and quality circles. Suggestion schemes offer some form of reward to encourage employees to submit suggestions about how work processes could be improved.

Quality circles are small groups of workers who meet regularly on a voluntary basis, to solve existing process problems or to seek process improvements. While the learning factory may use these mechanisms, employees would also be able to take on more responsibility for their own work, and team leaders would have been provided with the appropriate training to encourage team members to solve problems. Team members would have open access to resources and information, and communication and coordination would be established to transfer knowledge across intra-organisational boundaries.

Just-in-time inventory systems

The objective of just-in-time inventory systems is to eliminate inventory buffers and to procure, hold or produce materials or components that are immediately required for the next step in the production process.

Relationship management tools

The relationship management tools include high commitment human resource practices, customer relations, supplier relations and rewards and recognition.

High commitment human resource practices

Learning factories should exhibit human resource practices that include selection procedures that emphasise potential to learn, work values, work ethic and personality, team-based production methods, extensive orientation (socialisation) for new workers, worker participation in problem-solving, job rotation, job enrichment and a high level of skill development through training. Learning factories may also provide job security (protection) for core employees, and thereby create a sense of reciprocal loyalty, by using contract or short-term employees to manage fluctuations in demand.

Customer relations

Learning factories enjoy close, mutually beneficial relationships between the organisation and its customers, putting a significant amount of time and effort into developing and maintaining the relationships. Their efforts may include direct participation on their

customers' product development teams, frequent visits to and from their customers' plants and participation in supplier groups sponsored by their customers.

Supplier relations

As with relationships with customers, the relationships between learning factories and their suppliers are generally viewed as long-term partnerships. Close relationships are developed over time using a variety of mechanisms that include the provision of training and assistance to suppliers through supplier groups, inter-company transfers of staff and reciprocal ownership arrangements. The learning culture of the learning factory is extended to include suppliers and other significant stakeholders and this includes the development of knowledge sharing systems.

Motivation, incentives and rewards

Amabile (1993) suggests that employees, who are motivated towards their work, will be persistent, creative and productive. Learning factories require employees to be highly motivated to participate and contribute well beyond the level expected in a more traditional manufacturing model. If, as Maslow (1970) argued, the actions of an individual would be driven by a desire to satisfy their lowest unsatisfied need, it is important for learning factories to identify any unsatisfied needs of their employees. The incentives and rewards provided by the organisation should be designed to enable the employees to satisfy those needs.

Although the unsatisfied needs will vary between individual employees, incentives and rewards in a learning factory are likely to include: pay and employee benefit programs such as subsidised or company housing (physiological needs); benefit plans, occupational health and safety, or the provision of child care (safety and security needs); work teams, coffee breaks or a social club (love and belongingness needs); autonomy, responsibility and pay (esteem needs); and a challenging job, job advancement, autonomy and authority (self-actualisation needs).

Support systems

The support systems included in the model – knowledge systems, organisational culture, structural empowerment and communications systems – provide access to

information and resources, as well as the context within which an organisational member can participate and/or learn.

Knowledge systems

Though not expressly addressed in the lean production literature, a key component of lean production is the communication and management of knowledge gained during the continuous improvement and problem-solving processes. The mechanisms commonly used include quality documentation, standard operating procedures, access to quality and performance data via computer terminals, company intranet and email systems. In a learning factory, these capabilities are expanded to incorporate and share knowledge gained through interaction with external stakeholders, such as customers, suppliers, industry associations and research organisations.

Organisational culture

In Chapter 3, culture was described as an enduring, autonomous phenomenon that consists of some combination of artefacts, values and beliefs that govern the behaviour of organisational members (Detert et al., 2000, Slater and Narver, 1995).

Based on the discussion in the previous chapter, the cultural aspects of a learning factory are likely to include: clear goals and objectives; a safe environment; freedom and risk-taking; a dynamic and forward-looking orientation; an awareness of the external environment; trust and openness; organisational slack; cross-functional interaction and freedom; a real commitment and involvement by organisational leaders; appropriate awards and rewards; time set aside for innovation and training; and autonomy and flexibility built into the organisational structure (Ahmed, 1998, Ahmed et al., 1999).

Structural empowerment

The management of a learning factory would have taken action to ensure team leaders have appropriate training to enable them to encourage their subordinates to solve their own problems. Lower level employees would have responsibility for the product or services they produce and the human resource policies would be used support empowerment. Management would be aware of the effect of the predominant social structures on lower level employees. Two of the primary responsibilities of management would be to actively monitor and/or

improve employee access to resources and information, and to establish communication and coordination across the organisation.

Communication systems

Communication systems are important for the successful implementation of both lean production and learning organisation models. The knowledge gained from individual learning and experimentation must be shared if the organisation is to gain any long-term benefit. Organisational knowledge should be available to organisational members in a form that can be communicated to others. The communication systems used by the organisation are critical, and may include email and intranet systems, providing opportunities for networking, and access to the expertise of high-level managers.

Predicted outcomes

The outcomes predicted by the model include: a productive and safe climate, high levels of interpersonal trust, high levels of commitment and participation, and improved productivity.

Productive and safe climate

Climate has been described as the 'feeling in the air' which is a reflection of the employee's interpretations of the events, actions and outcomes that arise from their interaction with organisational systems (Schneider et al., 1994, Hinsz, 1995, Wilson and Rutherford, 1989). The management of the organisation cannot directly manipulate the climate, but it can alter the organisational systems that give rise to the events, actions and outcomes, which are subject to interpretation by their employees.

A safe and productive climate is likely to be characterised by the absence of fear of being ridiculed or punished for making mistakes, and the mutual respect and openness to the ideas of others (Edmondson, 1996a, Edmondson, 1996b).

Trust in and within the organisation

In a learning factory, managers trust that employees will not take advantage of decision-making processes, and are reliable and competent to make important decisions about their work activities (Spreitzer and Mishra, 1999). Lower level employees feel trusted by the

management of the organisation and they believe that management will keep the promises made to employees in exchange for their cooperation and contribution to improvement processes.

An organisation with high levels of interpersonal trust will exhibit shared values including benevolence, integrity and respect for others, and to the extent that trust is absent, the organisation will have in place obvious penalties for breaches of trust.

Commitment and participation

In a learning factory, lower level employees can see personal benefit in contributing their ideas and putting in the additional effort to participate in the decision-making process, and are actively encouraged to participate in employee involvement programs.

Employee commitment and participation will be high, and employees will be motivated to contribute. The organisation will be using a high involvement approach to employee participation and cross-functional collaboration to solve problems, design products and undertake improvement programs, and the management will act consistently to reduce employee uncertainty.

Improved productivity

Improved productivity in the learning factory will be characterised by improved quality performance, reduced production costs and higher levels of employee and customer satisfaction.

Summary

The purpose of this chapter was to develop a comprehensive model of the learning factory that incorporates the factors that are likely to influence an employee's decision to participate more fully in a learning factory. In Chapter 3, twelve components (or groups of 'like' components) were identified as core elements of the success of a learning factory. These components are: team-based work organisation, lean manufacturing operations, continuous improvement, just-in-time inventory systems, human resource practices, supplier and customer relations, motivation systems, knowledge systems, communication systems, structural empowerment and organisational culture. Further analysis of these components identified similarities amongst the components enabling them to be grouped into three

categories: operational tools and techniques, relationship management tools, and support systems. The outcomes predicted by the model include a productive and safe work climate, trust and openness, commitment and participation at all levels of the organisation, and improved productivity. A summary of the learning factory characteristics discussed above is provided in Table 4.

Table 4: A learning factory model

Operational Tools and Techniques	
Team Based Work Organisation	• Workers organised into teams • Team Responsibilities
Lean Manufacturing Operations	• Preventative maintenance • Quality improvement • Physical flow • Process control and discipline • Synchronised work processes
Continuous Improvement	• Training in Continuous improvement and problem-solving techniques • Suggestion schemes • Short-term problem-solving groups • Long-term problem-solving groups
Just-In-Time Inventory Systems	• Pull system of inventory supply between stations • Low level of finished goods inventory • Frequent deliveries to customers • Frequent deliveries from suppliers
Relationship Management Tools	
High Commitment Human Resources Policies	• Selection on learning potential rather than existing skills • Extensive orientation and induction • Job rotation, job enrichment and multi-skilling • Skill development and training • Job security for core personnel
Customer Relations	• Close long-term relationships • Knowledge sharing • Frequent visits to and from customer plants
Supplier Relations	• Close long-term relationships • Knowledge sharing • Frequent visits to and from supplier plants

Rewards and Recognition	• Competitive pay rates and staff benefits • Payment by results • Reward programmes
Support Systems	
Knowledge Systems	• Intranet • Access to knowledge databases • Discussion groups
Organisational Culture	• Vision • Organisational values • Goals and Objectives • Policies, rules of conduct
Structural Empowerment	• Supportive leadership • Clarity of objectives • Delegation of authority • Access to resources • Access to information
Communication Systems	• Email • Access to higher level managers
Outcomes	
Productive and Safe Climate	• Absence of fear of ridicule or punishment for making mistakes • Mutual respect and openness to the ideas of others
Trust in and within the Organisation	• Shared values including benevolence, integrity and respect for others • Obvious penalties for breaches of trust
Commitment and Participation	• Employees motivated to contribute • High involvement approach • Cross functional collaboration • Consistency from management
Improved Productivity	• Improved quality performance • Reduced production costs • Higher levels of employee and customer satisfaction

Having reviewed the relevant literature in Chapters 2 and 3, the remaining chapters in this thesis now address the collection and analysis of data to determine how closely Australian organisations conform to the proposed model.

Chapter 5
Research methods

The purpose of this chapter is to discuss the data collection procedures and the methods used to evaluate the performance of four plants operating in the Australian automotive components industry and the extent to which they matched the model of the learning factory.

The chapter commences with an overview of the background to this study and the relationship with its parent studies from the UK and Australia. The second section provides an overview of the methods used in the Australian study to investigate continuous improvement and problem-solving activities. The third section provides details of the content of the survey instruments used to collect data and how they were developed. The chapter concludes with a discussion of how and why the four plants included in this study were selected for analysis in this thesis..

Background to this study: the parent studies

In 1991, Oliver, Delbridge, Jones and Lowe conducted a systematic benchmarking project of a matched sample of UK and Japanese automotive component suppliers. The study was designed to test the relationship of lean production with performance proposed by the International Motor Vehicle Program. The findings were widely reported in the press, publicised through a series of presentations to the industry and published in academic journals (Delbridge et al., 1995, Delbridge, 1995).

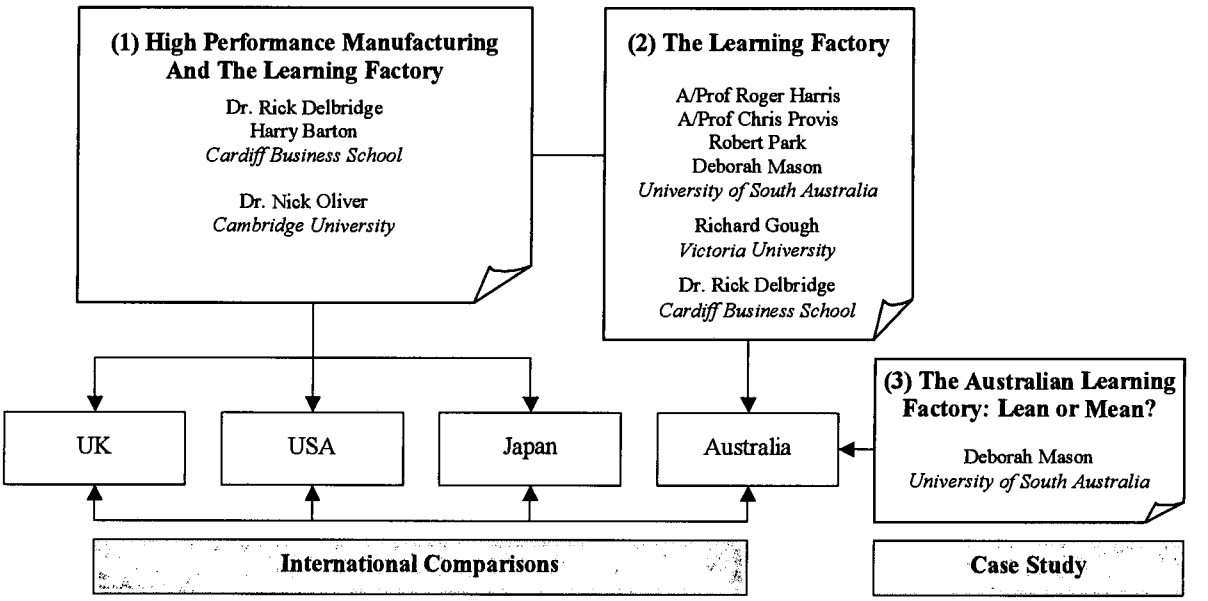
The success of the above project spawned a second, larger study, which was completed in 1994. It involved research in nine countries across Europe, North America and Asia. In total, 71 auto component suppliers were benchmarked, 13 of which achieved world-class productivity and quality performance. The top-performing plants demonstrated high levels of internal process discipline and control, consistent with the lean production model. Andersen Consulting published 30,000 copies of the report, the findings received press coverage internationally and presentations of the findings were made in several countries. This research made a significant contribution to academic debates over best practice and performance and the findings have been disseminated through leading academic journals (Oliver et al., 1994, Oliver et al., 1996).

Delbridge's study, 'High performance manufacturing and the learning factory', commenced in 1999 (Study 1 in Figure 10), and is a UK government research council project

to examine the links between problem-solving, continuous improvement and manufacturing performance. One of the objectives is to develop models of best practice for learning in a manufacturing environment. The research is an extension of the previous work and is benchmarking performance in samples of Japanese, UK and USA automotive components' makers.

In collaboration with Delbridge, a group of researchers at the University of South Australia (including the author) developed a project to extend the investigation to include automotive components' manufacturers in Australia. This project, titled "The Learning Factory" (Study 2 in Figure 10), is an attempt to examine the links between organisational learning and performance through a combination of qualitative and quantitative research into the processes and management of improvement activities. The project is investigating continuous improvement and problem-solving in sixteen organisations in Australian automotive components manufacturing. It is examining how learning structures and processes impact on productivity and performance in these organisations, and comparing the findings with those from the above-mentioned research in UK, Japanese and North American plants.

Figure 10: The parent studies



The study carried out by the author and reported in this thesis (Study 3 in Figure 10) examines a subset of the data collected during the Learning Factory project (Study 2), firstly to analyse the performance of four plants in more depth than that allowed by the scope of the parent project, and secondly to determine whether the model proposed in the previous chapter is supported in practice.

The learning factory

The objectives of the Australian study (Study 2 in Figure 10) were to investigate continuous improvement and problem-solving in different organisations in Australian automotive components manufacturing, in order to extend understanding of the management of knowledge creation and application, to examine how learning structures and processes impact on productivity and performance in these organisations, and to compare the findings with those from comparable research in UK, Japanese and North American plants.

The issues investigated by the study required the use of a combination of research approaches to examine both 'espoused theories' and 'theories-in-use' (Argyris et al. 1985) within the organisations. The proposed methodology included a robust quantitative analysis of performance and of problem-solving and improvement activities, to be complemented with qualitative data collection to allow richer examination of the processes occurring within each organisation and the impact of those processes on knowledge acquisition, development and dissemination.

From the literature, and drawing on prior work by Delbridge and his colleagues, the Australian research team (including the author) developed items for assessing the performance of organisations in the Australian automotive industry. This required the identification of measurable items which bear directly on performance, and which reflect elements of knowledge acquisition, development and dissemination within organisations. Examples included engineering changes motivated by ease-of-manufacture or cost-reduction, or acquisition of production-related skills by employees.

Robert Park, Dr. Richard Gough and the author shared the responsibility for carrying out the fieldwork. During the first visit to the participating companies, the project was fully explained and the instrument developed for the Australian study was left with the participant companies to be completed. The researchers collected the instrument on the second visit, when all responses were double-checked with participants. This process was essential for gathering the most comparable and trustworthy data possible.

The intensive qualitative phase of the study was undertaken during the second visit. Using structured interviews, the researchers explored systems and processes that affect knowledge acquisition, development and dissemination. The method used drew on MacDuffie (1995), whose approach centered on comparing problem-solving processes to ubiquitous quality problems that could not be solved by a standard procedure, stemmed from several sources and required high levels of interaction and coordination.

In contrast to traditional problem-solving models, recent studies report the importance of 'learning by doing' or 'adaptive learning' (Adler and Clark, 1991, Tyre and von Hippel,

1997). It was necessary to investigate the production conditions under which problem-solving occurs (Tyre and von Hippel, 1997), and the influences on the learning process, including the worker's own sense-making of the process (Weick, 1979) and the role of the physical environment (MacDuffie, 1995). The data included details of technology and managerial practices, the firm's employee relations climate, the nature of social relationships in the workplace, and the firm's relationships with customers, suppliers and government. The methods used in this phase of the study included in-depth interviews with selected production workers, supervisors and managers (taped if agreed to by interviewees, otherwise noted), content analysis of relevant company documents and records and observations of the shopfloor.

The sample for study comprised automotive component parts' suppliers – five in Victoria and 11 in South Australia (over 75% of companies in the Australian industry are in those States). The criteria for selection were: (a) membership of the Federation of Automotive Products' Manufacturers (FAPM); (b) first tier suppliers; (c) performance on FAPM's most recent quality survey; and (d) willingness to participate in the study.

Data collection methods

As noted above, The Learning Factory study used questionnaires, semi-structured interviews, on-site observations and analysis of company documents and records to gather information on plant performance, management practices, continuous improvement and problem-solving activities.

Questionnaires

The questionnaires recorded the data required for the performance evaluations and also collected information on key management practices and the operating conditions of the plant (see Appendix I). Some questions requested information for two separate time periods: 1994 and 1999. This was to enable the research team to make comparisons over time for each respondent and against international benchmarks for each of these two time periods. The questionnaire was designed so that different specialists could complete individual sections of the instrument.

Each questionnaire had two parts, management practices and plant performance. The first section included questions related to problem-solving and continuous improvement, worker responsibilities and organisation, human resource management, relations with

suppliers and relations with customers. The second section asked a series of questions about the volume, quality and variety of finished goods that each plant produces, which were to be used to give each plant a score on a series of dimensions of management practice.

The methodology was designed to perform audits at the plant level. The purpose of the methodology was to permit detailed comparison of manufacturing performance between plants (producing similar products) and to 'profile' the management practices of these plants.

Semi-structured interviews

The interview design used by the Cardiff University research team for the previous studies was unstructured, dispensing with interview schedules and ordering of questions to allow the conversation to flow with minimal control so as to elicit as much in-depth information as possible. This interview method was considered appropriate in large part as a majority of the researchers had extensive prior experience with the subject-matter and with the participants in the UK, USA and Japan, some of whom had by then participated in four studies over a period of eleven years. However, in the Australian study, the members of the research team undertaking the fieldwork were relatively inexperienced and unfamiliar with the types of questions and prompts used by the Cardiff team to draw out the required information, and therefore decided to develop an interview schedule (refer to Appendix II) to use as a guide. The author developed the schedules in collaboration with Delbridge.

The interview schedules resemble ones that would be used for a structured interview. The questions were carefully ordered and worded, with the questions divided into sections (Minichiello et al., 1995). However, all of the questions were open-ended, and as a result, the responses often led to further questions that were not necessarily included on the schedule, but which added to the richness of the data obtained.

During the interviews the researchers tended to follow the question order of the schedule, but rather than reading the questions word for word, the questions were asked in language that was thought appropriate for the skill or ability level of each of the respondents.

In-depth interviews were conducted with the general manager, a number of functional managers including continuous improvement managers, quality engineers, human resource managers, customer relations managers, supplier development managers, production managers, and industrial engineers, maintenance technicians, team leaders and production workers. The shopfloor personnel who participated in the in-depth interviews, however, were not selected by the research team, but by the management of the participant company, introducing the possibility of bias.

Although a different interview schedule was developed for each type of employee, the first two sections of each schedule were identical. These sections included:

- questions related to the respondent's identity, current position and length of service
- a question to determine how each respondent interpreted the term 'continuous improvement'
- descriptive and knowledge questions relating to the management of continuous improvement activities within the plant

The remaining sections of each schedule were tailored to the position of the respondent and included questions related to:

Customer relations managers:

- Managing relationships with customers

Production supervisors:

- Recruitment and selection
- Induction and training
- Shop-floor operations
- Supervision and management practices
- Employee career progression
- Communication

Continuous improvement managers:

- Specific continuous improvement policies and practices

Industrial engineers:

- Shop-floor operations

Shop-floor operators:

- Shop-floor operations
- Induction and training
- Job content
- Communication

Human resources managers (heads of personnel):

- Recruitment and selection
- Pay and benefits
- Job content
- Supervision and management
- Career progression
- Communication

Quality engineers:

- Shop-floor operations

Supplier development managers:

- Shop-floor operations

Observations: factory tours

During the first visit to each plant, the research team was taken on a tour of the factory floor, during which the researchers were able to observe production processes, work flow and the level of inventory held at each stage of production. Whenever possible, two members of the research team would attend the first visit to each of the plants. This enabled one team member to take the lead during the tours, asking questions about the processes, work practices and inventory systems, thus enabling the second team member to observe what was happening on the floor with only minor distraction from the host or guide. The second team member was required to closely observe and document anything of interest during the tour. This might include: interactions between workers, reactions to visitors on the floor, the condition of typical work spaces and the content of notice boards.

Documentary sources

Documentary sources analysed during the study were gathered from a variety of sources, including: information available in the public domain, such as company websites, company reports, articles in industry magazines or publications by the professional body; and documents provided by the plant.

The Australian learning factory: lean or mean?

The research design for this study (Study 3 in Figure 10) is an example of a mixed methodology. Often where both qualitative and quantitative methods are used, this represents an attempt to overcome or compensate for some of the limitations inherent in each approach and also to develop a richer, more complete picture of the phenomenon being studied (Foster, 1997, Rabinowitz and Weseen, 1997). Quantitative methods can identify what 'is' or 'is not' and tell us how many of 'it' there are likely to be in similar settings, but often cannot accurately determine 'how' or 'why'. Qualitative methods can often describe what 'it' looks

or feels like, how and why 'it' looks like that in a particular setting, but not how likely it is that 'it' will or does occur elsewhere.

The use of a single method for the study of a social phenomenon gives only a partial explanation at best:

> *To understand the methods of social scientific research, you must appreciate that there are multiple methods that give useful information primarily when used in combination. No one procedure or method can provide a complete description.*
>
> (Judd, Smith & Kidder, 1991, p.4)

However, as with many examples of the use of multiple methods in empirical research in the social sciences (Judd, Smith & Kidder, 1991; Rabinowitz & Weseen, 1997), despite the extensive collection of qualitative data, the primary focus of the parent studies is on the quantitative data, with minimal use of qualitative data to support the quantitative findings.

This may be due to a number of reasons including the intended audience of the research findings (predominantly engineers) and the need to develop statistical support for the concept of world-class performance. Other likely contributing factors could be the sheer volume of the data collected, the relative ease of undertaking statistical analysis of quantitative data compared with analysing qualitative data and the time limitations imposed by the structure of the study.

