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Management Initiatives And The Implementation Of Just-in-time Manufacturing By Canadian Firms

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MANAGEMENT INITIATIVES AND THE IMPLEMENTATION OF JUST-IN-TIME MANUFACTURING BY CANADIAN FIRMS

by

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ABSTRACT

Numerous benefits have been claimed for firms which implement just-in-time approaches to manufacturing.

A fair number of Western firms have been successful at such implementations, obtaining dramatic performance improvements. However, many other firms which could benefit appear to be addressing only a few features rather than the overall philosophy and system. It is not clear what differentiates one firm's choices and results from those of another; the general research problem is to understand these differences.

The associated research questions are: (1) What explains how well firms are able to implement elements of JIT? and (2) What explains the choices by firms to pursue particular elements and implementation sequences of JIT?

This thesis uses a case-based methodology. Six plants claiming to be implementing some form of just-in-time manufacturing were visited. Data were obtained via interviews, questionnaires, direct observation, and collection of documents. Answers to the research questions were centred mainly around management initiatives, with reference to plant environments.

For the first research question, of six management initiatives considered in propositions, the results showed four to be necessary conditions for flow and quality aspects of JIT as well as for employee involvement. These four were: (1) promotion of employee responsibility, (2) provision of training, (3) promotion of teamwork, and (4) demonstration of visible commitment. The results also indicated that employee involvement plays a central role. Furthermore, a clan-like plant environment is strongly associated with these management initiatives and results.

For the second research question, five factors which partially explain the choices of JIT elements pursued by various plants were derived from the data. These were: (1) the organizational level of the initiator of JIT efforts, (2) the extent of active support by the plant manager, (3) the elapsed time since initial JIT efforts, (4) any workforce reductions clearly seen as actions of last resort, and (5) the absence of a piece rate incentive system.

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1 The Research Problem

For the past decade, just-in-time (JIT) operations have received much attention from firms in Western industrialized countries, as the JIT approach was perceived to be a major reason for Japan's competitive success (De Treville, 1987:1-1; Mehra & Inman, 1992:160). Numerous benefits have been claimed for firms which implement philosophies and systems associated with JIT or similar approaches to manufacturing. These approaches resemble the Toyota production system but come under many labels such as just-in-time manufacturing, non-stock or stockless production, continuous flow manufacturing, synchronous manufacturing, or lean production, to name a few.

The term JIT is very confusing; it means different things to different people. These views can range from seeing JIT as simply another buzzword for management's latest improvement program to an almost mystical approach to the management of operations. Whatever it is, it is not simply another program like management by objectives, quality circles, or sensitivity training, to name a few (Myers, 1987:29). These are often one-shot, behavioural approaches which do not yield sustainable advantages. Myers argued that JIT can succeed where other efforts have failed because JIT has demonstrated credibility, provides fast feedback on a large number of improvement measures, and is pervasive through total employee involvement (1987:29). JIT is different because it is an approach to operations which can yield sustainable competitive advantages. It does so through continual improvement of the production process. For this study, JIT refers to both an overall production philosophy aimed at the elimination of all waste in a productive system and a corresponding set of techniques which strongly resemble those of the Toyota production system (see Chapter Two).

In response to Japanese competition, many firms in Western industrialized countries were forced to try implementing JIT or similar systems. Many have shown dramatic performance improvements (e.g. Schonberger, 1986, 1987; Sepehri, 1986). However, many other firms which could conceivably benefit from such an approach appear to be addressing only a few features, or none at all, rather than an overall philosophy and system.

In the preface to his book, Goddard (1986:vii) said that most executives attending the Oliver Wight top management classes are familiar with just-in-time, yet few are actively implementing it. He asks: "If it's so good, why isn't everyone doing it?" Similar observations were made by Voss and Robinson (1987:51). And, Walleigh (1986:38) asked: "If JIT provides all the benefits claimed for it, why have so few factories adopted it?" There are numerous plausible explanations (discussed in Chapter Two). A few of many examples include lack top management support, an inability to deal with "soft" issues such as employee involvement, executives saturated with buzzwords, or the perception that JIT may be good for others but it would not work in the plant's particular situation.

It is not clear what differentiates one plant's approach from another's; the overall research problem is to understand these differences.

This study attempts to explain the extent of a plant's implementation of JIT, with particular reference to initiatives of the plant's manufacturing management in light of the plant environment. Managers who are interested in a JIT approach can benefit from a knowledge of management and environmental factors which appear to be necessary conditions for JIT implementation. This should allow them to direct JIT efforts more effectively within their own organizations.

2 Advantages and Benefits of JIT

JIT has been shown to lead to performance improvements. Schmenner (1988a, 1988b) concluded, based on factory interviews and two large mail surveys in the United States and Europe, that the only distinguishing characteristics reflecting factory productivity gains are those related to JIT. He stated (1988b:12): ". . . out of many potential means of improving productivity, only the JIT-related ones were statistically shown to be consistently effective." He further stated (1988b:13): "The only consistent distinctions were those relating to JIT, specifically, throughput time reduction, improved quality, lower inventories, and participative management techniques." And based on the same data, he concluded (1988a:337):

> Of the wide variety of policies touted to enhance productivity, it is JIT manufacturing principles that appear to be the most firmly grounded. The themes of throughput time reduction and quality are elevated in the results, as is, to a somewhat lesser extent, inventory reduction. All three of these policies are clearly in the JIT camp. Workforce involvement, another JIT-related policy, is also somewhat supported by the results. The thrusts of the JIT movement thus appear to be substantiated statistically by the experience of a diverse assortment of plants, many of which would not have claimed themselves to be devotees of JIT.
>
> Investment in new equipment and automation remains puzzling. It is supported somewhat in the results, but not universally.
>
> Other, often highly touted, productivity policies such as gain-sharing, traditional industrial engineering, and MRP systems, among others, have little or no support in the results. Characteristics such as unionization or factory size (employment) also appear not to have an influence on productivity gain.

Adding a third survey from Korea to the above data, Schmenner and Rho (1990:31) concluded that three themes stand out as most consistent in improving productivity, two of which support JIT manufacturing philosophies, namely, improved flow and improved human resource management.

An initial part of the MIT International Motor Vehicle Program study (Womack, Jones, & Roos, 1990) compared, in 1986, two plants, one a mass producer (General Motors, Framingham) and one a lean producer (Toyota, Takaoka). They found (1990:81) that:

> Takaoka was almost twice as productive and three times as accurate as Framingham in performing the same set of standard activities on our standard car. In terms of manufacturing space, it was 40 percent more efficient, and its inventories were a tiny fraction of those at Framingham.

Krafcik (1988:48), based on comprehensive field surveys of ninety auto assembly plants as part of the same MIT program, found that a measure of "leanness" of the plant's production management policy was an excellent predictor of performance. This measure of leanness is composed of four components, namely, the degree of teamwork, worker span of control, unscheduled absenteeism, and proportion of floorspace dedicated to repair facilities. He cited an example (1988:45) in which he found a roughly 40% productivity differential and substantially better quality in favour of the American-based GM-Toyota joint venture (NUMMI - New United Motor Manufacturing Inc.) compared to traditional GM plants. A lean, as opposed to a buffered, system represents a system much like the Toyota production system (Womack et al., 1990:11). The study also found (1990:83) that NUMMI matched Toyota Takaoka's quality and nearly matched its productivity.

As well, there are other indicators of a link between JIT approaches and performance. Sakakibara, Flynn, and Schroeder (1990:24) found a high correlation between three typical JIT performance criteria (inventory turns, cycle time, and lead time to fill orders) and a set of fourteen JIT measurement scales. Lieberman (1989:217) considered the more rapid productivity growth of Japanese firms to stem primarily from two factors, namely, the just-in-time approach to coordinating production flows and the human resource management policies of Japanese firms. Suzaki (1985:16) found that labour productivity increased about 40% whenever work-in-process inventory levels were halved, relative to production volume. And, Stalk and Hout (1990:31) found that for every doubling of work-in-process turns, productivity increased 20 to 70 percent. Mankin (1988:231) concluded that one of the benefits of JIT production was the reduction in lot processing times. He had earlier pointed out (1988:72) that increased processing time variability, which is affected by lot size, adversely affected facility performance.