The study in this thesis is an in-depth study of both the qualitative and quantitative data relating to four of the sixteen plants included in The Learning Factory study. The research design makes extensive provision for triangulation of data, which enables the author to evaluate a number of issues from different viewpoints.

Triangulation is described as using different types of measures or data collection techniques to investigate the same variable (Neuman, 1997). Many of the questions asked in the questionnaire are also asked during the semi-structured interviews, and a number of questions are asked of each interviewee. This enables factual responses to be verified and comparisons to be made of perceptions of reality between different levels of the hierarchy.

The participant companies

All four of the plants selected for this thesis are located in South Australia, and the author was the primary investigator during the fieldwork at these sites, with some assistance from Robert Park. Thus, a significant proportion of the data (approximately 85%) was collected and verified by the author.

The following sections introduce each of the plants included in this study by discussing their company profiles and backgrounds. The general information is drawn from company web sites and promotional material, and as such represents the public persona of each company. Each plant supplied the data related to general plant characteristics in The Learning Factory questionnaire.

Company A

Company A is a multinational company, employing 21,000 people across 89 countries. The company operates 17 automotive manufacturing plants, 11 industrial manufacturing plants and 12 recycling facilities worldwide. Company A is the largest manufacturer of automotive lead acid batteries in Australia and New Zealand. The plant investigated during this study employs over 700 people in the northern suburbs of Adelaide, and is a major supplier to new vehicle manufacturers, namely Ford, Holden and Mitsubishi.

All products are manufactured and distributed to meet the highest quality standard and to meet or exceed the Australian Standard 2149, and the plant has attained QS9000, ISO9001 and ISO4001 quality and environmental accreditation.

Table 6: Plant A – general characteristics

PLANT CHARACTERISTICS	1994	1999	% Change
Total Value of Sales	$87,488,000	$89,475,000	+2.27%
Indirect Employees	89	74	-16.85%
Factory direct headcount	255	202	-20.78%
Capacity utilization (%)	85%	85%	0%
% of assembly steps automated	10%	20%	+100%

Company A's stated objectives are as follows:

- Achieve a high level of customer satisfaction by consistently meeting customer needs and expectations.
- Provide all [Company A] associates with adequate training in order to understand and implement the ISO 14000, QS & ISO 9000 series and AS4804 standards.
- Provide all associates with learning opportunities to improve all aspects of business and achieve sustainable growth through people working in an environment of continuous improvement.
- Provide leadership in protection and preservation of the environment by re-cycling materials.

Company B

Company B is a vertically integrated supplier of functional seating systems for domestic and international automotive assemblers. It is a major supplier to all vehicle manufacturers in Australia, including Ford, Toyota, Mitsubishi and Holden.

Table 7: Plant B – general characteristics

PLANT CHARACTERISTICS	1994	1999	% Change
Total Value of Sales	DNA[2]	DNA	DNA
Indirect Employees	50	53	+6.00%
Factory direct headcount	103	115	+11.65%
Capacity utilization (%)	DNA	80%	DNA
% of assembly steps automated	DNA	DNA	DNA

The metals plant investigated in this study is located in the southern suburbs of Adelaide and employs 156 people. It supplies metal components to other plants in the Company group, and to other (unrelated) seating system manufacturers in Australia and overseas. The plant has achieved Q1 (Ford), QS 9000, ISO 14001 and ISO/TS 16949 certification.

Company C

Company C is a major supplier of automotive equipment to the OEM worldwide, specialising in vision and lighting systems. The plant included in the study designs and manufactures interior and exterior rear view mirrors for passenger and commercial vehicles. The plant is located in the southern suburbs of Adelaide and employs approximately 823 people. Their customer base includes Ford USA, Mazda, Suzuki and Isuzu in Japan, and Ford, Holden, Toyota and Mitsubishi in Australia.

The plant attained ISO 9001 accreditation in 1994, QS 9000 in 1997 and has won a number of quality awards including The Australian Quality Award for Business Excellence, SA Manufacturer of the Year Award, SA Exporter of the Year and the FCAI Manufacturer of the Year.

[2] DNA – Data not available

Company C claims to have adopted lean principles into its manufacturing operations, management structures and business processes as well as encouraging its suppliers to achieve best practice. The company has espoused a commitment to an ongoing programme of personnel development and makes extensive use of teams.

Table 7: Plant C – general characteristics

PLANT CHARACTERISTICS	1994	1999	% Change
Total Value of Sales	$70,105,000	$118,489,000	+69.01%
Indirect Employees	288	292	+1.38%
Factory direct headcount	419	435	+3.82%
Capacity utilization (%)	80%	85%	+6.25%
% of assembly steps automated	45%	60%	+33.33%

Company D

Company D is a multinational group of businesses operating in China, South East Asia, Australia and New Zealand, employing over 1,000 people. The company has been operating in South Australia for 30 years and produces medium to large injection moulded components. The South Australian plant is located in the northern suburbs of Adelaide and employs approximately 180 people.

The company is committed to product performance, quality assurance and on-time delivery, and has achieved ISO 9001 and QS 9000 accreditation.

Table 8: Plant D – general characteristics

PLANT CHARACTERISTICS	1994	1999	% Change
Total Value of Sales	$19,051,000	$24,370,000	+27.92%
Indirect Employees	43	34	-20.93%
Factory direct headcount	79	77	-2.53%
Capacity utilization (%)	35	55	+57.14%
% of assembly steps automated	25	30	+20.00%

Data analysis

As the study was limited to an in-depth analysis of four cases, it was considered

inappropriate to use data analysis software such as SPSS. The data were entered into a Microsoft Excel workbook. The graph capability and statistical functions of Excel proved to be more than adequate for the purposes of this study.

The qualitative text was entered into a Nud.Ist (version 5.0) database. The questions included in the interview schedules were coded to enable the researcher to search both by question number and key word.

Summary

This chapter has described the data collection procedures used in this study, and how this study is related to the parent studies being undertaken in the UK and Australia. It has explained how this study is analysing, in-depth, four automotive component plants in different regions of Adelaide.

The next chapter presents the results from the data analysis.

Chapter 6
Presentation of results

This chapter presents the results of the study into the management practices and performance of four automotive components manufacturers located in South Australia. It examines both the quantitative and qualitative data on the four plants described in Chapter 5 with respect to the research of the learning factory.

The divisions within the chapter focus on the research model presented in Chapter 4. The major sections relate to operational tools and techniques, relationship management tools, support systems and predicted outcomes.

Operational tools and techniques

This section addresses each of the operational tools and techniques described in Chapter 4, and include team-based work organisation, lean manufacturing operations, continuous improvement and just-in-time inventory systems.

Team based work organisation

There were two measures of team-based work organisation included in the research model - whether or not production workers are organised into work teams, and the type of responsibilities assigned at the team level.

Workers organised into teams

Of the four plants included in this study, only one, Plant D, reported low use of teams on the factory floor (25%). One hundred percent of Plant A's direct employees are organised into teams, 90% of Plant B's and 95% of Plant C's. The number of members in each team ranged from 4 (Plant D) to 12 (Plant A).

It is important to note that the instruments developed for the parent studies did not investigate the type, scope or structure of the teams used in each plant, which, based on observations during the shop floor tours of each plant, varied considerably from one plant to another. For example, whereas the teams in one plant (Plant B) could only be described as a collection of people who, while working independently of each other, were under the supervision of a team leader, at least one of the plants (Plant D) in the study was operating semi-autonomous and interdependent teams.

Team responsibilities

Production workers and team leaders in Plants B and C are responsible for work allocation (90% in each case), and have considerable input into setting the work pace (50% and 80%). The production workers at Plant A have no input into work allocation and team leaders have only limited input (only 10%), though these two groups have complete control over work pace (100%).

In Plant D, the production workers and team leaders have only limited responsibility for work allocation (10%) and no control over the work pace (0%). Although production workers and team leaders at Plant B shoulder 70% of the responsibility for production scheduling, the same workers at Plants A and C only have limited responsibility (30% and 10%) and those at Plant D have no responsibility at all (0%). Figures 11 and 12 present the breakdowns of the key team responsibilities of work allocation and work pace by worker types.

Figure 11: Work allocation

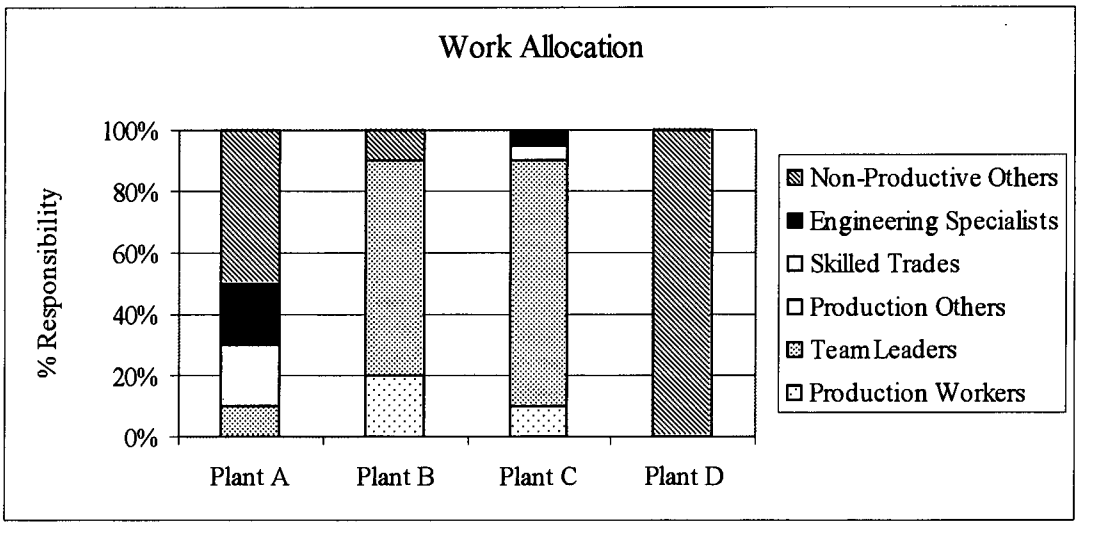
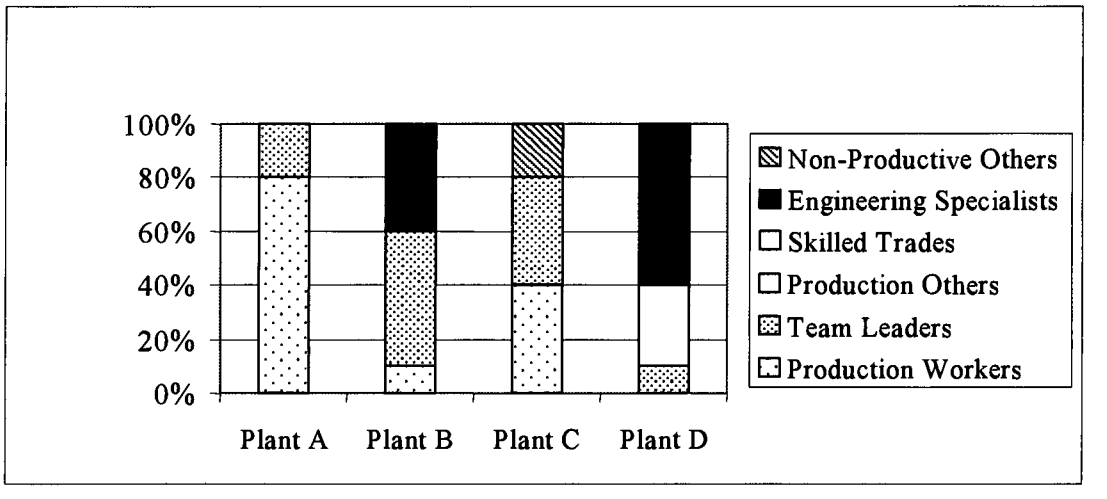


Figure 12: Setting work pace



Only one of the plants, Plant C, involves production workers and team leaders in decisions regarding the hiring (85%) and dismissal (90%) of employees (See Figures 13 and 14).

Figure 13: Hiring decisions

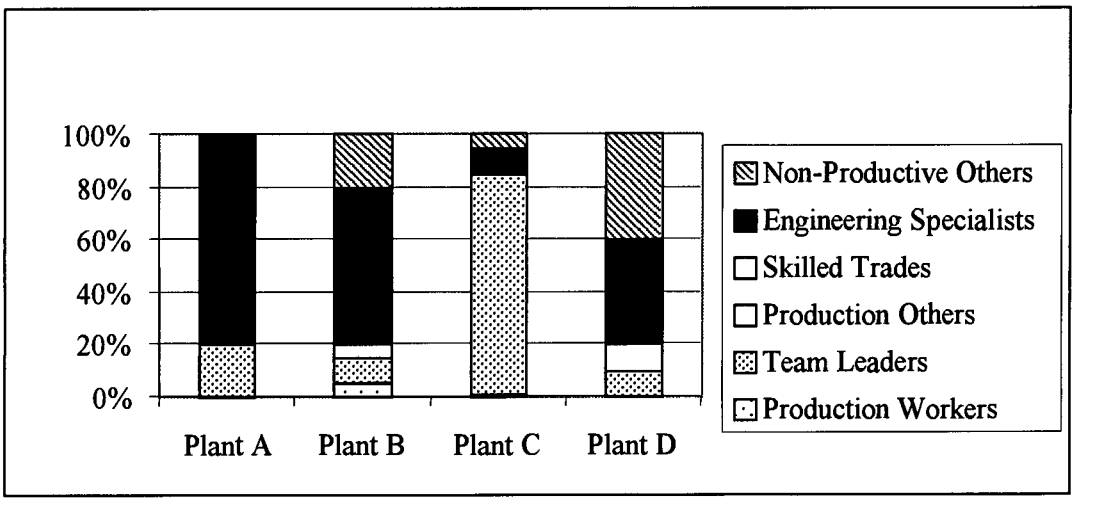
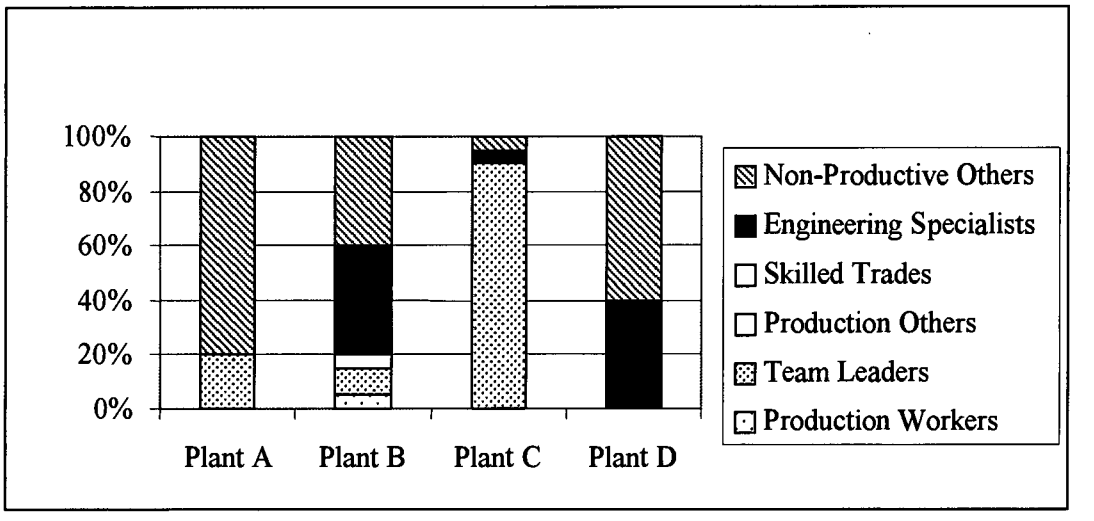
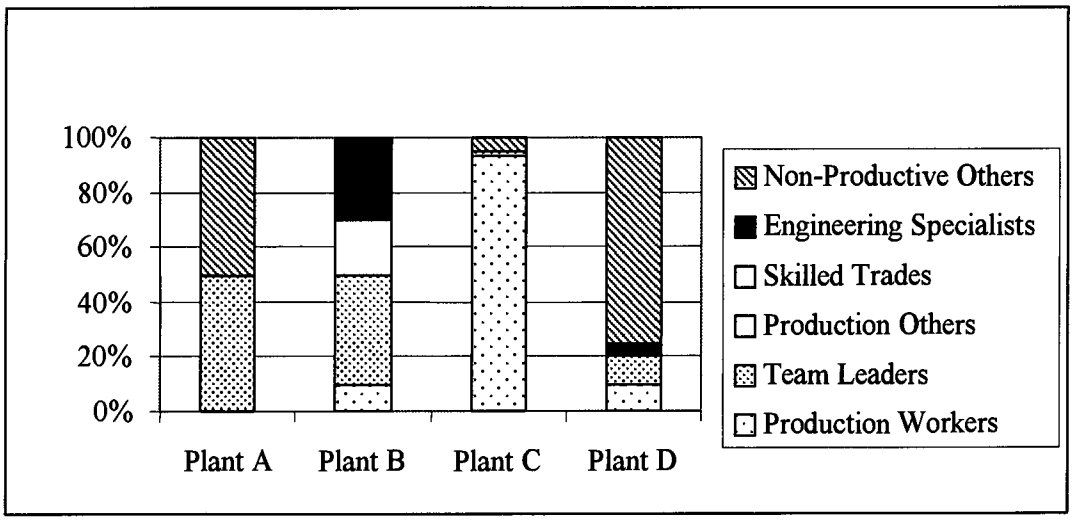


Figure 14: Dismissal decisions



Plant C reported that production operators make 93% of the decisions regarding training activities. However, this is quite misleading (Figure 15). This plant offers comprehensive in-house training up to and including accredited trade certifications. The decisions these employees are faced with tend to be, as one shop floor employee put it, "You do the training, or you look for another job", rather than decisions regarding the content and availability of training. Non-productive others (management) and team leaders share responsibility for the majority of decisions about training activities in Plant A. At Plant B, engineering specialists, skilled trades, team leaders and production workers share the decisions, while at Plant D; the managers make most of the decisions.

Figure 15: Training activity decisions



Lean manufacturing operations

The measures of lean manufacturing operations included in this study were preventative maintenance, quality improvement processes, physical flow on the production line, process control and discipline and synchronised work processes.

Preventative maintenance

All of the plants in the study schedule planned preventative maintenance (refer to Figure 16) in addition to maintenance on the basis of monitoring (Figure 17). Plant A shares the responsibility for planned preventative maintenance between engineering specialists and skilled trades, and skilled trades bear 80% of the responsibility at Plant D. Although Plant C's team leaders bear 70% of the responsibility for pre-planned preventative maintenance, this plant is the only plant in the study to use production workers to undertake preventative maintenance. Plant B relies predominantly on engineering specialists with support from skilled trades and team leaders.

Both Plants C and Plant D reported that skilled trades bore 100% of the responsibility for undertaking preventative maintenance scheduled in response to performance data collected on each machine. At Plant A, skilled trades bore 60% of the responsibility with the remainder shared between engineering specialists and team leaders. At Plant B, engineering specialists bear 70% of the responsibility with the support of skilled trades (20%) and team leaders (10%).

Figure 16: Responsibility for pre-planned preventative maintenance

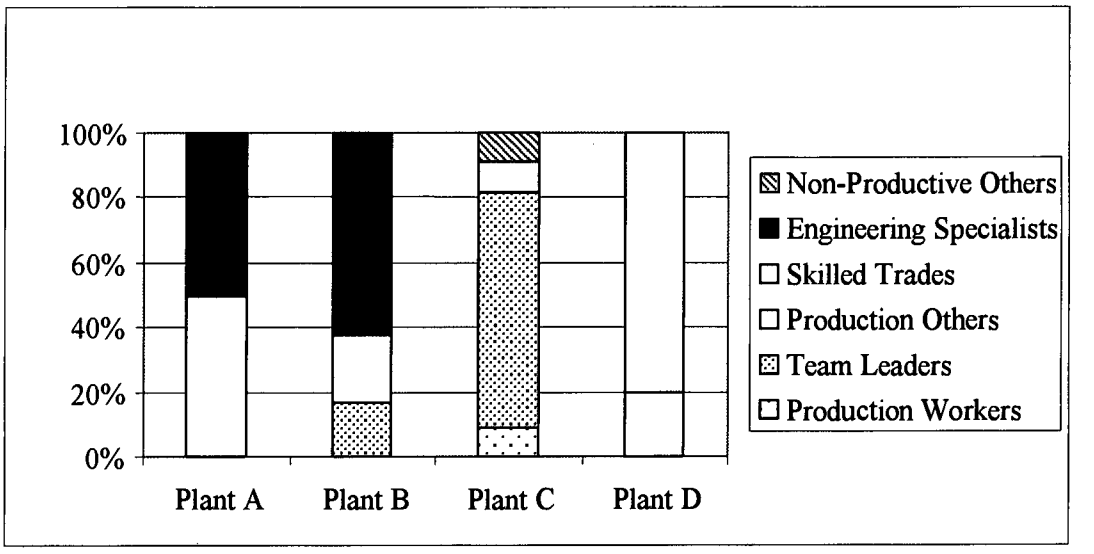
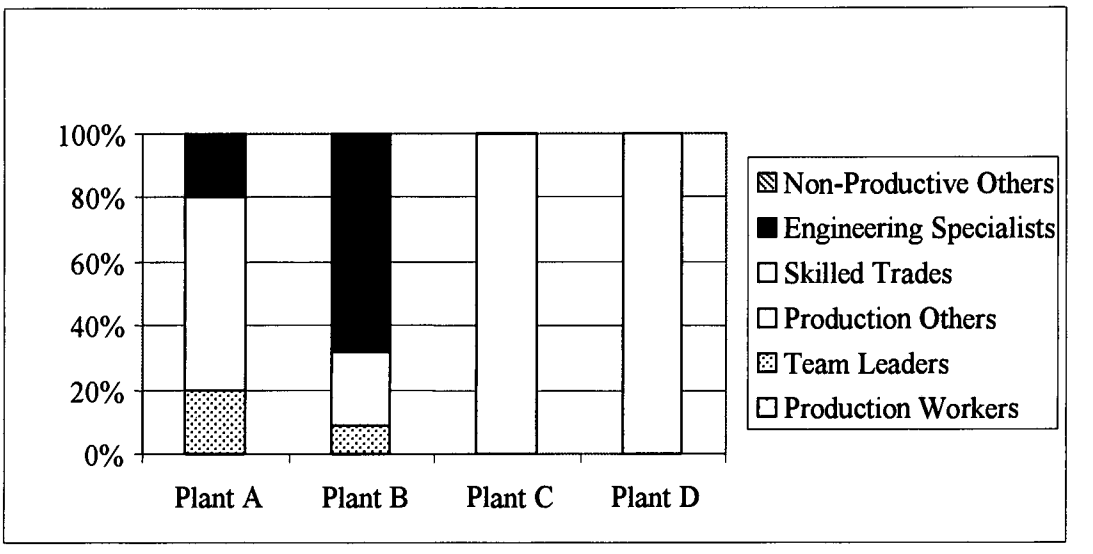


Figure 17: Responsibility for preventative maintenance based on monitoring



It is possible that the type of equipment utilised by each plant may offer a partial explanations for the differences. Although Plants C and D manufacture different components, they both employ the same basic technology to produce their products.

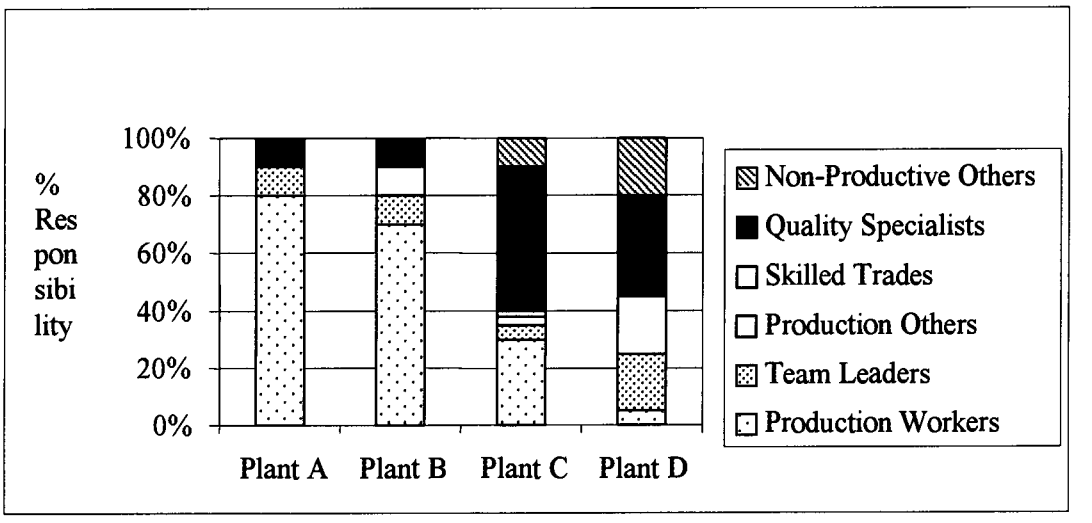
Quality improvement

Two of the plants, A and B, rely heavily on the input of production workers and team leaders to monitor quality (90% and 80% respectively), whereas Plants C and D expected a lower level of input from the production floor (35% and 25% respectively), choosing to rely more on quality specialists and non-production others (see Figure 18).

Plant A makes extensive use of daily meetings to make sure that operators are reviewing the quality data, rather than just recording them. Plants B and D use standardised

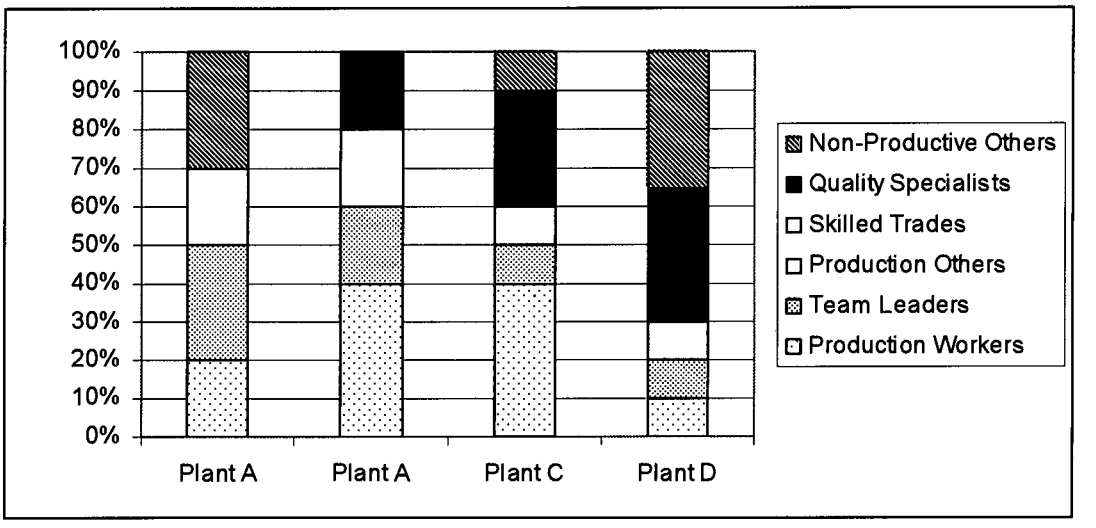
procedures to enable operators to monitor their own quality performance at specific times during the job cycle.

Figure 18: Monitoring quality performance



Quality improvement on the other hand is shared fairly evenly between production floor workers, skilled trades and quality specialists in all four of the plants (Figure 19). Production workers and team leaders make a significant contribution to quality inspection in all four plants with support being provided by quality specialists.

Figure 19: Quality improvements



Physical flow

Although data regarding physical flow were not collected during the parent study, the author was able to observe the factory layout during factory tours, and although many of the managers spoken to during these visits pointed out new initiatives which were slowly moving

each of the plants towards the ideal, the organisation on the factory floors tended to follow a more traditional factory model.

In all four plants, the layouts within sub-sections of the production process were arranged in a linear or cellular fashion. However, in most cases these sub-sections were not physically located next to the following step in the production process and, as a result, work in progress had to be man-handled or transported from one area of the factory to another.

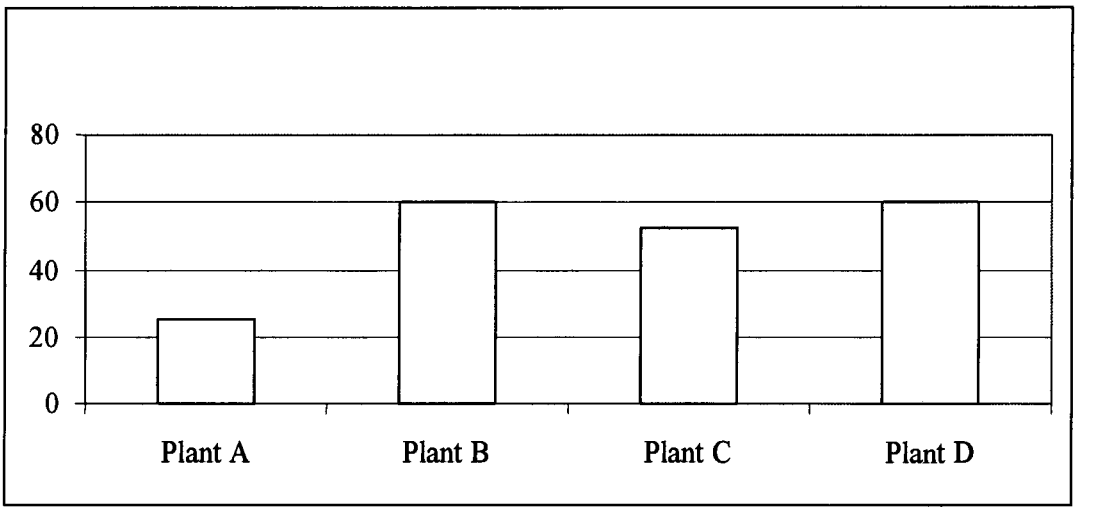
Process control and discipline

All four plants in the study make extensive use of standard operating procedures (SOPs). The standard operating procedures are maintained as a part of the quality assurance process and are considered control documents. In all four plants, suggestions for alterations to the standard operating procedures may be made by anyone, but at three of the plants, the suggestion must be vetted and approved by senior managers (the production engineers at Plant A and B, and the General Manager at Plant D) before the control document is altered to reflect the change. However, at Plant C, the change can be authorised by a line leader or supervisor.

Synchronised work processes

The typical job cycle time reported by all four plants was 60 seconds or less (Figure 20). During plant visits, synchronisation of the job cycles was reported to be one of the aims of the improvement processes at all four plants.

Figure 20: Job cycle time (in secs)



The managers highlighted areas of the plants where job cycles had been successfully synchronised within sections of the plant, but reported difficulty achieving synchronisation across the entire production process.

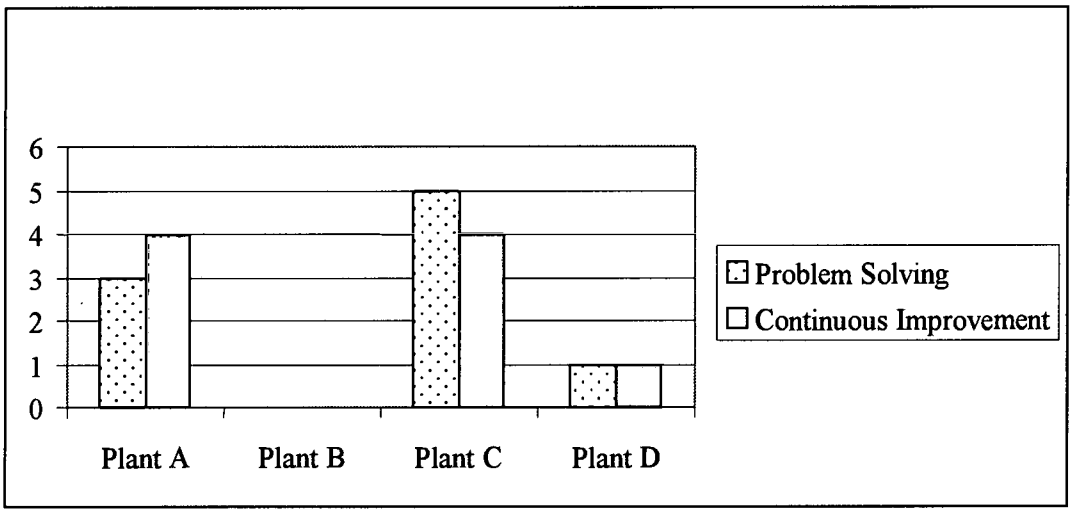
Continuous improvement and problem-solving

The measures selected to measure continuous improvement and problem-solving included: worker responsibility for and training in continuous improvement and problem-solving techniques; suggestion schemes; short-term problem-solving groups; and long-term problem-solving groups.

Worker responsibility for continuous improvement and problem-solving

Three of the four plants have personnel with direct management responsibility for shopfloor problem-solving and continuous improvement, and all four plants have a budget for continuous improvement activities in 1999. Two of them, Plant A and Plant D, did not have this budget item in 1994 (Figure 21).

Figure 21: Personnel with direct responsibility for problem-solving and continuous improvement



In many of the interview transcripts of all four plants, involvement in continuous improvement or problem-solving activities was described as a right of shop floor workers. For example, one manager claimed, "all operators have the right to put forward suggestions for improvements". However, one of the main complaints of shop floor workers was that they had very little or no involvement in the improvement process arising from their suggestions and that they frequently received no feedback on the outcomes of their suggestions.

The general impression was that, although management was eager to receive suggestions from lower level employees, and indeed all the managers interviewed expressed the desire to capitalise on the ideas from shop floor operators, they also expressed the belief that the management of the improvement projects arising from these suggestions would be handled more effectively by higher level or middle managers.

One of the constraints on improvement activities commonly cited by shop floor operators and team leaders was the fear of improving oneself out of a job. On the other hand, management assumed that shopfloor workers understood that, unless they made a contribution to the viability of the plant, the jobs would cease to exist. Although many of the managers interviewed felt that keeping their jobs was sufficient reward for the contribution of shop floor workers, as indicated by the following passage, at least one manager was well aware of this issue and was developing a training strategy to counteract its effects.

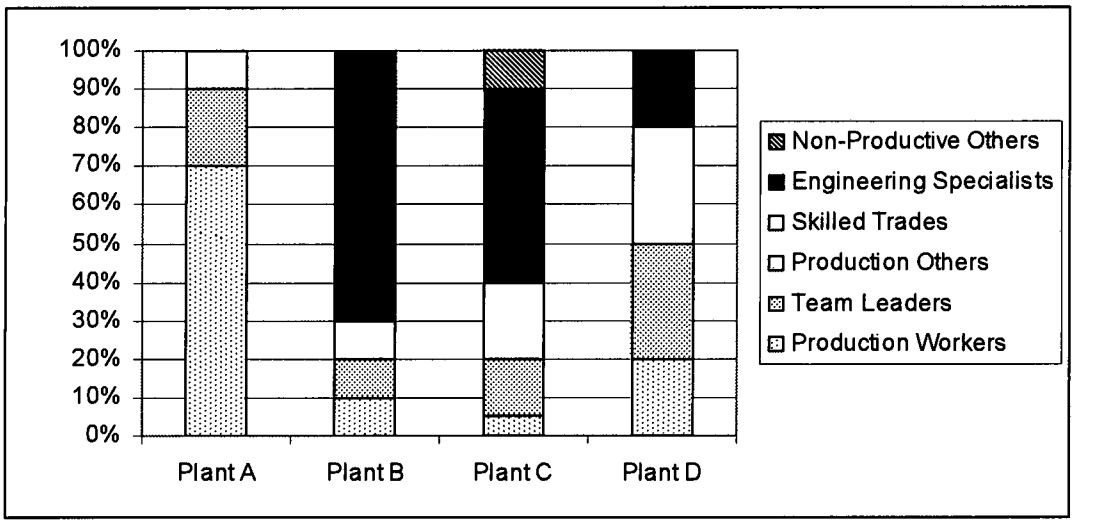
Q: How would an individual contribute to continuous improvement activity?

A: Any way they can, and to expand on that further, the only way that you can really get everyone contributing to the effort is:

a) they have to understand what it is,
b) they have to feel secure in the fact that it's not going to eventually affect their job, and
c) they have to see that in some form or another, there is a reward there for them other than just 'I've got a job tomorrow'.

Responsibility for process improvements is varied across the plants.

Figure 22: Process improvements



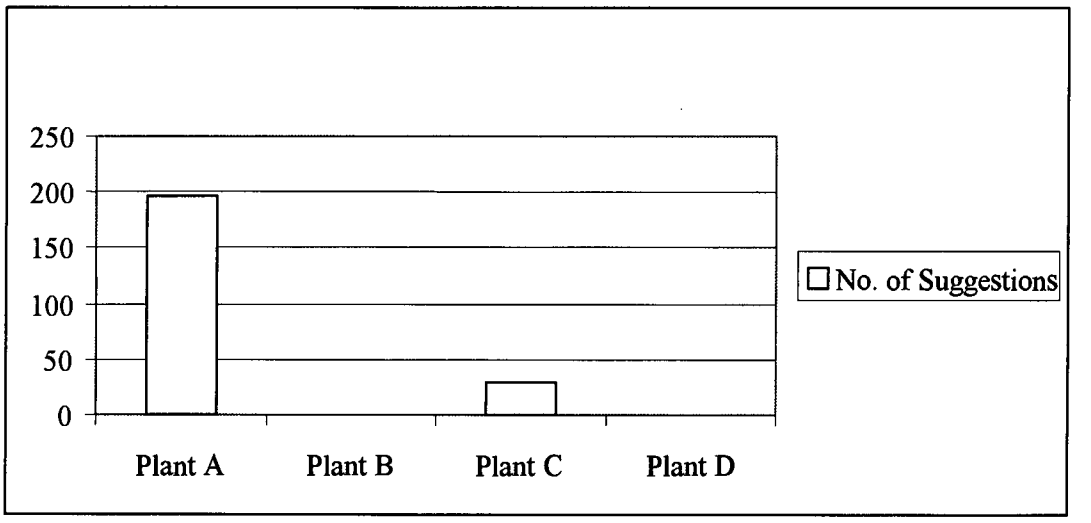
Production workers and team leaders at Plant A have a combined responsibility of 90%, and at Plant D, 50%, whereas at Plants B and C they only bear only 20% responsibility (Figure 22).

Suggestion schemes

Only two of the plants in the study used suggestions schemes as a method of engaging employees in the improvement process (Figure 23).

Both of these plants had introduced their suggestion schemes at some time between 1994 and 1999. The other two plants reported that they did have suggestions schemes in 1994 and had since dismantled them. Plant B had several management changes between 1994 and 1999, and each new manager introduced new ideas and different ways of doing things, which included the dismantling of the suggestion scheme.

Figure 23: Total number of suggestions submitted by production operators in 1999



Short-term problem-solving groups

All four of the plants in the study use short-term problem-solving groups to investigate ideas for process improvements. Although information about the percentage of production workers involved in these groups was not available for Plant C, with the exception of Plant B, the percentage of production operators involved in short-term problem-solving teams is higher than that for long-term problem-solving groups. The group size varied from five to nine (Figure 24).

On average, Plants B and D included one production operator in each group, while Plants A and C included three (Figure 25).

Figure 24: Percentage of production operators in short-term problem-solving groups

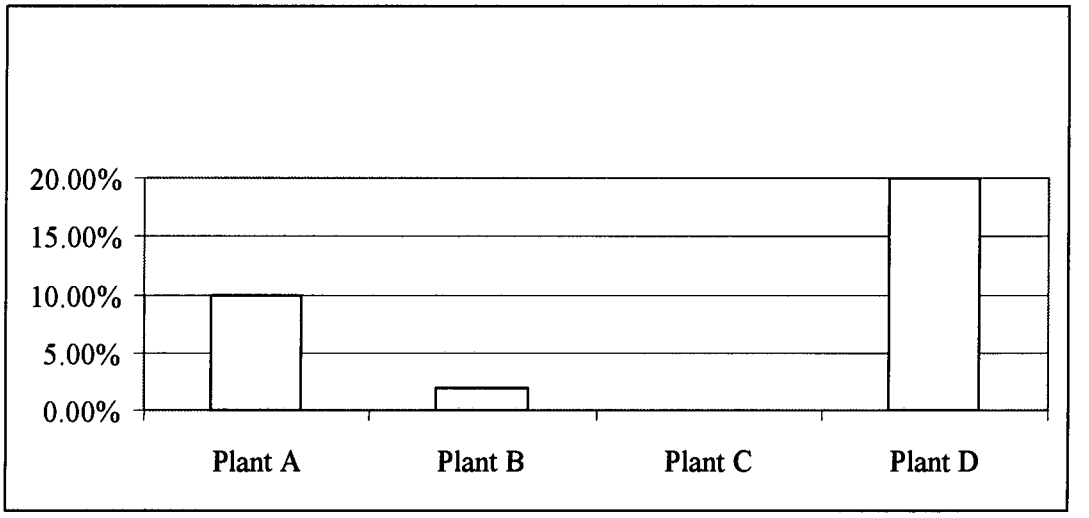
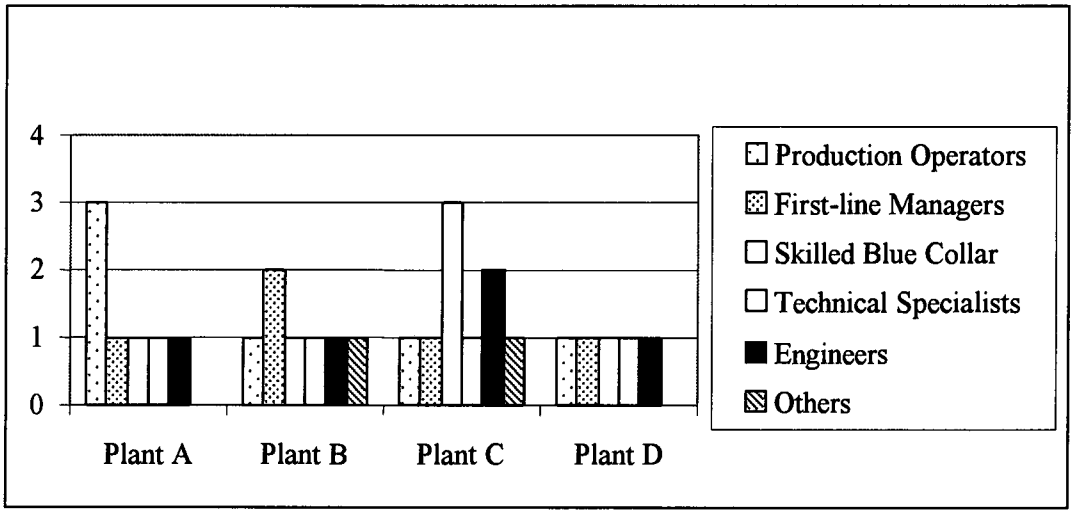
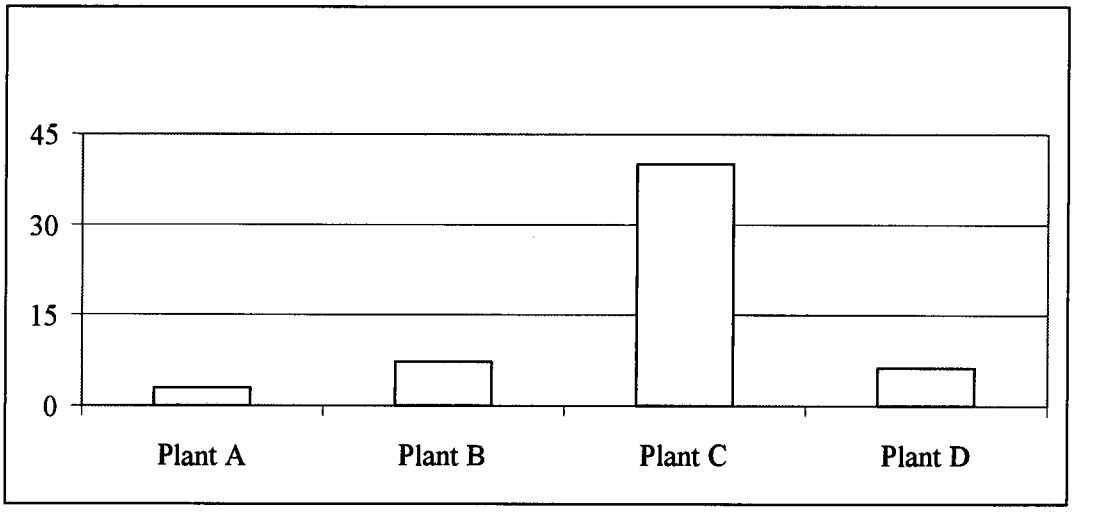


Figure 25: Composition of short-term problem-solving groups



The amount of time allocated for group meetings ranged from three to 40 hours per month. Management directs the tasks and objectives of short-term problem-solving groups in each of four plants, and they do not have their own budgets (Figure 26).

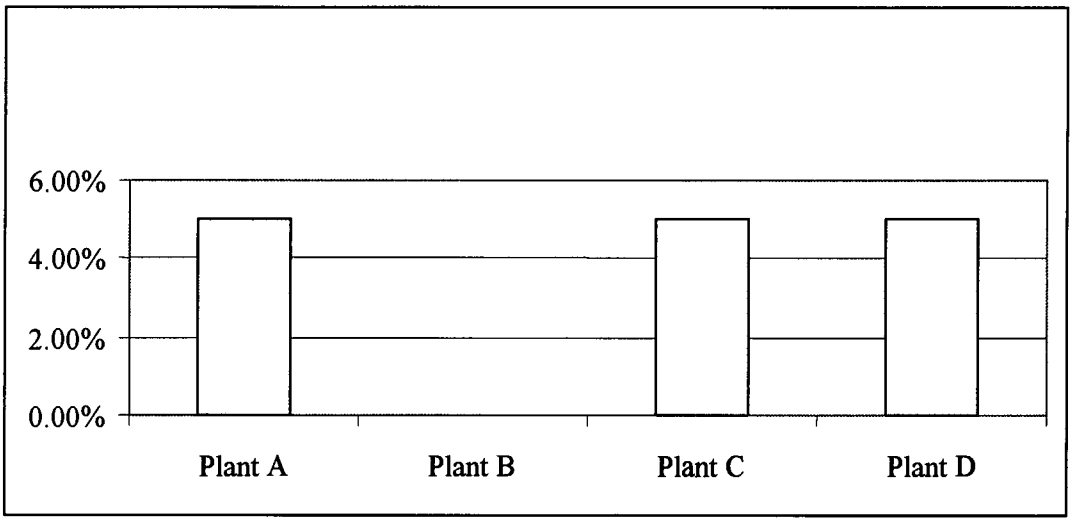
Figure 26: Time allocated for meetings (in hours)



Long-term problem-solving groups

The percentage of operators involved in long-term problem-solving groups was low for the three plants that use long-term problem-solving groups to manage improvement projects. All three plants reported that at any one time, approximately five percent of their production workers were assigned to one of these groups (Figure 27).