Earlier indicators of JIT's influence on performance included a 1977 study by Hertz which showed the repair rate for three North American car models being more than six times the rate for Toyota (Wantuck, 1989b:737) and dramatic differences in setup times, lot sizes, and labour-days per vehicle at Toyota compared with an American, a Swedish, and a West German plant (Sugimori, Kusunoki, Cho, & Uchikawa, 1977:563). Cusumano (1985:207) pointed out that as early as 1965, after adjusting for differences between Japan and the United States in vertical integration, utilization, and labour hours, Toyota workers produced 1.5 times as many vehicles per employee with 80 percent as many fixed assets.

As well as the performance advantages outlined above, a few authors mentioned the financial advantages of JIT. Inman (1988:120) found a fairly strong and statistically significant relationship between JIT implementation success and financial success. Goddard (1986:5) reported results from the Harbour study which estimated the net cost advantage in favour of a Japanese car to be $1718. Of this, only $550 was attributed to lower wages and fringe benefits. The rest ($1398) was mostly attributed to better management systems and partly to better union-management relations. Similarly, Halberstam (1986:308) reported the results of a study by the Boston Consulting Group showing a dramatic reversal over 20 years in the gap between Japanese and American car prices. For example, in 1952, Japanese cars were almost twice the cost of similar American cars; by 1970 the situation had reversed, with American cars almost twice as much in price.

Based mostly on surveys, a number of authors provided lists of benefits claimed for plants implementing JIT philosophies and systems. For example, Schonberger (1982:13) reported benefits of reduced lot sizes, lower inventory, improved quality, reduced waste and rework, improved motivation, greater process yield, and increased productivity. Voss and Robinson (1987:50) listed, in rank order, major benefits of JIT, some being, work-in-process reduction, increased flexibility, raw material reduction, increased quality, increased productivity, reduced space requirements, and lower overhead. And, Crawford, Blackstone, and Cox (1988a:1564) listed a number of main benefits of JIT including reduced inventories, reduced manufacturing cost, reduced lead time, and improved product quality, to name a few. Im and Lee (1989:9) ranked major benefits of improved quality, inventory reduction, cost reduction, cycle reduction, and problem solving.

Of course, JIT can have a number of disadvantages. One major problem concerns the increased capabilities possible under JIT which mean that increased market share or new markets must be discovered. Otherwise, labour productivity increases may only be realized by reducing levels of employment. However, where productivity gains lead to layoffs, there is a good chance that JIT improvement efforts will cease. As well, there can be a human cost to JIT implementation that manifests itself in a loss of worker autonomy (Klein, 1989:63-64) due to the tighter linkages resulting from reductions in buffer inventories.

A JIT approach to manufacturing can be strategic. In reviewing the manufacturing strategy literature, Adam and Swamidass (1989:196) stated that, although JIT benefits have not been systematically documented, the impact on competitiveness, as reported by practitioners, has been anything but marginal. They said that this qualifies JIT for consideration as a strategic variable.

There are many reasons why results can be so dramatically different under JIT. The major reason, however, is that JIT can lead to sustainable competitive advantage of the type contemplated by Porter (1985:20) in which a firm, through continuous improvement, becomes a moving target to competitors. Firms which do not react to the new pressure from JIT-like competitors can be in serious difficulty as competitive benchmarks change. JIT is a form of technological innovation, in particular, incremental technological process innovation. As such, it has the power to upset industry structure and change the basis of competition within an industry (Porter, 1983:211-214; 1985:Ch.5). Thus, the implementation of a JIT approach can be a strategic competitive move, one often necessary for a firm's survival.

JIT can lead to a sustainable competitive advantage because it is difficult to emulate. It is based on incremental innovation through an emphasis on continual process improvement and learning using the full shop-floor capabilities of the workforce at an individual plant. Incremental innovation can be as important as, if not more important than, radical innovation. The cumulative effects of a series of minor innovations can be devastating to a competitor because the overall effect is not noticed until well after the incremental improvements begin. Thus, a series of incremental improvements at a particular plant can be seen as a radical new system by the plant's competitors once they notice declining market share. As Porter (1985:181) pointed out, cumulative improvements in many activities can be more sustainable than a breakthrough that is more noticeable to competitors and becomes an easy target for imitation. To catch up, a competitor usually has to follow the same incremental path, giving the innovator a competitive edge.