Figure 27: Percentage of operators involved in long-term problem-solving groups



These groups ranged in size from five to 10 members, however, all three plants stated that on average only one team member would be drawn from the production line (Figure 28). The time allocated for meetings ranged between two and six hours per month (Figure 29). Management directs the tasks and objectives of short-term problem-solving groups in three of the four plants, with the exception of Plant C. Only Plant A provided these groups with an operating budget.

Figure 28: Composition of long-term problem-solving groups

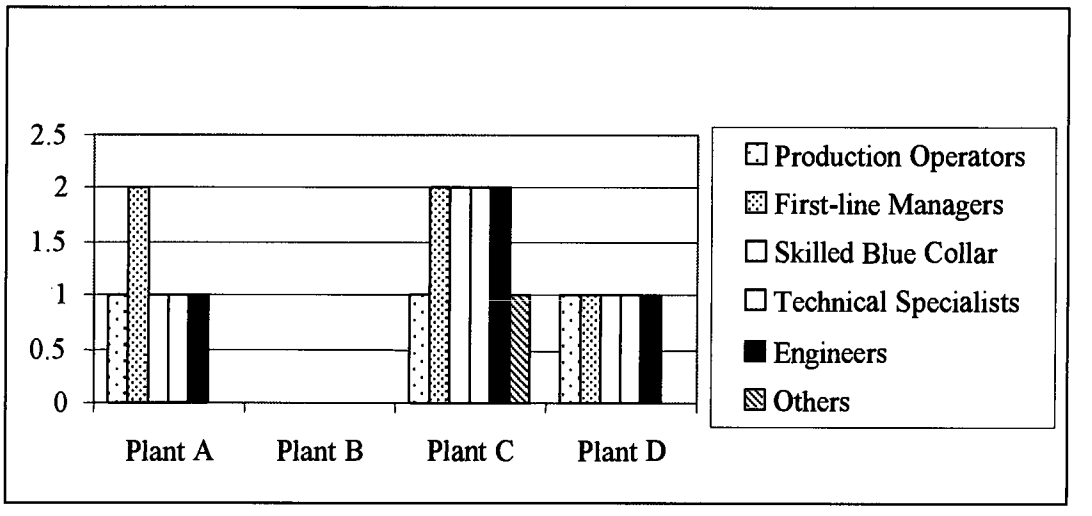
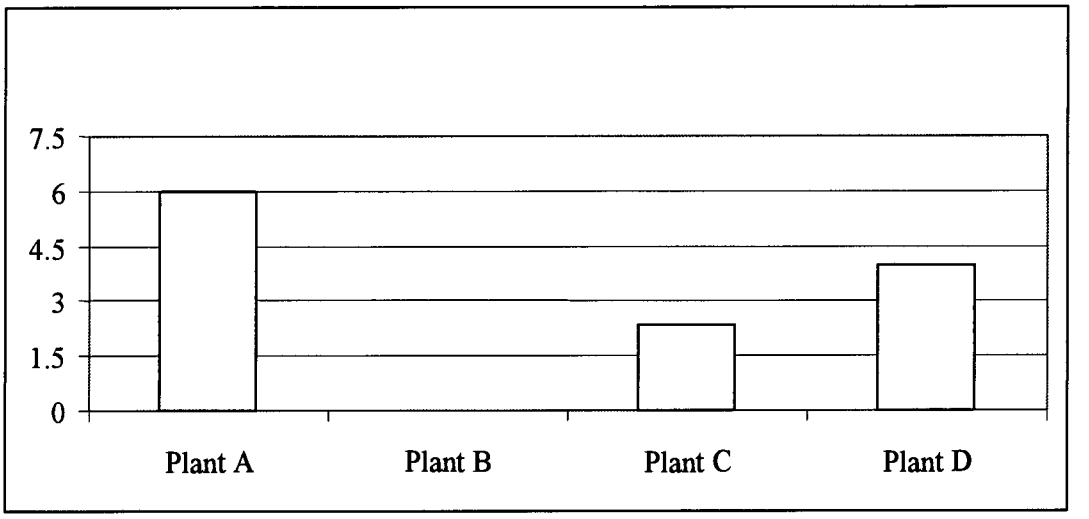


Figure 29: Time allocated for meetings (in hours)



Just-in-time inventory systems

As the objective of just-in-time inventory systems is to eliminate inventory buffers and to procure, hold or produce materials or components that are immediately required for the next step in the production process, this section investigates pull systems of inventory supply between work stations, the level of finished goods inventories, frequency of deliveries to customers and frequency of deliveries from suppliers.

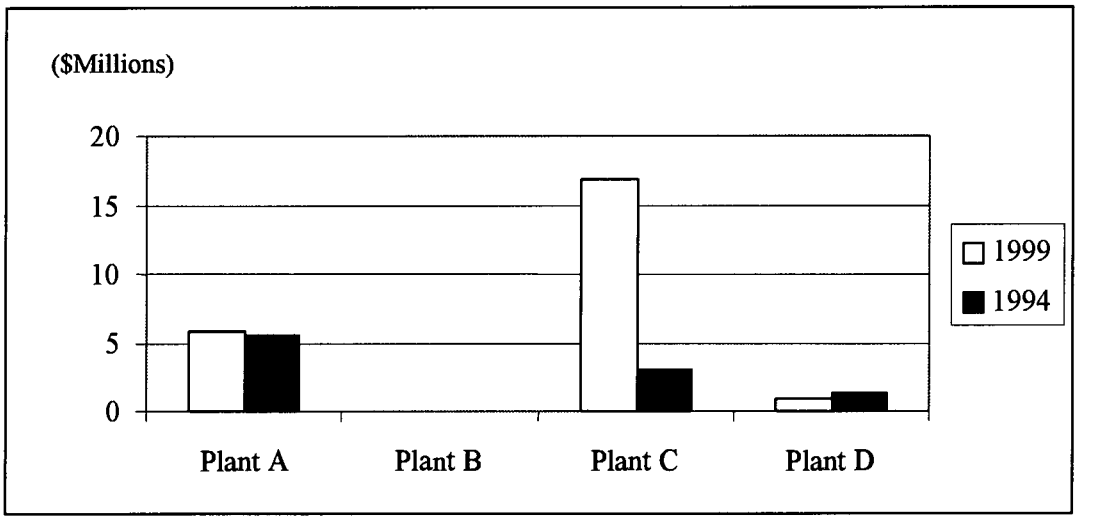
Pull system of inventory supply between stations

Although two of the plants in the study (Plants C and D) used a *kanban* card system to 'order' components from the previous step in the production process, all of the plants had holding areas for storing work-in-process between stations. For example, Plant C holds one to two days of stock between stations.

Finished goods inventory

A low level of finished goods inventory is one of the features of lean production and a learning factory. Of the three plants that were able to provide data regarding the finished goods inventory as at the end of the 1993 –1994 and 1998 – 1999 financial years, two reported an increase in finished goods inventories. Plant C reported an increase in the order of 82% (Figure 30).

Figure 30: Finished goods inventory 1994 and 1999



Frequent deliveries to customers

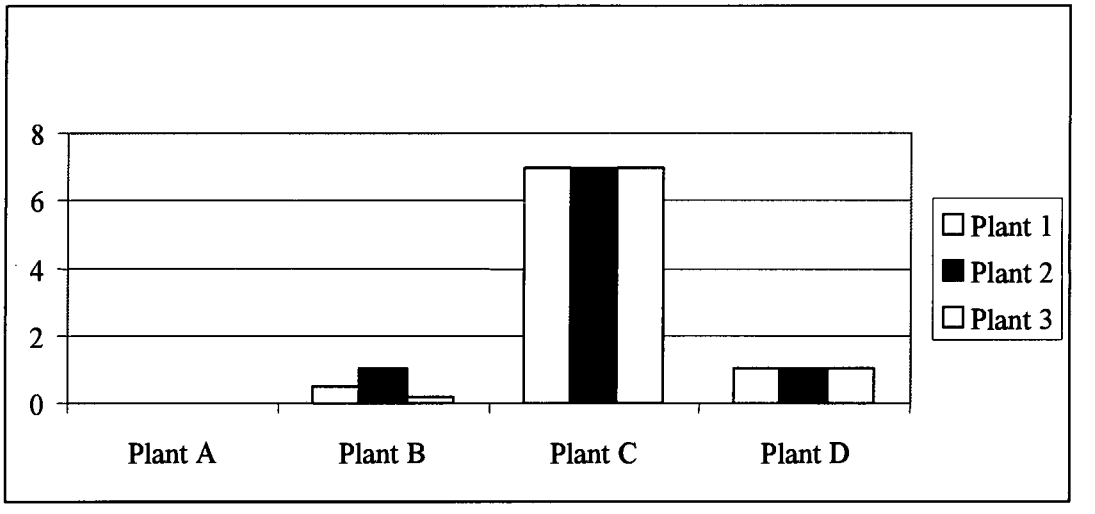
Each plant was asked to provide data related to the deliveries made to their three major customers.

Plant B delivers to its three major customers twice a day, daily and three to four times a day. Two of its customers are reasonably close (a journey time of one hour or less); the customer plant that receives daily deliveries is located in Victoria.

All of Plant C's major customers are located overseas, with shipments going to the UK, USA and France involving journey times of between 30 and 48 hours (Figure 31).

Plant D delivers to customers on a daily basis, and the journey time to all of its major customers is half an hour or less. Thus three of the plants are able to minimise their inventory levels by making frequent deliveries to their customer.

Figure 31: Frequency of delivery to major customers in days

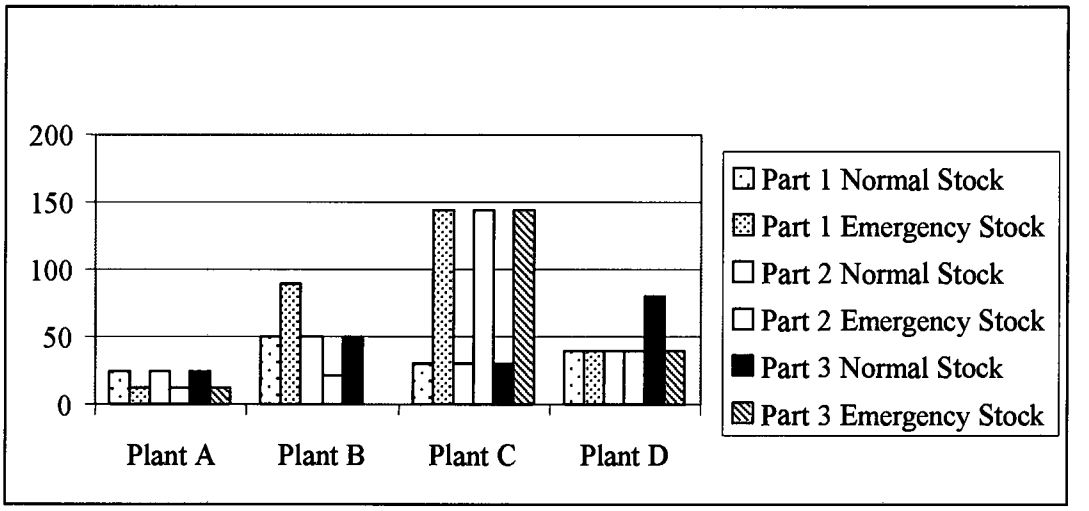


Frequent deliveries from suppliers

The survey instrument used in the parent study asked for information about the stock levels and supply of three key components.

Plant A holds approximately three days of stock (combined normal and emergency stock). The level of stock held by Plant B ranges from just less than one week's supply to more than two weeks' supply. Plant D holds approximately stock for approximately two weeks. Plant C, however, maintains stock levels at a considerably higher level (Figure 32). Although it has daily incoming deliveries, the management of this plant reported that it holds 30 hours of normal stock and 144 hours of emergency stock for all of the three key components.

Figure 32: Stock levels of incoming parts in hours



Two of the plants were able to provide information on their stock levels in 1994 and 1999. Although the levels of emergency stock for both of these plants remained unchanged, one plant had managed to reduce the level of normal stock for each component by half. Although the normal stock level of one component at the second plant had remained the same, the normal stock levels of other two components had been reduced by 80%.

Relationship management tools

This section addresses each of the relationship management tools described in Chapter 4, and includes high commitment human resources practices, customer relations, supplier relations and rewards and recognition.

High commitment human resources practices

This section reports the results of the investigation into selection procedures, induction and orientation procedures, the use of job specifications, job rotation, interplant transfers and the use of contract or short-term employees to cope with fluctuating production demand.

Selection on learning potential rather than existing skills

All four of the plants in the study have outsourced the recruitment function to external employment agencies or labour hire companies. Production operators are not hired directly by the plants but are taken on as contractors who are employed by the labour hire companies.

If and when a permanent vacancy arises on the production floor, the position is usually offered to a contract employee who has proven him or herself to be reliable and competent. Although this method involves making an additional lump sum payment to the labour hire company to compensate for the loss of their employee to their client, all of the managers spoken to during this study agreed that it was less time consuming.

However, the major benefit of recruiting from their pool of labour hire contractors was the risk reduction, as the period of time spent as a contractor provided the plant management with time to evaluate the suitability of each employee before making a commitment to them.

Extensive orientation and induction

Plant A provides a full day of induction and orientation for new hires. The induction covers the policies and procedures used in the plant, including health and safety, equal opportunities and sexual harassment. New hires are also provided with information about administrative matters such as work hours, dress code, rules regarding overtime, car parking and so on. No new hires are allowed onto the shop floor until they have completed the induction training.

At Plant C new hires are given a quick tour of the plant, which is followed up at a later date by a formal induction session. However, one employee who had been a permanent employee for approximately five years did say that, as a result of production pressure in his work area, he had never been scheduled for the induction session.

Information provided on the induction of new hires at Plants B and D was limited, although managers at both plants commented that the responsibility for ensuring the new hires were appropriately trained resided with the labour hire company.

Job rotation, job enrichment and multi-skilling

Of the four plants, only Plant C rotates its engineers through development, manufacturing and quality departments. Production operators on the line are arranged into cells, with two-hourly rotations within the cell, and daily rotation between cells.

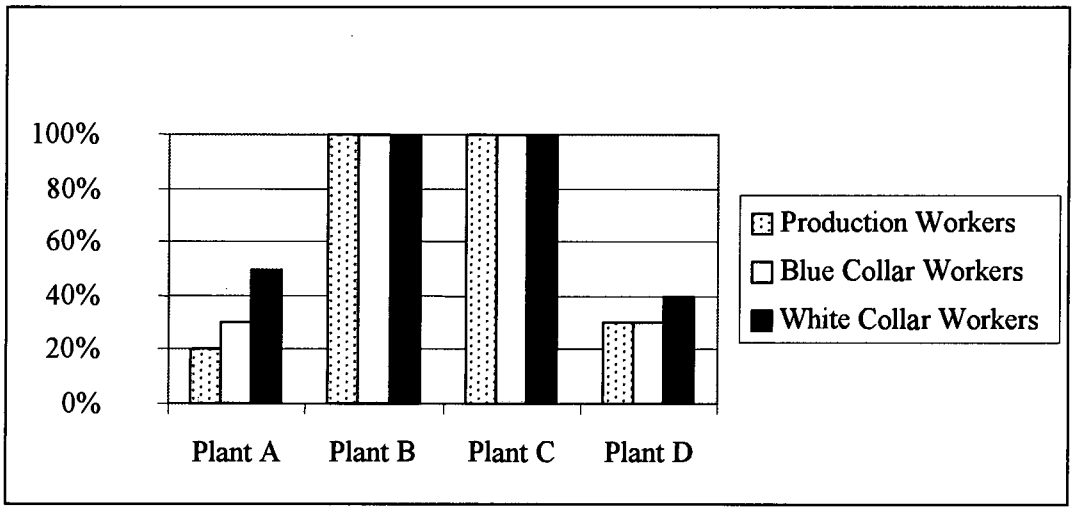
Plant A has a formal rotation schedule developed from an ergonomic study of every machine in the plant. The study was organised by the Human Resource Manager, primarily in response to occupational health and safety concerns; however, most of the workers interviewed at this plant commented that rotation helps to prevent their "minds from numbing".

Although all four plants are members of a group of plants or companies, only two of them reported that employees are transferred between plants within the corporate group. Both Plants C and D regularly transfer employees in the short to medium term. Employees of Plant C are offered the opportunity to work for a six-month period in one of three overseas plants.

Skill development and training

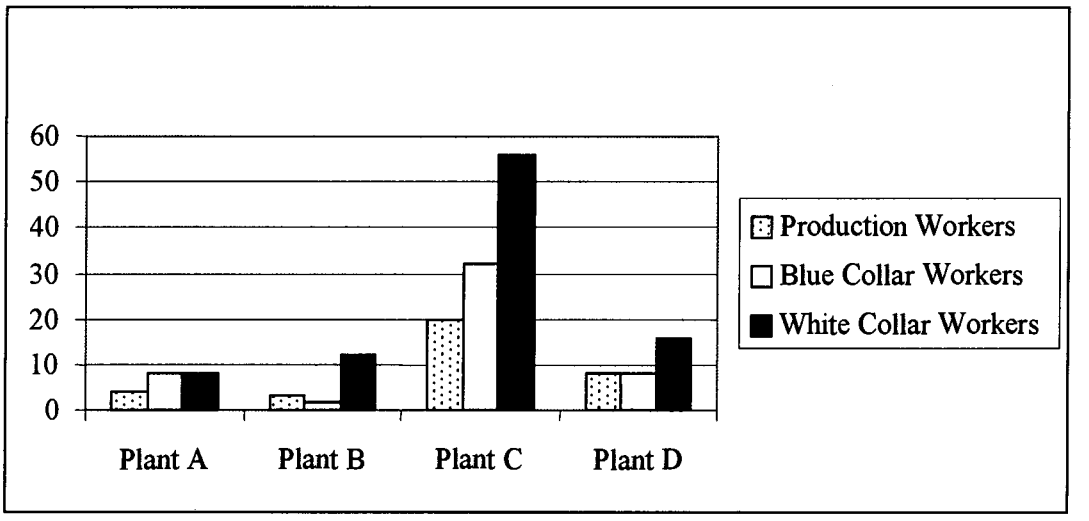
The level of off-the-job training varies significantly (Figure 33). Plants B and C provide training for 100% of all categories of employees. Plants A and D offer training to a higher percentage of white-collar workers than blue-collar workers or production workers.

Figure 33: Percentage of workers receiving off the job training



The training offered by the plants, other than Plant C, consisted of sixteen hours or less per year. Plant C, on the other hand, offers all of their production workers an average of 20 hours per year. Blue-collar workers receive an average of 32 hours per year, and white-collar workers receive an average of 56 hours per year (Figure 34).

Figure 34: Average number of hours of off the job training



While the management view at all four plants is that any request for training would be considered, only one of the production operators who agreed to be interviewed felt that management would be receptive to such a request. One felt that he would have no hesitation in asking about additional training, but in his own words, "whether I got it or not is another story".

The following exchange was typical of the response made by production workers and team leaders.

Q: Are you encouraged to develop your skills further?

A: I encourage myself.

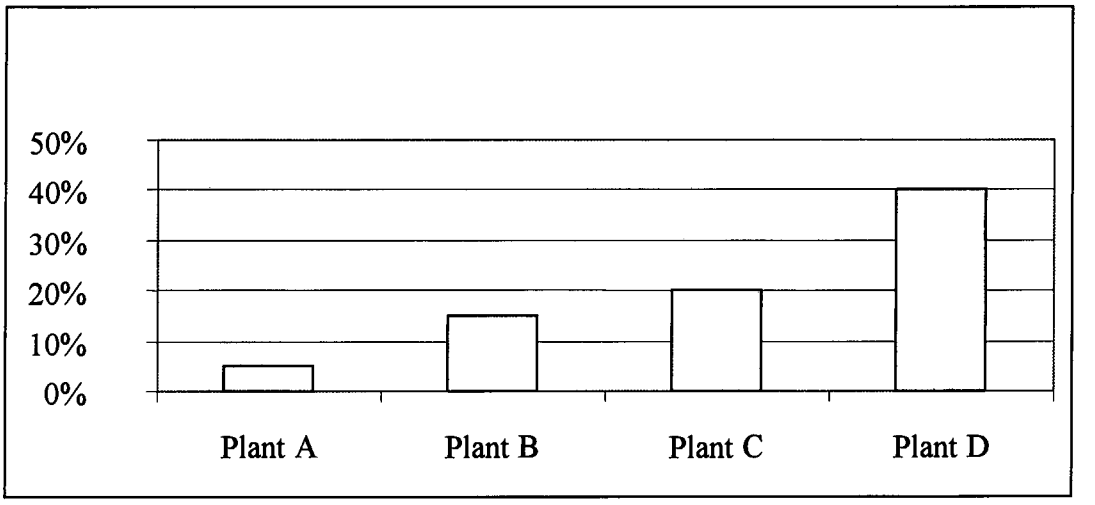
Q: But do your supervisors encourage you too?

A: Not really, no.

Job security for core personnel

As indicated above, all four plants in the study use temporary or contract employees - Plant A 5%, Plant B 15%, Plant C 20% and Plant D 40% (Figure 35). However, the practice is used as a means of avoiding the risk associated with employing people off the street, rather than to protect their permanent staff from the effects of variation in production demands.