Manufacturing systems innovations tend to diffuse more slowly than other types of innovation (Lieberman, 1989:228-230). The diffusion is slower because the changes require substantial person-to-person contact, are difficult to codify, and are usually inherently complex. This was confirmed by Dertouzos et al. (1989:166) who said that the diffusion of the best industrial practices identified in their study was inhibited by ingrained beliefs, attitudes, and practices. Thus, the comparatively slow diffusion from Japan of manufacturing systems innovations yielded competitive advantages which were more sustainable than those derived from other sources such as product design or innovative advertising. As well, Porter (1985:185) stated that the constant process innovations emphasized by Japanese firms often develop more sustainable advantages than available to the U.S. or European firms which often pioneered the process. And, Mankin (1988:24), referring to the work of others, pointed out that improvements in production systems diffuse slowly, as evidenced by differing levels of productivity across plants producing similar products and owned by the same firm.

As technological process innovation, the cumulative effect of JIT can disrupt the status quo by causing discontinuities in process characteristics. Utterback and Kim (1985:122) referred to a discontinuity as a radical innovation which casts aside the value of established positions. Abernathy and Clark (1985:3) referred to this capacity to disrupt as "transilience" which they define as the capacity of an innovation to influence the established systems of production and marketing. A competence destroying process discontinuity represents a new way of making a given product and may involve combining previously discrete steps into a more continuous flow (e.g. float glass), thus fundamentally altering the set of relevant competencies within a product class (Tushman & Anderson, 1986:442).

An associated advantage of JIT is that measures of competitive performance usually complement each other rather than being tradeoffs. Plants engaging in JIT find they can eventually have concurrent improvements in quality, cost, delivery reliability, throughput time, and flexibility. For example, it was long assumed that there was a tradeoff between low cost and high quality. Under these assumptions, a plant could only improve quality by increasing inspection and/or slowing the production line, thus increasing unit costs. With a JIT approach, however, this tradeoff no longer exists. The reduction in waste that results from the assignment of responsibility for quality to line employees also means lower costs due to less rework, less scrap, less expensive warranty work, and fewer lost sales. Under JIT, the system can improve on many fronts simultaneously. This was confirmed by Krafcik (1988:51) who concluded that lean plants (as opposed to buffered) are more capable of simultaneously achieving high levels of productivity, quality, and mix complexity. He found that plants producing high-quality products did so with substantially less effort (1988:47). As well, Mankin (1988:256) found that the previously hypothesized tradeoff between cost and delivery did not hold for his data. Nemetz-Mills (1989:204) concluded that it is the internalization of principles associated with time-based technologies that drives the ability to achieve multiple advantages.

Ferdows and De Meyer (1989:7) suggested that the nature of tradeoffs among manufacturing capabilities is contingent upon the sequence in which management attention and resources are applied. They proposed a "sandcone model" in which lasting manufacturing performance depends on pursuing improvement efforts in a particular order, namely, improvements in quality first, followed by dependability, then speed, and finally cost. Quality represents the base of the sandcone with cost reduction representing its peak. A plant can only attain lasting cost reduction if it is built on a base established by improving quality, dependability, and speed. So, for example, the cost-quality tradeoff is only a tradeoff if cost reduction is pursued first, at the expense of quality. However, if quality is emphasized first, and continues to be emphasized, lasting cost improvements will eventually build on the quality improvements. This is consistent with JIT approaches to cost reduction via process improvement.

3 Western Experience with JIT

In the late 1970s, the West began to feel the cumulative effects in many of their product markets of Japanese competition, from Toyota and other Japanese firms using systems similar to Toyota's. At about this time, English language accounts by Japanese authors began appearing. The earliest of these was by Sugimori et al. (1977), followed closely by Monden (1981) and Shingo (1981; revised 1989). Schonberger (1982) and Hall (1983) were two of the earliest non-Japanese treatments of such systems.