Figure 35: Contract workers as a percentage of the plant workforce



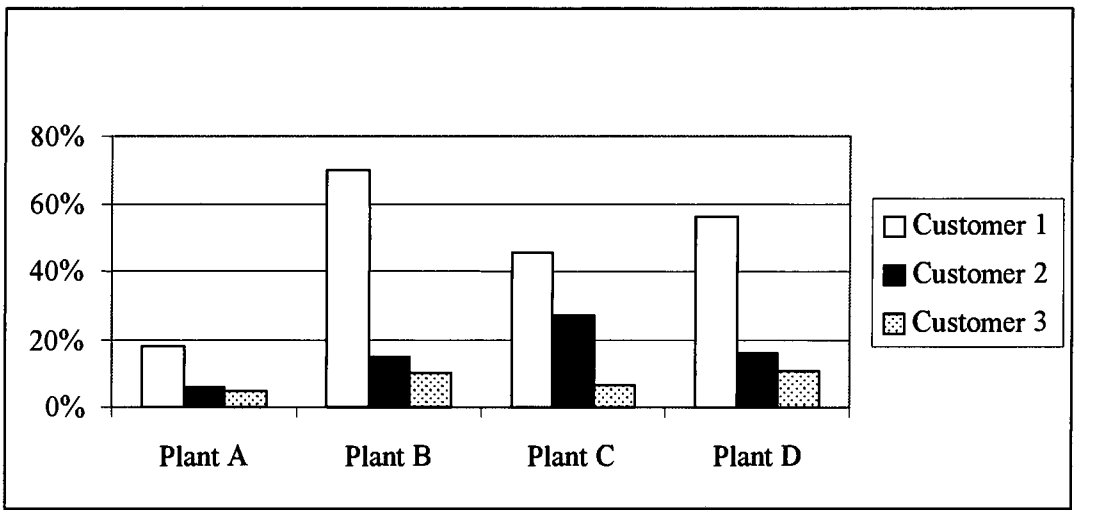
Customer relations

As learning factories enjoy close, mutually beneficial relationships with their customers, this section reports on the relationship between each plant and its customers, knowledge sharing and frequency of visits to and from customer plants.

Close long-term relationships

Of the four plants included in this study, only one participates in supplier clubs organised by their customers. The top customer of three received between 45% and 70% of the components produced, while the percentage of sales to the top customer of the fourth plant was considerably lower at 18% (Figure 36). Unlike the other plants in the study, Plant A's customer base includes a significant number of distributors supplying the aftermarket.

Figure 36: Percentage of sales for top three customers



Knowledge sharing with customers

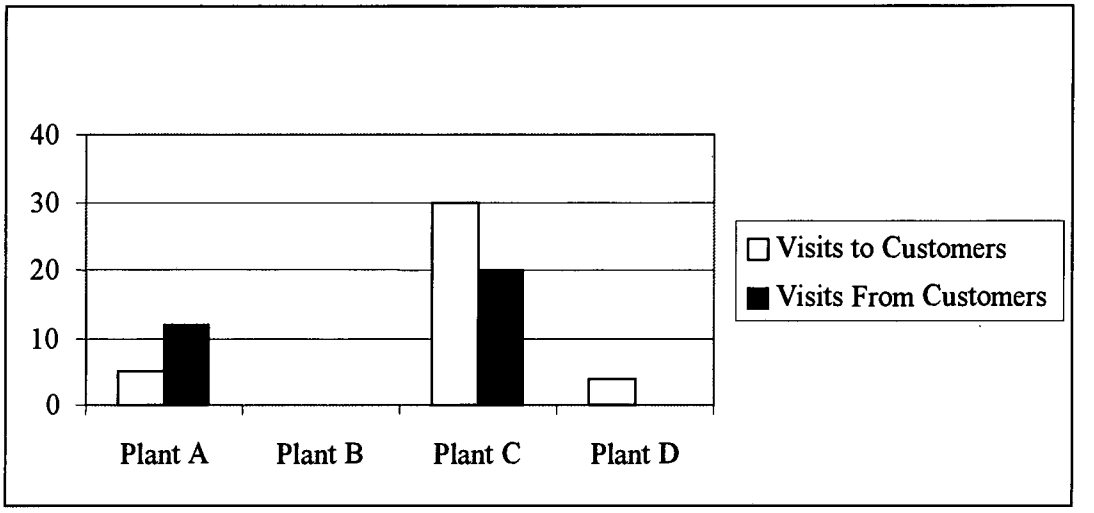
As the main focus of the managers interviewed during the study was satisfying customer needs, the knowledge sought by all four plants consisted of improved understanding of customer requirements rather than process improvements or operating methods. A typical comment about sharing knowledge with and learning from customers was:

> Well, ... we've learnt through increased customer contact that customer satisfaction really does mean listening to what the customer wants. Previously we thought, and this comes back from being a bit internal focussed, ... we know the best about [component] design, so all we have to do is send this product out and it will be what the customer wants.

Frequent visits to and from customer plants

Plant B did not provide any information about visits to or from customer plants (Figure 37). Plant D reported somewhat infrequent visits by its production personnel to customer plants, and stated that these visits were generally related to quality where the customer had demanded their presence to solve a problem with their components. This plant also reported that its customers did not visit their plant. Plant A also reported infrequent visits to the plants of its customers, but did host customer representatives on average about once a month.

Figure 37: Customer visits



Plant C reported by far the most visits to and from customers, which is surprising as, in contrast to the other three plants in the study, the majority of Plant C's customers are located offshore.

Supplier relations

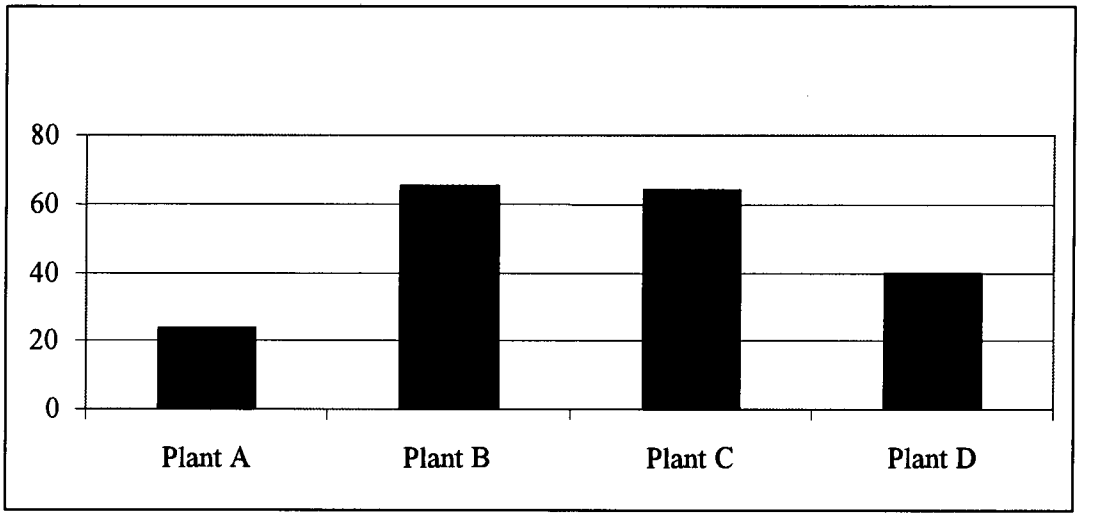
As learning factories enjoy close, mutually beneficial relationships with their suppliers, this section reports on the relationship between each plant and their suppliers, knowledge sharing and frequency of visits to and from supplier plants.

Close long-term relationships

The number of suppliers ranged between 24 and 65 (Figure 38). Only plants B and D had reduced the number of suppliers over the previous five years (by 10% and 12.5% respectively). None of these plants operate supplier clubs for their suppliers.

When the supplier development managers were questioned as to the profile of their supplier base, and in particular if the base had changed in recent years, the responses indicated a trend toward consolidating the supplier base. The managers also acknowledged that reducing the number of suppliers lifts their reliance on each individual supplier, resulting in an increasing need to manage the relationships more closely to ensure delivery of high quality supplies as and when required.

Figure 38: Number of suppliers



Knowledge sharing with suppliers

Of the four plants in this study, only one, Plant C, has a plan in place to share knowledge and assist suppliers to improve manufacturing performance. The supplier development manager at Plant C gave the following description of his plan:

I see it as a four-stage program.

1) We need to measure our suppliers' past performance, which we are now doing.

2) From that, we will establish which ones do need improvement and see in what areas. We measure them in three categories: quality, delivery and competitiveness. That combined with some other major key performance indicators, which we will identify. Not sure what they will be at this stage. But such things as responsiveness and contributions to design teams and so forth. Based on that, we will sit down and work out what their strengths and weaknesses are.
3) Then sitting down and jointly developing an improvement program with them.
4) Then facilitating implementation of that improvement plan.

It's all very simple and straightforward when you say it quickly like that. But I know that it's going to take years to do. The first three steps are the quickest. I hope that with most suppliers we can have those first three steps up and away within six to twelve months. But step number four may take a number of years. Some suppliers of course will respond quicker than others.

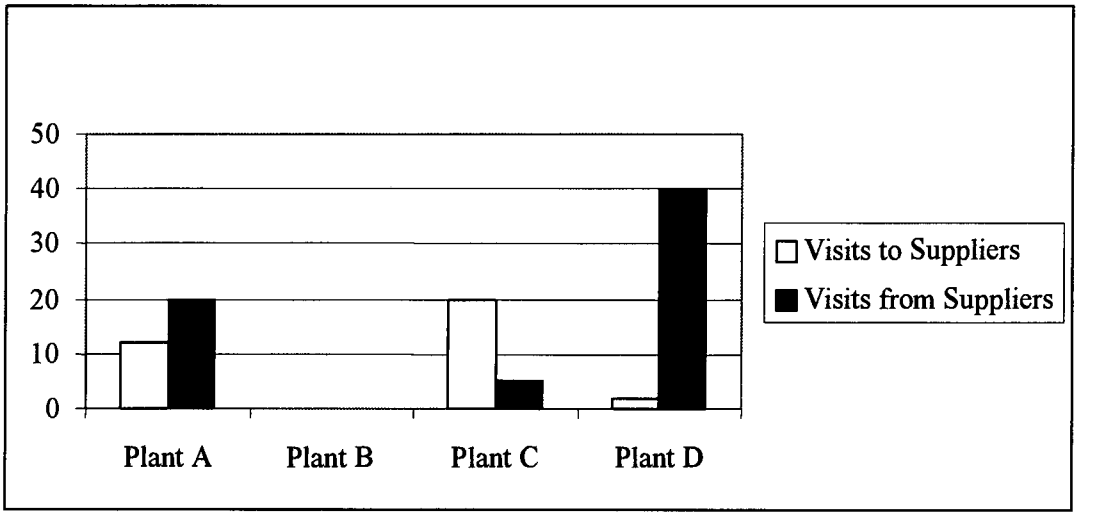
The remaining three plants either did not or did not intend to share knowledge with suppliers other than informing suppliers of their requirements.

Frequent visits to and from supplier plants

Data were supplied by three of the four plants regarding visits to and from supplier plants (Figure 39). Representatives from Plant A visited supplier plants approximately once a month. Representatives from Plant C made 20 visits in 1999.

Although Plant D sent representatives to a supplier's plant only twice during 1999, representatives from their suppliers visited Plant D on 40 occasions.

Figure 39: Supplier visits



Motivation, incentives and rewards

The rewards and recognition provided for employees in a learning factory, other than those tied to suggestion schemes, often include competitive pay rates and staff benefits, payment by results and reward programmes.

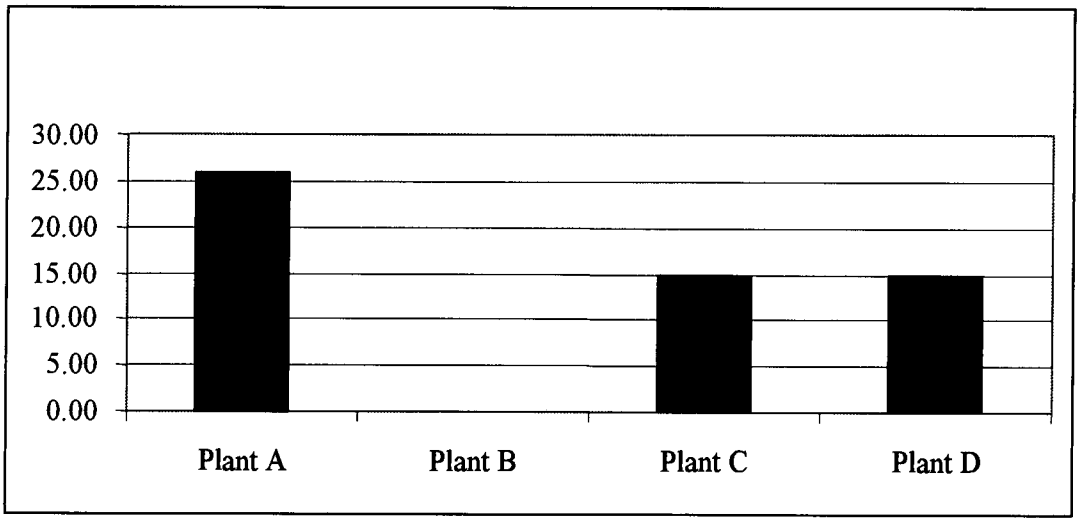
Competitive pay rates and staff benefits

None of the four plants in the study pay their production workers above standard industry levels. As indicated by the following quote, the state of the economy and the relatively good working conditions within each plant mean that sourcing new employees is not difficult, particularly as all four plants use external recruitment agencies to fill any vacancies.

> We're not the highest but we're not the lowest, we're sort of middle of the road but external recruiting companies don't have any difficulty in selling us as a good place to work for.

Although Plant B did not provide an hourly rate, the production workers interviewed during the study confirmed that the plant pays a similar rate to those of other manufacturers in the area. Plant A pays approximately ten dollars an hour more for production workers than either Plant C or Plant D, however, the higher rate of pay is a reflection of the potential health hazards faced by workers employed by Plant A that do not affect employees at the other plants (Figure 40).

Figure 40: Hourly rates for production workers



Payment by results

None of the plants currently use any form of payment by results, preferring to reward outstanding performance by non-monetary means. As indicated by the following quote, there was some evidence that plants favoured eliminating performance-based bonuses:

> We've previously had you know different types of bonuses: absenteeism bonus, production bonus, even blood lead bonus - we've got to have our blood lead tested every few months. In our latest enterprise agreement we actually got rid of all bonuses and incorporated them in the hourly rate.

Reward programmes

Plant D has several programmes to recognise outstanding performance of their production workers. Each month a production worker is selected as the 'champion of the month', the employee is awarded a trophy and has his/her photograph displayed prominently on the noticeboard on the shop floor. The managers regularly provide barbeques when the production teams meet or exceed production targets, with the managers cooking breakfast or lunch for the production workers. Plant C provides production workers with gift vouchers redeemable at a national department store chain for meeting or exceeding production targets and initiating production or safety improvements.

Support systems

This section addresses each of the support systems described in Chapter 4, and includes knowledge systems, organisational culture, structural empowerment and communication systems.

Knowledge systems

Knowledge systems enable organisations to operationalise and share the learning of individuals within the organisation. The features of a knowledge system investigated in this study include the use of an intranet system, access to knowledge databases, and discussion groups.

Intranet

Three of the four plants in the study have an intranet system and provide access to email. However, it is clear that not all of the production workers interviewed during the study feel they want or need email access, and many did not know how to use it. Although they did not have access to intranet or email systems, the production team leaders at the fourth plant were provided with mobile phones and were encouraged to communicate with other team leaders in their own plant and those in their sister plants.

Access to knowledge databases

All four plants in the study provided computer access to performance and quality data stored on computer systems via terminals located on the shop floor. However, in practice very few production operators had the time or the desire to access the information. It is also questionable whether the majority of production operators have the computer or analysis skills to access and interpret the information.

Discussion groups

Plants A, B and C all reported regular meetings or teleconferences with their counterparts within their own corporate groups, but this tended to occur only at the management level. Plant D indicated that there was little or no discussion between plants within their corporate group and this was considered to be a weakness.

Organisational culture

Measures of organisational culture included in the model of the learning factory include vision, organisational values, goals and objectives, policies and rules of conduct. However, the instrument used in the parent study did not address these issues.

Structural empowerment

Structural empowerment has been defined as the tools and techniques which are implemented by management to encourage and support employees to exercise initiative. Measures of structural empowerment include supportive leadership, clarity of objectives, delegation of authority, access to resources, access to information and rewards.

Supportive leadership

The management of all four plants have an open door policy, where shop-floor employees are given the opportunity to talk to any of the senior managers about any issue they are facing. However, while all of the shop-floor workers we spoke to agreed that they could knock on the 'boss's' door if they wanted to, all but one (from Plant A) stated that they would feel more comfortable taking their issues to a team coordinator. The coordinators were preferred for a number of reasons. Some of the operators did not feel comfortable approaching 'management', while others felt that the coordinator would be more likely to understand what they were talking about and see the need for action as they also work on the shop-floor.

Clarity of objectives

The instruments used in the parent study did not address the objectives of the organisation.

Delegation of authority

As each of the plants in the study has or is introducing lean production principles, many of the responsibilities previously held by middle management (for example, scheduling work, monitoring quality and identifying process improvements) are being delegated to shift coordinators or team leaders.

Access to resources

Although high level managers reported that work teams had access to and control over (albeit limited) resources with which small (in terms of cost) improvements could be undertaken at the team level, the shop floor operators the author talked with felt pressure from middle- and high-level management to constantly 'do more with less'. One operator said that the team's small discretionary budget would be cut next year if it they did not spend it all, causing the team to spend the money on anything as long as they could justify the expenditure, rather than focussing specifically on improvements.

Access to information

At all four plants, the high-level managers reported that shop-floor operators had regular access to information through feedback meetings, daily performance reports, team

meetings and in some cases through internal databases and intranet or email systems. However, in practice very few operators reported that they felt information was as freely available as their managers seemed to think. Many reported that information feeding down the hierarchy was heavily censored by middle management and, in most cases only the team leader or coordinator had access to computer systems on the shop floor.

Communication systems

The communication systems of a learning factory ensure that all employees have access to relevant information about organisational objectives, policies and performance. The communication methods used to ensure the smooth flow of information include email, networking (i.e. regular meetings) and access to high-level managers.

E-mail

All four plants in the study have an e-mail and intranet system to facilitate communication within the plant and with other plants within their corporate group. However, access to the e-mail system is not available for a majority of the production workers on the shop-floor.

Networking

Plant A has monthly feedback meetings, which all production workers attend to enable management to feed information down to the shopfloor. All of the production teams at Plant B have an hour-long team meeting every month and fortnightly meetings via the telephone system with another plant in their group. Plant D holds quarterly executive meetings, and daily meetings with delegates from each area of production to discuss production issues and to circulate new information across the plant.

Access to higher level managers

As discussed above in regard to supportive leadership (as related to structural empowerment), shop-floor operators in all four plants are provided with the opportunity to approach high-level managers at any time, yet most are reluctant to do so. The preferred lines of communication are up through the organisation hierarchy beginning with their direct supervisor. However, shop-floor workers at Plants A, C and D reported that communication up or down was frequently blocked by middle management and as a result high-level

management only received positive messages, while lower-level employees received information on a need-to-know basis. The need was most often determined by a middle manager.

Predicted outcomes

In the learning factory, the implementation of the operational tools and techniques, relationship management tools and support systems included in the model should contribute to creating a happier more productive workplace resulting in improved performance. These outcomes would be characterised or measured by a productive and safe climate in the workplace, high levels of interpersonal trust, commitment and participation at all levels of the organisation and production improvements over time.

Productive and safe climate

A productive and safe climate in the workplace would be characterised by an absence of fear, and high levels of mutual respect and openness to the ideas of others. Employees would be able to experiment and take risks without being afraid of being ridiculed or punished for making mistakes.

Absence of fear

While aspects of the climate were not specifically addressed by the parent studies, the presence of fear in the workplace became evident in at least two of the four plants during the plant tours. Apart from comments of shop floor operators regarding the censoring of information fed up and down the hierarchy, and being expected to do more with and for less, the behaviour of shop floor operators when high-level managers walked onto the floor was a strong indicator of at least low levels of fear.

In all of the plants, shop floor workers were polite and expressed positive thoughts and sentiments when managers were present or they were in their line of sight. However, at two of the plants, once the managers had moved through their workspace, the attitudes of the operators appeared to change. During the tours of these two plants, the author observed operators muttering obscenities, throwing tools and making obscene gestures in the general direction of the managers.

All of the operators we spoke to were very concerned about confidentiality, and were not prepared to be open about their working conditions unless they received assurances that

the management would never hear what they had said.

Mutual respect and openness to the ideas of others

The instruments used in the parent study did not address this aspect of the organisation.

Trust

High levels of interpersonal trust in a learning factory would be characterised by the existence of shared values, including benevolence, integrity and respect for others, and the routine enforcement of obvious penalties for breaches of trust. The instruments used in the parent study did not address these aspects.

Commitment and participation

High levels of commitment and participation in a learning factory would most likely be characterised by the use of high involvement approaches and high levels of employee motivation to participate, extensive cross-functional collaboration and a history of consistency from management.

High involvement approach and employee motivation

The approaches to employee involvement in these four plants vary from relying on suggestions schemes to encouraging and/or expecting all employees to be involved in improvement processes.

Plant A relies heavily on team leaders and coordinators but expects very little involvement from shop-floor operators. Plant B does not necessarily expect shop-floor employees to be actively involved in the improvement processes and, in many cases, those employees perceive such involvement as some how 'above and beyond the call of duty' and expect some form of extra payment or recognition for their efforts.

Plants C and D both take a high involvement approach and actively encourage lower level employees to be involved. Plant C has provided both team leaders and operators with extensive training in continuous improvement and problem-solving techniques in the past, and as the following quote demonstrates, Plant D is planning to do so in the near future:

> So to that end from the beginning of next year, every employee in this entire site will go through a learning manufacturing course to give them the understanding of why it's important, how it's done, how they can contribute but also they will be given an assurance that this isn't being done to take their job away from them, it's being done to keep us viable for the future.

Cross-functional collaboration

All four plants in the study reported that problem-solving using cross-functional teams was common if not standard practice.

Consistency from management

The instruments used in the parent study did not address this aspect of the organisation.

Improved productivity

The measures selected to measure improvement in productivity for a learning factory include improved quality performance, reduced production costs and higher levels of customer and employee satisfaction.

Improved quality performance

The change in quality performance predicted by the model is measured using the change over time in internal and external defect rates. In theory, if the plants in the study had been successful in their attempts to introduce lean production and learning organisation principles, we could expect both the internal and external defect rates to have reduced between 1994 and 1999.

Data were not available for the internal defect rates of Plant B. Plant D's internal defect rate remained unchanged, Plant C's internal defect rate had decreased over the five year period, but Plant A's internal defect rate had increased significantly (Figure 41).

However, all four plants reported a decreased level of external defects in 1999 as compared with 1994 (Figure 42). This suggests that the plants still rely heavily on postproduction inspection to identify quality problems.

Figure 41: Change in internal defect rate (ppm)

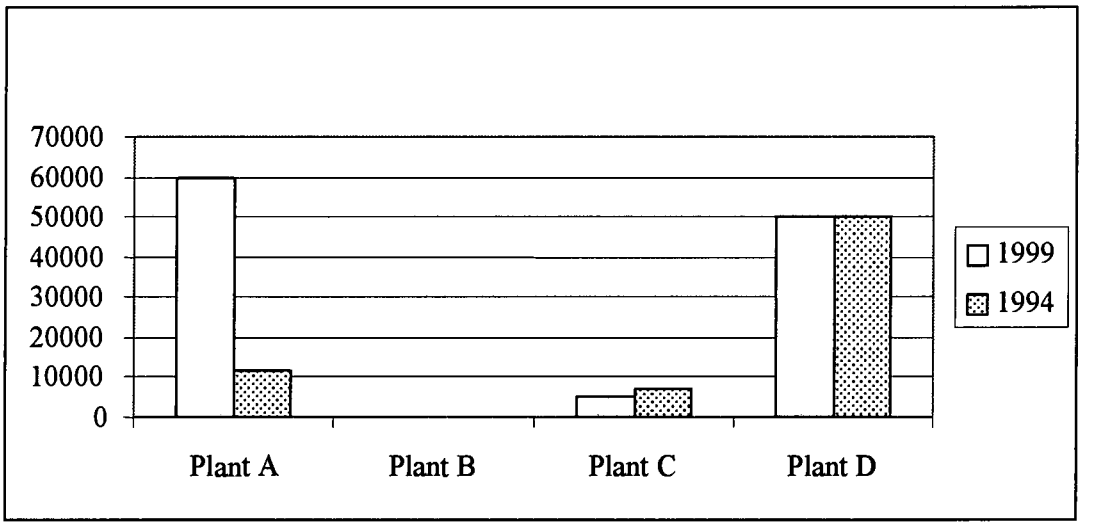
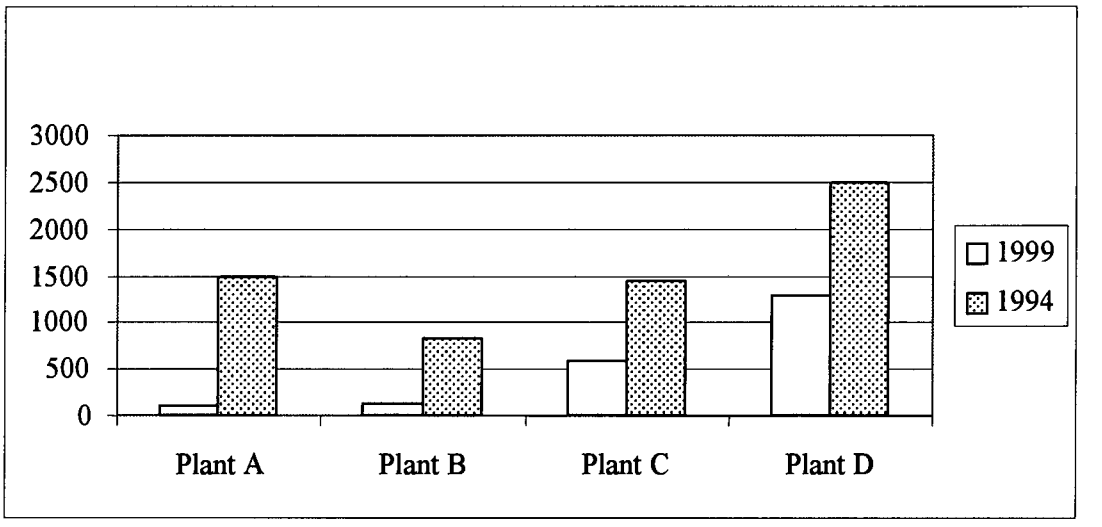


Figure 42: Change in external defect rate



Reduced production costs and higher levels of employee and customer satisfaction

The instruments used in the parent study did not address these aspects of the organisation.

Summary of results

This chapter has presented the results of the data analysis undertaken during this study. The results of the study are summarised below (Tables 10, 11, and 12). Data regarding a considerable number of the variables included in the model were not available (DNA), as the survey instruments and interview schedules of the parent study did not address

those specific issues. Some data are also missing where the question was asked, but the plant did not provide the data (DNP).

Predicted outcomes

When considering the data that were available on the variables included as outcomes of a learning factory, only one plant (Plant C) demonstrated the existence or absence of every characteristic predicted by the model.

Another plant in the study, Plant D, demonstrated several characteristics that the model suggests are indicative of a learning factory, specifically an absence of fear and a high-involvement approach to employee participation. The major difference between the two plants relates to quality improvements. Both plants reported improvements in the external defect rate, but where Plant C had improved the internal defect rate, Plant D's internal defect rate was unchanged.

In contrast, Plants A and B used a low-involvement approach to employee participation, the author observed shop floor workers displaying hostility towards high-level management when they thought they were not being observed, and Plant A's internal defect rate increased rather than decreased between 1994 and 1999.

All four plants reported the use of cross-functional collaboration.

Operational tools and techniques

For the plants in this study, the operational tools and techniques should be the least difficult component of the learning factory model to implement and manage as the operational tools and techniques consist of the structural systems, procedures and processes typically implemented in an organisation using a lean production model. The findings are summarised in Table 9.

Teams

All four plants in the study reported the use of clearly defined and relatively fixed teams on the shopfloor. However, one plant (Plant D), reported that only 25% of their direct production operators were organised in this way.

The team responsibilities investigated in this study included work allocation, setting the work pace, hiring and firing and training decisions. Of all four plants, only one (Plant C) delegated up to 80% of the decision-making authority to production operators and team leaders. For the other three plants, other than decisions regarding work pace (Plant A) and

work allocation (Plant B), the majority of the responsibility for making decisions resides at the management level.

Table 9: Operational tools and techniques

Operational tools and techniques	Plant			
	A	B	C	D
Team-based work organisation				
Workers organised into teams	✓	✓	✓	x
Team responsibilities	x	✓	✓	x
Lean manufacturing operations				
Preventative maintenance	✓	✓	✓	✓
Quality improvement	✓	✓	✓	✓
Physical flow	x	x	x	x
Process control and discipline	✓	✓	✓	✓
Synchronised work processes	x	x	x	x
Continuous improvement				
Continuous improvement and problem-solving	✓	x	✓	✓
Suggestion schemes	✓	x	✓	x
Short-term problem-solving groups	✓	✓	x	✓
Long-term problem-solving groups	✓	x	✓	✓
Just-in-time inventory systems				
Pull system of inventory supply between stations	✓	✓	✓	✓
Low level of finished goods inventory	x	✓	x	✓
Frequent deliveries to customers	DNP	✓	x	✓
Frequent deliveries from suppliers	✓	✓	x	x

Lean manufacturing operations

All four plants demonstrated a commitment to and processes supporting preventative maintenance, quality improvement and process control and discipline. However, there is very little involvement of shop-floor operators and team leaders in preventative maintenance. The responsibility for preventative maintenance is predominantly the responsibility of skilled trades at Plants C and D, and at Plants A and B is shared between engineering specialists and skilled trades. Although these results may be indicative of management attitudes to the roles

and expectations of production operators, the differences in machinery and processes in each plant may provide an alternative explanation. Although Plants C and D produce different products, the processes, techniques and machinery used by these two plants are similar, whereas the processes, techniques and machinery used by Plants A and B differ from each other as well as from those used by Plants C and D. It could be that the processes, techniques and machinery used by Plants C and D require a higher proportion of operators with a more specialised skill set (skilled trades) to be directly involved in production, (in this case, technical skills in operating and maintaining die-setting and moulding machines) than the other two plants, where the day-to-day operation of machines and equipment do not require such specialised technical skills.

Two of the plants, Plants A and B, rely on production operators and team leaders to monitor quality performance, whereas Plants C and D tend to rely on quality specialists and non-productive others. Quality improvements are sourced from the shop-floor in Plants A and B. Plants C and D tend to involve employees from all levels of the organisation.

None of the plants in this study were able to demonstrate physical flows or synchronised work processes across the entire production process. However, the managers of each plant reported plans, objectives or projects already formulated to improve both the physical flow through the process and to synchronise tasks wherever possible. As at least one of the plants has or is receiving recognition as high performance manufacturer of automotive components from one of the leading automotive manufacturers in the world, it is possible that these two components of lean production contribute, but may not be critical, to high performance.

Continuous improvement

All plants but one in the study (Plant B) have personnel with direct management responsibility for continuous improvement and problem-solving.

In plants B, C and D the responsibility for process improvements is shared across all levels of the organisation, with a significant contribution from engineering specialist. Plant A, however, relies on production workers, team leaders and skilled trades for improvements. Two of the plants in the study (Plants A and C) were using suggestion schemes in 1999 to obtain ideas from their shop floor workers, whereas the other two plants (Plants B and D) had recently dismantled suggestion schemes.

All four plants in the study used problem-solving groups to investigate ideas for process or quality improvements or to plan improvement projects. Plant C invested between

2.5 – 3 times as many resources, in terms of labour hours, in short- and long-term problem-solving groups than any other plant in the study.

Just-in-time inventory systems

Although all four plants in the study reported the use of a pull system of inventory flow between workstations, only Plant B reported low levels of finished goods inventory, and frequent deliveries to from suppliers and to customers. Plant A receives frequent deliveries from suppliers but holds high levels of finished goods inventory. Plant D has low levels of finished goods inventory and delivers to customers frequently but only receives infrequent deliveries from suppliers. Plant C holds high levels of finished goods inventory, and does not receive or make frequent deliveries. This is perhaps because the majority of Plant C's customers and suppliers are in the US or Europe.

Relationship management tools

The relationship management tools included in the model have been described as the 'softer aspects' of the Toyota Production System and are often the least likely to be implemented in Western manufacturing organisations. The findings for the plants in this study are summarised in Table 10.

High commitment human resources practices

All four plants reported that shop-floor operators are selected on their potential to learn, and that the plant provides opportunities for job rotation, job enrichment, multi-skilling and training and development. However, only one plant, Plant A, provides an extensive orientation and induction program for starting employees. One possible explanation for this apparent anomaly may be that all four plants recruit permanent staff from their casual pool. This provides the plant with the opportunity to observe potential employees and evaluate their performance potential prior to making a long-term commitment, and presumably reduces the need to orientate new employees.

All of the plants also offered protection for core personnel by varying the numbers in the casual pool in response to production demand.

Table 10: Relationship management tools

Relationship management tools	Plant			
	A	B	C	D
High commitment human resources practices				
Selection on learning potential rather than existing skills	✓	✓	✓	✓
Extensive orientation and induction	✓	x	x	x
Job rotation, job enrichment and multi-skilling	✓	✓	✓	✓
Skill development and training	✓	✓	✓	✓
Job security for core personnel	✓	✓	✓	✓
Customer relations				
Close long-term relationships	✓	✓	✓	✓
Knowledge sharing	✓	✓	✓	✓
Frequent visits to and from customer plants	✓	DNP	✓	x
Supplier relations				
Close long-term relationships	✓	✓	✓	✓
Knowledge sharing	x	x	✓	x
Frequent visits to and from customer plants	✓	DNP	✓	✓
Motivation, incentives and rewards				
Competitive pay rates and staff benefits	✓	DNP	x	x
Payment by results	x	x	x	x
Reward programmes	x	x	✓	✓

Customer relations

The four plants in the study all reported favourable responses for a majority of the variables related to customer relations. The only two exceptions were Plant D, which did not report frequent visits to and from customer plants and Plant B which did not provide data for such customer visits.

Supplier relations

Relations with the suppliers of all four plants were identified as close, long-term relationships, and three of the four plants reported frequent visits to and from suppliers.

However, only Plant C reported the exchange of knowledge between their own operations and those of suppliers.

Motivation, incentives and rewards

In contrast to the other relationship management tools, the four plants in the study had implemented very few measures to improve motivation. Only Plant A reported that it offered pay rates above the industry award rate and none of the plants makes use of payment by results. Reward schemes were only currently in use at two of the plants, Plants C and D; however, the other two plants reported the use of reward schemes in the past that had been discontinued.

Support systems

The support systems included in the model were knowledge systems, organisational culture, structural empowerment and communications systems. These components provide employees with access to information and resources as well as creating a context within which an employee can not only participate and learn, but also share that learning with his or her fellow employees.

The findings for the plants in this study are summarised in Table 11.

Knowledge systems

With the exception of Plant B, all of the plants provided employees with access to an intranet which enabled them to access up-to-date performance data and web reports on events and activities occurring in the plant. All four plants use knowledge databases to store and communicate knowledge gathered about processes and techniques used in the plant, and with the exception of Plant D, offer employees the opportunity to participate in discussion groups.

Organisational culture

Data were not available for three of the four variables included in the model under organisational culture. However, for three of the four plants, there was evidence that the management had articulated organisational values which had been acknowledged if not accepted by a majority of employees.

Table 11: Support systems

Support systems	Plant			
	A	B	C	D
Knowledge systems				
Intranet	✓	×	✓	✓
Access to knowledge databases	✓	✓	✓	✓
Discussion groups	✓	✓	✓	×
Organisational culture				
Vision	**DNA**	**DNA**	**DNA**	**DNA**
Organisational values	✓	**DNP**	✓	✓
Goals and Objectives	**DNA**	**DNA**	**DNA**	**DNA**
Policies, rules of conduct	**DNA**	**DNA**	**DNA**	**DNA**
Structural empowerment				
Supportive leadership	✓	✓	✓	✓
Clarity of objectives	**DNA**	**DNA**	**DNA**	**DNA**
Delegation of authority	✓	✓	✓	✓
Access to resources	✓	✓	✓	✓
Access to information	✓	✓	✓	✓
Rewards	×	×	✓	×
Communication systems				
Email	✓	✓	✓	✓
Networking	×	×	**DNP**	×
Access to higher level managers	✓	✓	✓	×

Structural empowerment

Although there was insufficient data to determine whether the objectives of the organisation were clear, all four plants reported the existence of supportive leadership, delegation of authority, reasonable access to adequate resources and reasonable access to adequate information. However, only Plant C provided some form of reward to employees specifically for exercising initiative or participating in problem-solving or continuous improvement projects.

Communication systems

All four plants reported that shopfloor employees are provided with access to email systems to facilitate communication between different areas within the plant, across divisions and within the corporate group. Although none of the plants offer employees opportunities for networking, all four plants claimed that shopfloor employees were provided with direct access to higher level management.

The next chapter discusses the significant findings in terms of the objectives of the study (outlined in Chapter 1), and discusses the implications of the findings.

Chapter 7
Discussion

This chapter commences with an evaluation of the plants, which presents a discussion about possible explanations for the similarities or dissimilarities between the four plants. The 'reasonableness' of the model is discussed in the next section by assessing the results of one of the plants that has been independently identified as a world-class performer by Ford USA to determine whether or not this particular plant exhibits the characteristics suggested by the model.

The significant findings and implications of the study are presented in the following section and address the research questions outlined in Chapter One. The chapter concludes with a discussion of the limitations of the study and recommendations for future research.

Evaluating the plants

There are a number of characteristics that are common to all four plants in the study, both those predicted by the model and those that are contra to the model. This prompts the question: are these common characteristics an indication that all four plants have intentionally introduced learning factory principles into their operations, or are the common characteristics more indicative of labour market and/or mandated work conditions within Australia?

Operational tools and techniques

As all four plants in the study are operating under lean production practices, it is reasonable to expect they would share most if not all of the characteristics related to operational tools and techniques included in the learning factory model (refer to the discussion in Chapter 4). The common characteristics in this category include: team-based work organisation; routine preventative maintenance; quality improvement; process control and discipline; and pull systems for inventory control. None of the plants exhibit the physical flow predicted by either the lean production or the learning factory models; however, all of the plants explained this anomaly in terms of the time and capital requirements in making the transition from traditional factory layouts.

Relationship management tools

All four plants demonstrate the characteristics of high commitment human resource practices, with the exception of the use of extensive orientation and induction.

As with human resources practices, all four plants demonstrate the characteristics expected by the model in relation to customer relations. All four plants have close long-term relationships with their customers, share knowledge and have frequent visits to and from customer plants. However, these characteristics may be a result of the terms of trade imposed by the customers (that are predominantly lean producers themselves) rather than the result of the conscious relationship management by the plants in this study.

Although only one of the plants has a program of sharing knowledge with their suppliers, all of the plants exhibited close long-term relationships with suppliers and reported frequent visits to and from supplier plants.

In terms of motivation, incentives and rewards, the only shared characteristic is the absence of payment by results.

Support systems

There were insufficient data available to determine whether the plants shared common characteristics of organisational culture. All four plants shared characteristics of structural empowerment with the exception of reward systems. Although none of the plants use networking, all four use email systems to facilitate communication within and across corporate groups. However, access to email is not available below the team leader level.

Evaluating the learning factory model

One of the plants in the study (Plant C) has been operating using lean production and learning organisation principles for a number of years. In 2001 they were one of the nine companies worldwide which were awarded a Gold World Excellence Award from Ford USA for outperforming their competition in terms of quality, cost and delivery. Plant C received the same award in 2002, and as a consistent award-winning manufacturer with a commitment to both lean production and the principles of the learning organisation, Plant C is the most likely plant in this study to be an example of a learning factory.

The differentiating characteristics of Plant C

In terms of predicted outcomes, where data was available and unlike the other three plants, Plant C exhibited all of the characteristics predicted by the model. Employees on the shopfloor appeared to be comparatively relaxed and prepared to speak up about any problems or issues arising in relation to their work. The plant uses a high involvement approach to employee involvement, and encourages inter-disciplinary or cross-functional teams both in continuous improvement and problem-solving activities, production development and daily operations.

As would be expected of a 'lean' plant, Plant C exhibited all of the characteristics related to operational tools and techniques except for physical flow, synchronised work processes and inventory management. However, at the time of the visit by the research team, the plant was in the process of redesigning the factory layout to improve physical flow and to introduce synchronisation. The infrequent deliveries from suppliers and to customers, and the relatively high levels of finished goods inventories in comparison with industry standards and the other participants in this study are due to logistics. A majority of the plant's suppliers and customers are based in the Northern Hemisphere, rather than within Australia as is the case with the other four plants in the study.

Plant C has also delegated authority and responsibility to a much lower level than Plants A and D, and perhaps on a broader scope than Plant B. Although Plant C is the only plant in the study that does not use formal short-term problem solving groups, groups are often brought together at short notice to confer on any problems occurring during production. These groups include the operator involved, team leaders, maintenance personnel and production engineers. It is also interesting that Plant C invests between 2.5 – 3 times as many resources in terms of labour hours to long-term problem solving groups as the other three plants invest in short- and long-term groups combined.

For almost all of the relationship management tools, only the scope of the characteristics differs between the plants. While all four plants offer training and development to core personnel, only Plant C and Plant B offered training to 100% of their workforce in 1999, and while shopfloor operators at Plant C received 20 hours of off-the-job training on average, Plant B offered less than five hours. In fact, for all intents and purposes, Plant C makes continuing training a condition of employment. Customer relations for Plant C involve really listening to what the customer wants and working with them to deliver quality products. Plant C also reported a much higher level of visits between them and their customers, which would appear to indicate a serious commitment to fostering close,

committed relationships, as unlike the other three plants, the majority of their major customers are located in Europe and the USA.

While all four plants share knowledge on process improvements and quality issues with their customers, only Plant C has a plan in place to share knowledge and assist suppliers to improve their manufacturing performance.

If the proposition is accepted that, on the basis of its performance in the World Excellence Awards, Plant C is potentially a world-class performer, and given that Plant C did outperform all of the other plants in terms of quality performance, the differentiating characteristics may provide some insight into which characteristics facilitate world-class performance.

Plant C makes significant investments in several areas including, staff development and training, facilitating problem-solving and continuous improvement processes, managing relationships with customers and suppliers and developing knowledge sharing networks along the supply chain. Shopfloor employees are provided with opportunities not only for training and advancement, but also for overseas short-term placements with plants within the corporate group and customer plants overseas. The relationship with employees is seen as long-term and considerable care is taken in evaluating potential permanent employees before they are offered a position. Plant C was the only plant in the study that has a corporate uniform which, while not compulsory, is worn by staff across all levels of the plant, including shopfloor operators. Each year all of the employees are given gifts at Christmas, for example, one year each employee received two deck chairs with the company logo printed on the back, and another year they each received a company jacket. All of these initiatives are designed to create a sense of community and belonging.

How well did the model predict performance?

The research model assumes that if a plant exhibits all or most of the characteristics in the operational tools and techniques, relationship management tools and support systems sections of the model, the plant will be able to achieve world-class levels of performance and therefore will exhibit the outcomes predicted by the model. Although this analysis is far from conclusive as a result of the limitations of the current study, if Plant C is a word-class performer as suggested above, the characteristics of the plant should conform to the model.

Operational tools and techniques

As discussed above, Plant C exhibits most of the characteristics predicted by the model for operational tools and techniques. The results that did not conform to the model were the characteristics of physical flow, synchronised work processes, low levels of finished goods inventory, and frequent deliveries to customers and from suppliers. All of these anomalies can be explained in terms of logistics. Plant C has a plan in place to redesign the factory layout and is working towards the introduction synchronisation, so the detection of this anomaly is contingent on timing. The anomalies in terms of the levels of inventory and deliveries are a result of the distance between Plant C and their customers and suppliers and as such may be a function of the geographical location of Australia rather than an error in the model.

Relationship management tools

Of all of the characteristics prescribed by the model for relationship management, Plant C exhibits all of them except competitive pay rates and staff benefits, and payment by results. Payment by results is not as common in Australia as it is in other parts of the world, (for example in the UK and USA), and although Plant C only pays award rates (which for the purposes of this study do not meet the criteria as competitive pay rates), none of the other participants in this study or the Australian parent study pay above award rates either. Although the Enterprise Bargaining legislative framework implemented in Australia in 1991 has provided ample opportunity for employers to implement innovative payment systems, it is possible that the history of labour relations in Australia, which is often characterised by union hostility and employee resistance to change, may have prompted these plants to retain more traditional pay systems based on 'the rate for the job'.

Support systems

Plant C conforms to the characteristics predicted by the model in relation to support systems in all respects.

Predicted outcomes

Although the research design did not address all of the characteristics included in the model for predicted outcomes, Plant C exhibited all of the characteristics included in the study. This result is the one that the model would predict, given how closely Plant C conformed to the other three sections of the model.

The data provided by Plant C in this study are consistent with that predicted by the model, with the exception of a small number of anomalies that can be explained by geography and the political and economic climate in Australia. If Plant C is deemed to be a world-class performer, which is not entirely unreasonable given the assessment by and subsequent endorsement received from the Ford Motor Company in 2001 and 2002, the parallels between Plant C's data and the model are encouraging and suggest that there would be merit in testing the model further.

Implications of the study

This thesis investigated the literature regarding lean production, the learning organisation, employee participation, empowerment, motivation, trust, and organisational culture and climate, in an attempt to develop a comprehensive model of the learning factory. The results of the empirical component of the study, which have been presented in the preceding sections of this chapter, provide valuable insights not only for researchers investigating the introduction of the learning factory concept to a manufacturing environment but also for managers attempting to improve productivity and performance by utilising the concept.

The significant findings of the study are presented below and address the following questions:

- are lean production and the learning organisation models compatible in practice?
- are there examples of the learning factory in Australia?
- are learning factories in Australia lean or mean? and
- does the model developed in this thesis predict world-class performance?

Are lean production and the learning organisation compatible in practice?

The review of the research literature presented in Chapter 2 indicated that, on paper at least, lean production and the learning organisation were compatible and could potentially lead to improved or superior performance. One of the plants in the study, Plant C, claims to have implemented both lean production and learning organisation principles and practices into its operating methods. Evidence was found in the data provided by Plant C to support this claim. An evaluation of the performance of Plant C using the research model developed in Chapter 4 indicates that Plant C is achieving high levels of performance, possibly as a direct result of implementing both models simultaneously.

Are there examples of the learning factory in Australia?

Plant C has exhibited a majority of the characteristics of a learning factory, and has had its status as a world-class performer confirmed by Ford USA. Therefore it is likely that this plant is an example of a learning factory. If this is the case, then learning factories not only currently exist in Australia, but a number of other plants that may not currently meet the criteria for classification as learning factories, are well on the way to becoming learning factories. In this study, all of the remaining three plants have expressed an objective to become world-class performers and are in the process of implementing systems, tools and techniques which will allow them to evolve into learning factories.

Are learning factories in Australia lean or mean?

While this study is unable to provide a definitive answer to this question, there are a number of positive signs within the evidence gathered from the four plants. Although Plant C is the only plant in the study that can be tentatively identified as a learning factory, in one way or another the managements of all four plants are making good faith efforts to create a more supportive learning environment for shop floor workers. Programs have been developed to improve communication and all of the plants provide opportunities for additional training and development. The employees at all four plants are provided with the opportunity to put forward ideas for improvements and have ready access to higher-level managers. The Managing Directors of all four plants expressed an ongoing commitment to developing and supporting their staff.

The perceptions of the workers, however, are still a reflection of a more traditional manufacturing model. This is made evident by the obvious 'them and us' divide which surfaced during interviews with operational staff, many of whom expressed a high level of cynicism about programs designed to protect core employees, enrich jobs or improve morale and productivity. While many of the employees were willing to acknowledge management attempts to involve them in some of the decision making processes by improving communication and providing access to top management, they appear to question the motivation behind these initiatives. It would appear that the plants in this study have not yet achieved the mutual trust that is necessary for mutually productive relationships, and this is perhaps not surprising, given the wealth of theory about the difficulty of establishing and maintaining mutual trust in organisations. Thus it would appear that although learning factories in Australia are investing the time and money necessary to become 'lean' rather than 'mean', as the distinction between 'lean or mean' appears to be one of perception, there is perhaps, still a long way to go.

Does the learning factory model developed in this study predict world-class performance?

The data collected during the learning factory study and analysed in this thesis provides some support to the research model. Plant C, identified by an independent source as a world-class performer, exhibits a majority of the characteristics that are prescribed by the model, the exceptions being of inventory levels and frequency of delivery to customers, physical flow through the production processes, extensive induction and orientation and competitive pay rates. The distance between Australia and the majority of Plant C's major customers can potentially explain the inventory levels and frequency of delivery. The lack of extensive induction and orientation is most likely to be due to the Plant's policy of hiring permanent employees from their existing casual pool after an evaluation period of at least three months on the job, making a formal induction and orientation process unnecessary. As none of the plants in the Australian parent study pay significantly above award rates or offer payment by results, it is possible that by paying award rates for hours worked Plant C is conforming to the historical context of the labour market in Australia. Thus although the inclusion of these variables may be appropriate in the UK, USA or Japan where the study originated, it may not be appropriate in Australia.

Although the findings presented in this thesis indicate the model may have the potential for predicting world-class performance, the results are far from conclusive and further research is required before the model can be presented to industry as a useful tool.

Limitations of the study

The questions asked were drawn from a larger study, which involved specific automotive sectors (namely, brakes, exhaust and seat manufacturers). Participants in the international study were selected using strict criteria to ensure the results of individual cases were comparable with other participants in the study, thus enabling the researchers to 'rank' participants on quality and productivity performance measures and to investigate organisational characteristics that may be indicative of or at least common to world-class performers.

However, in Australia there are not sufficient numbers of plants in any specific automotive sector, and thus the companies that agreed to participate are operating in a number of different sectors of the automotive manufacturing industry. The participants produce a wide variety of products using vastly different processes and technology. As a result, much of the data collected, while interesting on a case-by-case basis, was not appropriate for comparison across cases.

Data were not available for several important dimensions of the research model proposed in the study, as the data collected during the parent studies either did not address those dimensions or were inadequate to make comparisons or draw conclusions. The project team was put together approximately twelve months before the author joined the team as a research student. Joining an existing research team on an established project limited the opportunities for the author to influence or amend the research design to collect any additional data for a number of reasons.

Firstly, there was only a very short window of time to adapt the survey instruments of the parent study for use with Australian companies, as this process involved Dr. Delbridge who spent two weeks in Australia working with the research team. During this period, Dr. Delbridge and the Australian research team not only attempted to adapt the survey instruments to local conditions but also commenced the fieldwork at four of the plants participating in the Australian parent study. During this process, the research team made the decision to keep any additional questions to a minimum. This decision was partially due to the limited amount of time available to finalise the instruments but also because the team was concerned that the survey instruments used in the international parent study were already long and complex, particularly as the Australian participants were unfamiliar with the study and were being asked to complete them for the first time.

The timelines of the various studies presented another difficulty for the author. The fieldwork for the Australian parent study was virtually completed before the author had fully developed the proposal for the study presented in this thesis. As a result, many of the issues identified in the literature review could not be addressed using the data collected in the parent study. Although the author did consider returning to the four plants selected in this study to gather additional data, this option proved to be impractical. Asking participants for more of their time may have created ill-feeling on their part as many of the participants were already expressing dissatisfaction regarding the time lag between providing the data and receiving a report on the outcomes of the parent study.

A number of the issues referred to in previous chapters are also relevant to the discussion of the limitations inherent in this and any other study undertaken by research students. This thesis is the end product of a series of learning experiences, and as such many of the thoughts, interpretations and conclusions drawn and presented here are necessarily imperfect or incomplete. Those thoughts, interpretations and conclusions, carefully drawn and thoroughly evaluated by the author, are still a reflection of past experiences, cognitive short-cuts and subjective analysis and therefore there is no guarantee that if presented with the same or similar experiences, any other researcher would reach exactly the same conclusions.

Nevertheless, this study demonstrates the broad range of issues and the level of complexity facing organisations that are attempting to become 'learning factories'. It also hints at the difficulties inherent in approaching this type of study from a single disciplinary perspective. By using an eclectic approach to reviewing the literature on lean production and the learning organisation, the author has been able to investigate the findings of researchers working in education; industrial, social, cognitive and behavioural psychology; industrial engineering; production or operations management; business and strategic management; and human resource management. Although this approach is useful in identifying the issues that may or may not impact on a change program in the workplace, it is unlikely that one researcher would have the level of expertise necessary in each discipline to successfully investigate inter-related issues and be able to integrate the findings in a comprehensive and cohesive manner.

Future directions for research

This thesis represents an attempt to develop and test a comprehensive research model of the learning factory, one that fully incorporates the 'soft' or human aspects. However, the structure of the present study prevented the author from testing all of the assumptions and predictions of the model to be tested. The next logical step would be to broaden the study to include all of the variables included in the model using a research design that identified and analysed the relationships predicted in the model.

One of the limitations of this study is that the findings cannot be generalised across industry sectors or national boundaries. This limitation could be partially addressed by undertaking a comprehensive comparison of the results with the findings of the two parent studies. However, as the UK based study concentrated on brake, seat and exhaust manufacturers and the participants in this study along with the majority of the participants in the Australian study are drawn from other sectors, this comparison would necessarily be limited to management practices such as problem-solving and continuous improvement, worker responsibilities, human resource management, customer and supplier relations rather than productivity and performance measures. These being the case, while it would not be possible to determine how well the Australian participants were performing in comparison to their UK, USA and Japanese counterparts, there may be some benefit in comparing management practices of the Australian cases with any international cases that are identified as world-class performers during the parent study.

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Appendix I

The learning factory questionnaire

HIGH PERFORMANCE MANUFACTURING

AND

THE LEARNING FACTORY

GENERIC QUESTIONNAIRE

Confidential

PLEDGE OF CONFIDENTIALITY

All the information collected in the course of this study will be treated in the strictest confidence and will not be released to anyone outside the research team other than in aggregate form.

If you have any queries about any of the items in the questionnaire please contact:

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INTRODUCTION

The aim of this project is to systematically measure manufacturing performance and to assess problem solving and continuous improvement activities. There has been increasing realization that the competitive environment in which manufacturers operate has meant that change and innovation are constants. However, there has been little research that has explored the relationship between the management of improvement efforts and manufacturing performance. This project seeks to establish models of best practice for the learning factory and examine the links between problem solving, improvement and performance.

This questionnaire records the data required for the performance evaluations and also collects information on key management practices and the operating conditions of the plant. You should provide information with specific reference to your manufacturing operations. Some questions will request information for two separate time periods, being 1994 and 1999. This will enable the research team to make comparisons over time for each respondent and against international benchmarks for each of these two time periods. This is important to ensure comparability of data across respondents. Individual sections of the questionnaire may be completed by different specialists. The questionnaire has two parts:

PART I **MANAGEMENT PRACTICES**

Questions cover five areas:

A Problem solving and continuous improvement
B Worker responsibilities and organization
C Human Resource Management
D Relations with suppliers
E Relations with customers

PART II **PLANT PERFORMANCE** (Section F)

Your answers to Part I of the questionnaire will be collated and used to give your plant a score on a series of dimensions of management practice.

Part II of the questionnaire asks a series of questions about the volume, quality and variety of finished goods that your plant produces. This information will be used to calculate the performance of your plant.

The methodology has been designed to perform audits at *plant* level. The purpose of the methodology is to permit detailed comparison of manufacturing performance between plants that produce similar products and to 'profile' the management practices of these plants.

After you have completed your questionnaire, we will carry out some preliminary calculations and ask you to verify these as accurate. We then intend to conduct interviews and observation research. On completion of this we will provide you with full feedback on your plant's management practices and performance.

PART I: MANAGEMENT PRACTICES

A PROBLEM SOLVING AND CONTINUOUS IMPROVEMENT

A1	Do representatives from company head quarters visit and review the activities of this plant on a regular basis?	Yes	No
A2	If yes, how many times a year?	_____	
A3	Is advance notice given of these reviews?	Yes	No
A4	Is this plant benchmarked by the company against other plants in the group?	Yes	No
A5	Does the plant have personnel with direct management responsibility for any of the following:		
	i) shopfloor problem solving?	Yes	No
	ii) continuous improvement?	Yes	No
A6	If yes, what is the full-time equivalent number of people with management responsibility for each of these activities:		
	i) shopfloor problem solving?	_____	
	ii) continuous improvement?	_____	

		1999	**1994**
A7	Is there a budget for continuous improvement activities?	Yes / No	Yes / No
A8	**Is there a suggestion scheme in use at the plant?**	**Yes / No**	**Yes / No**
A9	If so, how many suggestions were submitted during 1994 and 1999 from those involved in manufacturing?	_____	_____
A10	How many suggestions concerning manufacturing were accepted and implemented during 1994 and 1999?	_____	_____

A11	Does the plant offer financial rewards for employee suggestions?	Yes	No
A12	If so, last year what was the typical value of reward given for an individual suggestion (in $)	_____	
A13	Are production operators set targets for the number of suggestions they should submit?	Yes	No
A14	If so, what is the annual target per operator?	_____	
A15	Of the total number of suggestions made last year, approximately what proportion came from each of the following groups?		
	Production operators	_____	%
	Team leaders/supervisors	_____	%
	Skilled blue collar workers	_____	%
	Other Groups (please specify)	_____	%
		100	%

Long-term shopfloor problem solving groups

A16 Does the plant have shopfloor problem solving groups that meet regularly over the long term? Yes No

A17 What percentage of all production operators are involved in these activities? _____

A18 How many people for each of the following occupations are typically in one group:

i) operators _____
ii) first-line managers (team leader, supervisor) _____
iii) skilled blue collar workers _____
iv) technical specialists _____
v) engineers _____
vi) others _____

Total

A19 Are any people from the following occupations typically members of more than one group?

i)	Operators	Yes	No
ii)	first-line managers (team leader, supervisor)	Yes	No
iii)	skilled blue collar workers	Yes	No
iv)	technical specialists	Yes	No
v)	engineers	Yes	No
vi)	others	Yes	No

A20 How frequently do typical groups meet? _____

A21 In a typical month, how much time is scheduled for such meetings for a typical group? _____

A22 Where do these groups hold their meetings? _____

A23 Do these groups work to tasks and objectives set by management (i.e. they do not determine their own activities)? Yes No

A24 What <u>percentage</u> of a group's time is typically spent on each of the following:

i)	housekeeping	%
ii)	product quality problem solving	%
iii)	material handling and logistics problems	%
iv)	layout and ergonomics	%
v)	manufacturing process improvements	%
vi)	product development/improvement	%
vii)	other (please specify)	%
	_____	100 %

A25 Do these groups have their own budgets? Yes No

A26 Do groups receive financial rewards for their activities? Yes No

A27 Do groups meet other groups on a regular basis? Yes No

Short-term shopfloor problem solving groups

A28 Does the plant have short-term task-based problem solving groups? Yes No

A29 What percentage of all production operators are involved in these activities at any given time? _____

A30 How many people for each of the following occupations are typically in one group:

i) operators _____
ii) first-line managers (team leader, supervisor) _____
iii) skilled blue collar workers _____
iv) technical specialists _____
v) engineers _____
vi) others _____

Total

A31 Are any people from the following occupations typically members of more than one group?

i) operators Yes No
ii) first-line managers (team leader, supervisor) Yes No
iii) skilled blue collar workers Yes No
iv) technical specialists Yes No
v) engineers Yes No
vi) others Yes No

A32 Do these groups meet on a regular basis? Yes No

A33 If so, how frequently do such groups meet? _____

A34 In a typical month, how much time is scheduled for such meetings? _____

A35 Where do these groups hold their meetings? _____

A35 Do these groups work to tasks and objectives set by management (i.e. they do not determine their own activities)? Yes No

A36 What <u>percentage</u> of a group's time is typically spent on each of the following:

i) housekeeping _____ %
ii) product quality problem solving _____ %
iii) material handling and logistics problems _____ %
iv) layout and ergonomics _____ %
v) manufacturing process improvements _____ %
vi) product development/improvement _____ %
vii) other (please specify) _____ %

100 %

A38 Do these groups have their own budgets? Yes No

A39 Do groups receive financial rewards for their activities? Yes No

A40 Do groups meet other groups on a regular basis? Yes No

B WORKER RESPONSIBILITIES AND ORGANIZATION

Please answer these questions for all production areas, unless otherwise stated.

B1 Are newly-recruited operators engaged required to rotate through different tasks as part of their formal training programme? Yes No

B2 How long does it take for an operator in the manufacturing areas to be able to work to a satisfactory standard on these tasks *without* supervision? _____

B3 What is the typical job cycle time for a production operator working in the manufacturing area? _____

B4 What percentage of direct workers are members of clearly defined and relatively fixed teams? _____

B5 What is the typical number of people in an manufacturing team (including the team's leader and any other permanent members)? _____

B6 Please state whether the production teams in the manufacturing areas:

Hold daily meetings	Yes	No
Frequently rotate between jobs within the team (daily)	Yes	No
Regularly rotate between other teams (weekly)	Yes	No
Are managed by a team leader	Yes	No
Appoint their own team leader	Yes	No
Routinely hold problem-solving meetings	Yes	No
Manage their own budgets (for example tools & consumables)	Yes	No

B7 Which of the following is the *primary* channel of communication between management and the shopfloor? Please tick *one* only.

- Team leaders _____
- Elected representatives from a joint consultative committee _____
- Union shop stewards _____
- Other (please specify) _____ _____

B8 The purpose of this question is to measure where the responsibility for quality related activities lies in your plant. To do this, please estimate how much input each of the following groups makes to the activities listed below. When completed, each row should sum to 100%.

Production workers:	Those who work in the production areas, physically handing the products.
Production team leaders:	Those who have responsibility for a production team.
Others in team:	Any other staff who are part of the production team and who report to the team leader.
Skilled trades:	Blue collar workers who have a specialist skill. Examples include electricians, fitters, and machine setters.
Quality specialists:	Staff in a specialist department not reporting directly to the Production Department.
Others:	All other staff.

	PRODUCTION TEAMS				OTHER SPECIALIST DEPARTMENTS		
	Production workers	Team Leaders	Others in team	Skilled trades	Quality specialists	Others	Total
Monitoring quality performance	_____	_____	_____	_____	_____	_____	100%
Quality improvement	_____	_____	_____	_____	_____	_____	100%
Quality Inspection	_____	_____	_____	_____	_____	_____	100%
Re-work of faults attributable to the team	_____	_____	_____	_____	_____	_____	100%

B9 The purpose of this question is to measure where the responsibility for personnel issues lie in your plant. To do this, please estimate how much input each of the following groups makes to the activities listed below. When completed, each row show sum to 100%

Personnel workers: Staff in a specialist Personnel Department not reporting directly to the Production Department. These are likely to be white collar staff.

	PRODUCTION TEAMS				OTHER SPECIALIST DEPARTMENTS		
	Production workers	Team Leaders	Others in team	Skilled trades	Personnel specialists	Others	Total
Hiring decisions	_____	_____	_____	_____	_____	_____	100%
Dismissal decisions	_____	_____	_____	_____	_____	_____	100%
Settling of grievances or complaints	_____	_____	_____	_____	_____	_____	100%
Training activities	_____	_____	_____	_____	_____	_____	100%

B10 The purpose of this question is to measure where the responsibility for scheduling, maintenance and work design lies in your plant. To do this, please estimate how much input each of the following groups makes to the activities listed below. When completed, each row show sum to 100%

Engineering specialists: Staff in a specialist Engineering Department not reporting directly to the Production Department. These are likely to be white collar staff.

	PRODUCTION TEAMS				OTHER SPECIALIST DEPARTMENTS		
	Production workers	Team Leaders	Others in team	Skilled trades	Engineering specialists	Others	Total
Work allocation within team							100%
Setting work pace							100%
Process improvements							100%
Machine setting							100%
Production scheduling							100%
Reactive maintenance							100%
Pre-planned preventative maintenance							100%
Recording of information on machine utilisation							100%
Preventative maintenance based on monitoring							100%

C HUMAN RESOURCE MANAGEMENT

		1999	1994
C1	Excluding any new recruits, what percentage of operators assigned to manufacturing operations have received off the job training in the last year (include training conducted in-house and externally)?	_____	_____
C2	What was the average total length of time off the job training for a typical operator in 1994 and 1999?	_____	_____
C3	Excluding any new recruits, what percentage of skilled blue collar workers assigned to manufacturing operations received off the job training in 1994 and 1999 (include training conducted in-house and externally)?	_____	_____
C4	What was the average total length of time off the job training for a typical skilled blue collar worker 1994 and 1999?	_____	_____
C5	What percentage of production-related white collar staff has received off the job training in 1994 and 1999?	_____	_____
C6	What was the average total length of time off the job training for a typical white collar worker in 1994 and 1999?	_____	_____

C7 Does the plant have any formal arrangement for rotating between functions for each of the following:

i)	development engineers	Yes	No
ii)	manufacturing engineers	Yes	No
iii)	quality engineers	Yes	No

C8 Does the plant have an apprenticeship scheme? **Yes** **No**

C9 If yes, what is the average annual intake of apprentices? _____

C10 What is the average length of an apprenticeship? _____

		1999	1994
C11	What was your labour turnover rate for employees in manufacturing in 1994 and 1999?	_____	_____
C12	What is the average length of service for employees assigned to manufacturing?	_____	
C13	What is the total hourly cost of a typical manufacturing operator (including any additional costs such as bonuses, seniority payments, superannuation contributions etc)?	_____	

C14 When you recruit new production operators, to what extent are the following activities used in the recruitment process?

	Not at all	Some Use	A great deal of use
Group interview or exercise	1	2	3
Attitude tests	1	2	3

C15 What is the average length of time spent with each prospective new production operator during recruitment? _____

C16 When you most recently recruited production operators, how many applications did you receive per position available? _____

C17 Approximately what percentage of operators are employed on temporary contracts (i.e. one year or less)? _____

C18 Please identify the compensation scheme(s) which apply to each of the following groups of employees by ticking the appropriate response:

	Production Workers	Production Team Leaders
Hourly pay (based on job grade, seniority or skills learned)	_____	_____
Salary	_____	_____
Payment by results (PBR)	_____	_____
If yes to PBR:		
Is the bonus paid for individual performance?	_____	_____
Is the bonus paid for work group performance?	_____	_____
Is the bonus paid for plant/company performance?	_____	_____
Typically, what percentage of total pay is bonus-related?	_____ %	_____ %
Is there any payment for problem solving or continuous improvement activity (apart from suggestion schemes)?	_____	_____

C19 Are employees in this plant covered by an industrial agreement? Yes No

C20 Does this plant recognise trade unions? Yes No

C21 What is the union membership rate amongst production operators? _____

C22 Please indicate the level of union involvement in each of the following areas (1 = no involvement of trade union, 2 = trade union is informed, 3 = trade union is consulted, 4 = negotiated with trade union):

	None	Informed	Consulted	Full
Pay and conditions	1	2	3	4
Health and safety issues	1	2	3	4
Setting the pace of work (for example, agreeing job timings)	1	2	3	4
Changes to work processes	1	2	3	4
Staffing levels	1	2	3	4
Investment decisions	1	2	3	4
Communication between management and the shopfloor	1	2	3	4

	1999	**1994**
C23 What was your unscheduled absenteeism rate for direct employees in the last financial year?	_____	_____

C24 Approximately how many working days were lost due to industrial action in 1999? _____

C25 If this plant does recognise Unions, what type of agreement (i.e. Australian Workplace Agreement, certified agreement, etc)?

_____

D SUPPLIER RELATIONS

This section is concerned with the nature of the relationship between this plant and it suppliers. We are particularly interested in the closeness of this relationship, and the questions in this section are intended to gauge this. As before, we would like you to answer this section with respect to manufacturing.

D1 How many (direct) suppliers supply raw materials and components to this plant which are used in manufacturing? Please include suppliers of materials and components used in manufacture only: exclude catering, cleaning, office supplies, capital goods etc.

Total number of suppliers _____

D2 Have you significantly reduced the number of suppliers over the last five years? Yes No

D3 If so, by approximately what percentage? _____

D4 What was the total value (in $) of purchased parts and materials last year? _____

D5 Do you operate a 'club' or association for your suppliers? Yes No

D6 If you do operate such as association, how many suppliers are members of it? _____

D7 How often does the association meet? _____

D8 Last year, how many times did representatives of your suppliers visit this plant for planned supplier development activities? _____

D9 Last year, approximately how many times did a representative from this plant visit the premises of your suppliers for planned supplier development activities? _____

D10 Last year, from how many of your suppliers who supply parts did you request actual cost reductions? _____

D11 If applicable, what was the average cost reduction requested (%)? _____

D12 Do you have an agreed set of formal rules for sharing the gains from supplier cost reductions with your suppliers? Yes No

D13 Please indicate the relative responsibility for the design effort which went into the most recent significant component part sourced from your main supplier:

The car maker who will use the product	_____ %
The customer, if not the car maker	_____ %
Your company	_____ %
The supplier	_____ %
Other	_____ %

D14 Last year, with how many of your suppliers who supply parts did you engage in joint cost reduction activities? (i.e. your staff participate in the design and/or implementation of improvements.)

_____

D15 For significant incoming parts (please list below), please give the following information for your highest volume part (i.e. specific part number):

(1) the amount of 'normal' buffer stock you usually carry for that part

(2) the amount of 'emergency' stock you carry in addition to normal stock

(3) the frequency of delivery of that part

(4) your estimate of the defect rate (as a percentage) of that part

1999	**1**	**2**	**3**	**4**
Part name (Key components list)	Hours of 'normal' stock	Hours of 'emergency' stock	Frequency of delivery	Estimated defect level
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

1994	**1**	**2**	**3**	**4**
Part name (Key components list)	Hours of 'normal' stock	Hours of 'emergency' stock	Frequency of delivery	Estimated defect level
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

D16 Please indicate the geographical dispersal of your supplier base by giving the journey time in hours from the supplier's premises to your plant using the table below.

Typical Journey Time from your Plant (hours)	Percentage of suppliers
Less than 1.0 hour	_____ %
1.0 – 4.0 hours	_____ %
4.0 + hours	_____ %

D17 Approximately what percentage of deliveries from your suppliers are late?

_____

D18 What is the approximate average variation between planned order one month out and final firm order given to your major supplier?

_____

D19 What is the period from final firm order to receipt of parts from your major supplier?

_____

E CUSTOMER RELATIONS

This section is concerned with the nature of the relationship between this plant and it customers. We are particularly interested in the closeness of this relationship, and the questions in this section are intended to gauge this.

E1 Please indicate the nature of the customer base for this plant at the end of the last complete financial year using the table below:

	Number of ***Companies supplied***	Percentage of ***Total sales***
Car makers	_____	_____ %
After market	_____	_____ %
Total	_____	100 %

E2 Who are this plant's three largest customers and what percentage of total sales goes to each?

		Percentage sales
Customer 1:	_____	_____ %
Customer 2:	_____	_____ %
Customer 3:	_____	_____ %

E3 Do any of your customers operate supplier 'clubs' or associations? Yes No

E4 This asks you a series of questions about the plants of your major customer indicated in E2. Please complete the table below.

Column 1: The name of each plant supplied.
Column 2: The approximate journey time (in hours) from your plant to each plant.
Column 3: The approximate percentage of this plant's sales that go to each plant.
Column 4: The hours of finished goods inventory (in hours) for the products that go to each plant. This should include products in intermediary warehouses and any emergency supplies that are kept in the system.
Column 5: The frequency with which this plant makes deliveries of its high volume products to each plant (or ware house, if applicable).

	1 NAMES OF PLANTS	2 JOURNEY TIME (IN HOURS)	3 % OF SALES TO EACH PLANT	4 FINISHED GOODS STOCK (HOURS)	5 FREQUENCY OF DELIVERY
1.	_____	_____	_____ %	_____	_____
2.	_____	_____	_____ %	_____	_____
3.	_____	_____	_____ %	_____	_____
4.	_____	_____	_____ %	_____	_____

E5 Last year, how many days did members of the *Production Department* of your plant spend at the plants of your customers for planned supplier development activities? (Please estimate this by multiplying the number of members by the typical number of days per member) _____

E6 Last year how many times did a representative from your customers visit this plant for supplier development activities? _____

E7 Last year how many of your customers of demanded <u>actual</u> cost reductions? _____

E8 If applicable, what was the average cost reduction requested? _____

E9 Does your main customer audit the quality systems of this plant Yes No

E10 If so, how frequently does such auditing occur? _____

E11 Please indicate the relative distribution of responsibility for the *design and development* effort for your most recently introduced finished product:

	% of responsibility
The car maker	_____ %
The customer, if not the car maker	_____ %
Your company	_____ %
Other (please specify)	_____ %
	100 %

E12 Last year, with how many of your customers did you engage in joint cost reduction activities? (i.e. customers participated in design and/or implementation of improvements) _____

E13 Do you have an agreed set of formal rules for sharing the gains from your cost reductions with your customers? Yes No

E14 Approximately what percentage of deliveries from your plant to your customers are made later than the agreed delivery time? _____

E15 What is the approximate average variation between planned order one month out and final firm order given to you by your major customer? _____

E16 What is the period from final firm order to dispatch to your major customer? _____

PART II: PLANT PERFORMANCE

F PLANT PERFORMANCE 1999 and 1994

		1999	1994
F1	Please estimate your capacity utilization for 1999 and 1994.	_____	_____
F2	Please estimate the following for production, in 1999 and 1994		
	i) Scrap Costs ($'s)	_____	_____
	ii) Warranty claims costs ($'s)	_____	_____
	iii) Set-up times (mins)	_____	_____
	iv) Changeover times (mins)	_____	_____
	v) Downtime (%)	_____	_____
F3	At the end of the 1999 and 1994 financial years, what was the total value of your raw materials inventory?	_____	_____
F4	At the end of the 1999 and 1994 financial years, what was the total value of your work-in-progress inventory?	_____	_____
F5	At the end of the 1999 and 1994 financial years, what was the total value of your finished goods inventory?	_____	_____
F6	At the end of the 1999 and 1994 financial years, what was the overall value of your total inventory?	_____	_____
F7	What was the total value of sales (excluding any sales tax) of for the 1999 and 1994 financial years?	_____	_____

F8 Please indicate your structure of costs for manufacturing in 1999 and 1994 using the table below:

Item	% of Manufacturing Cost			
	1999		**1994**	
Purchased materials and components	_____	%	_____	%
Direct labour	_____	%	_____	%
All other labour	_____	%	_____	%
Other	_____	%	_____	%
Total manufacturing output (at cost)	100	%	100	%

F9 How many different variants of finished goods were produced at this plant (i.e. 'live' part numbers) in 1999 and 1994?

_____ _____

		1999	1994
F10	How many new variants (part numbers) of finished goods were during the twenty four month periods of 1998-1999 and 1993-1994?	_____	_____
F11	What percentage of your main product finished goods failed *first* final inspections and test in 1999 and 1994? (i.e. what was your *internal* defect rate?)	_____	_____
F12	What proportion of your main product finished goods did your customers claim were defective in 1999 and 1994 in PPM?	_____	_____

F13 Of the quality defects reported by your customers, what proportion would you ascribe to:

		1999		1994	
i)	design-related problems?	_____	%	_____	%
ii)	supplier-related problems?	_____	%	_____	%
iii)	manufacturing process: technical problems?	_____	%	_____	%
iv)	manufacturing process: human error?	_____	%	_____	%
v)	testing problems?	_____	%	_____	%
vi)	other (please specify)?	_____	%	_____	%
		100	%	100	%

		1999	1994
F14	What was the total area of factory used for manufacturing (include storage areas).	_____	_____

F15 Please estimate the number of employees in each of the groups listed below. Please adjust for part-time and temporary workers.

	1999	1994
Production operators:	_____	_____
Production team leaders:	_____	_____
Production supervisors:	_____	_____
Materials handlers:	_____	_____
Others (please specify)	_____	_____
SUBTOTAL	_____	_____
Maintenance staff:	_____	_____
Engineering staff:	_____	_____
Quality staff:	_____	_____
Production planning and control staff:	_____	_____
Finance staff:	_____	_____
Personnel staff:		_____

Purchasing staff: _____ _____

Dispatch and distribution staff: _____ _____

All other indirect staff: _____ _____

TOTAL STAFF _____ _____

F16 How many production hours are there in one working day (excluding overtime)? _____ _____

F17 How many shifts are there in one working days? _____ _____

F18 Of the total number of hours worked by direct employees in the 1994-95 financial year what percentage were overtime hours? _____ _____

F19 Please estimate the average age of the production equipment in use at this plant in 1994 and 1999 _____ _____

F20 Including machine loading and unloading, and the transfer of materials between processes please indicate the approximate percentage of steps in your manufacturing processes which were automated in 1994. This should be estimated by dividing the number of steps carried out by machines by the total operations in the process. :

i.e. Total number of steps = 8. Number automated = 5. Automation level = 62.5%

	% of steps automated	
	1999	**1994**
Manufacturing	_____	_____

F21 What measures do you use to measure labour productivity and manufacturing efficiency?

Labour productivity _____

Manufacturing efficiency _____

F22 For each measure, what was the performance change for the following years (as a %):	**1999**	**1994**
Labour productivity	_____	_____
Manufacturing efficiency	_____	_____

F23 Do you measure your Overall Equipment Effectiveness (OEE)? Yes [ ] No [ ]

OEE = availability x performance x quality

Where

$$availability = \frac{Total\ available\ time\ when\ needed - downtime}{total\ available\ time\ when\ needed} \times 100$$

performance = operating speed rate x operating rate
Or simply: (completed cycles) / (planned cycles) x 100

$$\textit{Quality rate} = \frac{\textit{Total output} - \textit{defects}}{\textit{Total output}} \times 100$$

Or (parts right first time) / (completed cycles) x 100

		1999	1994
F24	If yes, was the OEE (%) for 1999 and 1994?		
F25	Please indicate how long (in days and weeks) it typically took for production to settle down to normal levels of *quality* following the launch of a major new product in 1994 and in 1999.		
F26	Please indicate how long (in days and weeks) it typically took for production to settle down to normal levels of *productivity* following the launch of a major new product in 1994 and in 1999.		
F27	No of parts and components in the major finished product.		

THANK YOU VERY MUCH FOR YOUR ASSISTANCE

Appendix II

The learning factory interview schedules

1st Interview Questions

Plant Overview: Continuous Improvement and Problem Solving

Overview:

1. For the tape, can you please give your name, tell us what your position is in the company, what your job entails and how long you have been with the company?
2. Can you please give a brief overview of how continuous improvement and problem solving occurs at this plant?
3. Are performance targets set at the corporate level for this plant?
4. What are the key performance indicators for this plant?
5. Is continuous improvement part of the formal business plan of this plant, and if so, how?
6. How are business plans converted into objectives for departments and individual workers?
7. Are formal targets set for continuous improvement and problem solving activities, and if so what?
8. Do you have a suggestion scheme?
9. Do you have a specialist role within your company structure for managing and coordinating continuous improvement activities?
10. How are lessons learnt from continuous improvement activities or the introduction of new products or processes transferred or made available throughout the organisation?

Continuous Improvement on the Shop Floor

11. If I were an operator with an idea for an improvement that could make my job easier, what would I do?
12. If a work group or team has an idea for an improvement, what processes are in place to enable the idea to be evaluated and if accepted, acted on?
13. If an improvement idea is accepted and it requires a change to the standard operating procedures (SOP's), how does this happen?
14. Who would sign off on the changes?
15. How often do changes to the SOP's occur?

Operators

16. Are operators involved in continuous improvement or problem solving activities and if so, how?
17. Are operators trained in problem solving techniques?
18. Is involvement in continuous improvement or problem solving activities a part of the performance evaluation of operators?
19. What mechanisms do you use, if any to keep operators interested and involved in continuous improvement or problem solving activities?
20. Are there any impediments to employee involvement in continuous improvement or problem solving activities?

Team Leaders

21. Can you explain the role of team leaders or front line managers in continuous improvement or problem solving activities?
22. Are team leaders trained in problem solving techniques?
23. Is involvement in continuous improvement or problem solving activities a part of the performance evaluation of team leaders?
24. Are team leaders responsible for their team's performance, e.g continuous improvement?
25. Are there any impediments to team leader involvement in continuous improvement or problem solving activities?
26. Who do team leaders report to about continuous improvement or problem solving activities?
27. When you are selecting team leaders, which is more important – technical expertise or people management skills?

Management

28. Can you explain the role of senior management in continuous improvement or problem solving activities?
29. Are managers trained in problem solving techniques?
30. Is involvement in continuous improvement or problem solving activities a part of the performance evaluation of managers leaders?
31. Are there any impediments to management involvement in continuous improvement or problem solving activities?

Suppliers and Customers

32. Can you explain the role of suppliers or customers in continuous improvement or problem solving activities?
33. Is involvement in continuous improvement or problem solving activities a part of the performance evaluation of suppliers?
34. Are there any impediments to supplier or customer involvement in continuous improvement or problem solving activities?

Relations with Corporate

35. How are improvements communicated from one plant to another?
36. Is there a database of improvements for the corporate group?
37. Do you have an intranet?
38. Does the corporate group have a continuous improvement team?

General

39. Is there anything else that you would like to add, perhaps something that we have missed?

Interview schedule for second visit – Customer Relations Manager

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Customer Relations

CR1 What activities does this plant engage in with its major customer(s)?
CR2 Does your customer(s) have formal supplier development programmes?
CR3 Do you engage with your customers(s) in joint cost reduction activity?
CR4 In what ways has this plant learned from its customer(s)?
CR5 Does your major customer(s) expect this plant to meet with other of its key suppliers?
CR6 What communication links are in place between this plant and your major customer(s)?
CR7 What would happen if a series of defective components were delivered to your major customer(s) by this plant?

Interview schedule for second visit – Maintenance Technician

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Operations

OP1 What part of the manufacturing process are you responsible for?
OP2 What do you do if the machine breaks down? (Listen for response on repair and maintenance)
OP3 What happens if defects start occurring regularly?
OP4 Are you encouraged to think of ways of how to improve your machines output?
OP5 Who would you speak to about making improvements in the workplace?
OP6 How are changes and improvements made in your work area?
OP7 How are changes to operating procedures made? (e.g. moving machine versus changing tooling)
OP8 Do you think there is any value in having a suggestion scheme? Why?
OP9 Do you have discussion groups?

Induction and Training

TR6 What opportunities for further training are available?
TR7 Are you encouraged to develop your skills further?
TR3 Were you subject to a probationary period?
TR5 What initial training did you undertake?

Job content

JC1 Do you have any say in how your job is designed or the content of your job?
JC2 What team building techniques are used in your area?
JC3 Are you subject to an appraisal system?

Communication

CM1 How is communication managed within your manufacturing area?
CM2 How are you informed of changes and developments in this plant?
CM3 Do you have the opportunity of giving your views to senior management?
CM4 Are there ways you think that communication could be improved in this plant?

The Learning Factory

Interview schedule for second visit – Production Supervisor

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Recruitment and selection

RT1 What is your involvement in the recruitment and selection process?
RT2 Are job specifications prepared? Do they include matters of improvement activity and specify roles in that?
RT3 How are job specifications drawn up and by whom?

Induction and training

TR1 How are staff inducted into the plant?
TR2 Is continuous improvement specifically addressed at induction? Are problem solving techniques discussed?
TR3 Does the plant use probationary periods for new employees?

TR4 How does the plant ensure that induction and training is given to all new recruits?
TR5 What is the content of training given?

Operations

OP10 Does the plant use standard operating procedures on the shopfloor?
OP11 By what means may these procedures be amended?
OP12 At what level in the hierarchy may changes be authorised?
OP13 Who is responsible for anticipating future operational problems?
OP14 How are groups set problems to work on?
OP15 How is quality defect data used? (Are defects accounted for and blame apportioned to individuals?
OP16 Are defects seen as opportunities for improvement and learning?
OP17 Is plant performance fed back to the shopfloor? In what way?
OP18 Is there any form of payment by results? How are employees rewarded for contributing to improvement activity?
OP19 Is there formal job rotation within the plant?

Supervision and management

SM1 What aspects of staff management are line managers responsible for?
SM2 Are line managers responsible for the improvement activities of their subordinates?
SM3 Is the HR role of line managers clear and understood?
SM4 How is the performance of line managers on continuous improvement assessed and fed back?
SM5 What training do line managers have on staff management?

Career progression

CP1 What is the system for staff appraisal and development at the plant?
CP2 Is continuous improvement activity a specific issue for assessment during appraisal?
CP3 What is the role of line managers in staff appraisal and development? Is it clear?
CP4 Who is responsible for ensuring that action arises from staff appraisals are followed up and implemented?

Communication

CM1 How is communication with staff managed within the plant?
CM2 How are staff informed of developments and changes?
CM3 How does the plant ensure that managers listen to staff views as well as just give out information?

The Learning Factory

Interview schedule for second visit – Continuous Improvement Manager

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Continuous Improvement Manager

IM1 How is learning and innovation coordinated across plants in the company?
IM2 Is this plant part of larger cross-location teams or groups?
IM3 Does the company hold internal conferences, and if so, who attends?
IM4 Does the company have an internal team of consultants?
IM5 Does the company regularly transfer employees between plants in the group?
IM6 How is knowledge transferred across communities within the company?
IM7 Does the company have its own e-mail or intranet system?
IM8 Does the company have a directory of experts or a map of organizational knowledge?
IM9 Through what sources does the plant become aware of new technological developments?
IM10 Does the plant actively monitor its environment for innovations? (If so, is this role centralized and held by individuals or shared?)
IM11 Does this plant benchmark itself against other plants? What measurables are used in this exercise?

The Learning Factory

Interview schedule for second visit – Industrial Engineer

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Operations

OP20 Describe how the plant would manage the introduction of a new piece of production technology?
OP21 Where was this technology developed – off-site, lab-based v. in-process, shop floor based?
- Involvement of external specialists?
- Cross-functional team?
- Shop floor personnel involved?
- Does the plant use software simulations of processes?
- Who sees this?

OP22 How does the plant measure the success of new technology introduction?
OP23 How does the plant measure the success of new process introduction?
OP24 How does the plant spread the learning from one technology introduction to the next?
- Are there project de-briefings?

OP25 Does the plant assess the effectiveness of the management of new process and new product introductions?

The Learning Factory

Interview schedule for second visit – Manufacturing Manager

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Operations

OP26 How does the plant go about solving certain ubiquitous quality problems that cannot be solved by a standard procedure and stem from various sources, need interaction and coordination across departments or functional groups?
OP27 How are such problems framed or categorized? Who is responsible for finding these problems?
OP28 To what extent is problem solving activity standardised and routinised (i.e. use of predetermined procedures)?
OP29 Do problem solving groups have a common methodology for improvement?
OP10 Does the plant use standard operating procedures on the shopfloor?
OP11 By what means may these procedures be amended?
OP12 At what level in the hierarchy may changes be authorised?
OP13 Who is responsible for anticipating future problems and how are groups set problems to work on?
OP15 How is quality defect data used (Are defects accounted for and blame apportioned to individuals and are defects seen as opportunities for improvement and learning?)
OP17 Is plant performance fed back to the shopfloor, if so, in what ways?

The Learning Factory

Interview schedule for second visit – Operators

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Operations

OP1 What part of the manufacturing process are you responsible for?
OP2 What do you do if the machine breaks down?(listen for response on repair and maintenance)
OP3 What happens if defects start occurring regularly?
OP4 Are you encouraged to think of ways of how to improve your machines output?
OP5 Who would you speak to about making improvements in the workplace?
OP6 How are changes and improvements made in your work area?
OP7 How are changes to operating procedures made? (e.g. moving machine versus changing tooling)
OP8 Do you think there is any value in having a suggestion scheme? Why?
OP9 Do you have discussion groups?

Induction and Training

TR6 What opportunities for further training are available?
TR7 Are you encouraged to develop your skills further?
TR3 Were you subject to a probationary period?
TR5 What initial training did you undertake?

Job content

JC1 Do you have any say in how your job is designed or the content of your job?
JC2 What team building techniques are used in your area?
JC3 Are you subject to an appraisal system?

Communication

CM1 How is communication managed within your manufacturing area?
CM2 How are you informed of changes and developments in this plant?
CM3 Do you have the opportunity of giving your views to senior management?
CM4 Are there ways you think that communication could be improved in this plant?

The Learning Factory

Interview schedule for second visit – Head of Personnel

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Recruitment and selection

RT4 What is the involvement of the central personnel function in the recruitment and selection process?
RT2 Are job specifications prepared? Do they include matters of improvement activity and specify roles in that?
RT3 How are job specifications drawn up and by whom?

Induction and training

TR1 How are staff inducted into the plant?
TR2 Is continuous improvement specifically addressed at induction? Are problem solving techniques discussed?
TR3 Does the plant use probationary periods for new employees?
TR4 How does the plant ensure that induction and training is given to all new recruits?
TR5 What is the content of training given?

Pay and Benefits

PB1 What packages have been used to induce staff into the plant?
PB2 What benefits packages are available to offer staff?
PB3 Have pay and benefits been developed in consultation with staff? What consultation has taken place?
PB4 What policies and procedures are in place regarding staff benefits packages?
PB5 Is there any form of payment by results? How are employees rewarded for contributing to improvement activity?

Job content

JC4 What is the HR's role in job redesign and operator instruction changes?
JC5 Has job design or enrichment been considered by HR for any staff groups?
JC6 Is there formal job rotation within the plant?
JC7 Is there Corporate job rotation or Out-placing?

Supervision and management

SM1 What aspects of staff management are line managers responsible for?
SM2 Are line managers responsible for the improvement activities of their subordinates?
SM3 Is the HR role of line managers clear and understood?
SM4 How is the performance of line managers on continuous improvement assessed and fed back?
SM5 What training do line managers have on staff management?

Career progression

CP1 What is the system for staff appraisal and development at the plant?
CP2 Is continuous improvement activity a specific issue for assessment during appraisal?
CP3 What is the role of line managers in staff appraisal and development? Is it clear?
CP4 Who is responsible for ensuring that action arises from staff appraisals are followed up and implemented?

Communication

CM1 How is communication with staff managed within the plant?
CM2 How are staff informed of developments and changes?
CM4 What involvement do staff have in the development of new HR policies and procedures?
CM3 How does the plant ensure that managers listen to staff views as well as just give out information?

The Learning Factory

Interview schedule for second visit – Quality Engineer

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Operations

OP15 How is quality defect data used?

Are defects accounted for and blame apportioned to individuals?
Are defects seen as opportunities for improvement and learning?

OP17 Is plant performance fed back to the shop floor, and if so, in what ways?
OP30 What involvement do shopfloor operators have in monitoring quality?
OP31 How is quality of products improved?
OP32 What would happen if a quality problem on an internal manufacturing process recurred?
OP33 What would happen if a key component supplier began to supply poor quality parts?

The Learning Factory

Interview schedule for second visit – Supplier Development Manager

Employment

E1 What is your job title?
E2 How long have you worked at this plant?
E3 We're interested in change, particularly improvement activity. What are the major changes you have experienced in your time working at this plant?
E4 What do you understand by the term continuous improvement?

Continuous Improvement

CI1 In what ways are changes and improvements managed in your department?
CI2 Is improvement formally linked to the business plan of the organisation?
CI3 Are you given specific targets for improvement?
CI4 How is improvement measured?
CI5 Does your department have a budget specifically for improvement activity? If so, approximately how much is that budget per year?
CI6 Are there formal procedures governing continuous improvement activities?
CI7 To what extent would you say that continuous improvement effort is 'top down'?
CI8 How do individuals contribute to improvement activity?
CI9 Is your contribution formally assessed and appraised?
CI10 How do you and your department link with other groups?
CI11 Is there much cross-functional problem solving?
CI12 How are improvements communicated and made available to others who might benefit from them?
CI13 Exactly what role would your department have in regard to change and improvement on the shopfloor?
CI14 Do you and your colleagues have links with other groups in the corporation with whom you discuss ideas and improvements?
CI15 What factors have constrained improvement activity?

Operations

OP34 Has the profile of the supplier base changed in recent years?
OP35 Has there been a significant change in performance levels of this plant's key suppliers in recent years?
OP36 To what would you ascribe these changes?
OP37 In what ways is this plant involved in working with its suppliers on joint problem solving and continuous improvement activity?
OP38 In what other ways does this plant assist or lead supplies in improvement activity?
OP39 Are suppliers expected to communicate with other members of the supply base?
OP40 Do you have networks of suppliers that meet regularly?
OP41 How would a major quality problem with a key component be dealt with?