Western firms went through a series of responses to the tougher competition coming from Japan. As outlined nicely by Cosenza (1988:6-15), the first reaction was disbelief that Japanese management could work anywhere but Japan, followed by egotistical defenses such as assuming that Japanese firms were only capable of copying but not innovating. Next, government was blamed for having no industrial policy while the role of the Japanese government was overemphasized. Finally, when the disbelief would no longer hold, attempts to emulate the Japanese ensued at a faster rate. The success of the transplant firms finally dispelled most remaining skepticism about the efficacy of Japanese approaches to manufacturing. Last, the question became: "What's so Japanese about Japanese management anyway?" The answer was: ". . . if the Japanese could claim ownership of anything at all, it was the just-in-time system of production" (1988:15).

A number of Western firms saw the potential of JIT quite early and began serious programs to emulate such systems. These firms included Omark Industries, Hewlett-Packard, Ford, General Electric, John Deere, and Harley-Davidson, to name a few. A fair number of JIT implementations have been quite successful, with performance increasing dramatically (e.g. Giffi, Roth, & Seal, 1990:203; Schonberger, 1986, 1987; Sepehri, 1986; Voss & Clutterbuck, 1989:60). Sepehri (1986:v) noted that he did not have to go beyond his own backyard to find excellent examples of just-in-time manufacturing. He said the system worked, with results that were spectacular, but real, and did so regardless of culture, environment, type, and size of manufacturing. Womack et al. (1990:87) said that we must now stop equating "Japanese" with "lean" production and "Western" with "mass" production as not all plants in Japan are lean nor all Western plants buffered. Nevertheless, Dertouzos et al. (1989:128) reported that there were still only a few plants in the United States where the JIT system had been successfully implemented.

By the late 1980s, there were high levels of awareness of JIT (Goddard, 1986:vii; Lieberman, 1989:230; Voss & Robinson, 1987:51). However, many firms claimed to be engaging in JIT when they were, in fact, making less than full-fledged attempts to adopt the JIT philosophy and system (discussed in Chapter Two). As applied in the West, JIT may be variously seen as some combination of an inventory reduction technique, a supply phenomenon, teams and employee involvement, a set of industrial engineering techniques, a strictly Japanese phenomenon, and/or a whole philosophy of waste reduction and continuous improvement (discussed in Chapter Two). Thus, it is not surprising that some Western firms implemented whole systems and philosophies similar to the Toyota production system while others implemented only a few aspects of such an overall system.

4 An Operations Management Problem

Successfully responding to Japanese, or JIT-like, competition is primarily an operations management problem which must be addressed at the level of the individual plant. It concerns what manufacturing managers do with respect to shop-floor operations at specific plants, although what they do is strongly influenced by corporate parentage.

A major problem in addressing the issue of Japanese competitive success is the wide variety of explanations offered which often have some validity but ignore manufacturing management. These explanations include the unique characteristics of Japanese workers, government policies, unfair trade practices, and characteristics of Japanese national culture, to name but a few. However, numerous authors have shown that these types of explanations, whether valid or not, miss the main explanation, namely, differences in manufacturing management.

After conducting a large-scale mail survey of hundreds of U.S. and international (mostly European) plants, Schmenner (1988b:13) concluded: "It appears that management, rather than geography, size, union status, age, or industry, holds the key to a factory's productivity gain." And, Krafcik (1988:41) found links among plant performance, corporate parentage, and the management philosophies in place at each plant, but not with other usually assumed factors such as the national location of the plant. He also found consistent multinational worldwide performance (1988:47), for U.S. as well as Japanese multinationals.

Lieberman (1989:230) stated very clearly:

> Japanese companies have demonstrated that effective management and continuous improvement of manufacturing operations can yield major competitive advantages. Indeed, Japanese producers have been most successful in those industries where superior manufacturing management provides the greatest competitive leverage (as opposed to advantages gained from low labor or material costs, or patentable technology).

Sepehri (1986:13), drawing on Waters (1984:80), related an early view:

> The Big Four automakers could not understand how Japan could import all raw materials, produce a quality car, ship it 7,000 miles, and still enjoy a $1,200 to $1,500 cost advantage in the American market. When American study groups were sent to Japan to find out, they discovered that the answer was not slave wages. When two dozen GE executives visited Tokyo Sanyo Electric, Toshiba Tsurumi Works, and Yokogawa Electric Works, they had the preconceived notion that the meaningful differences between Japanese and American manufacturing were cultural and environmental. After the visit, they admitted that the real differences might be described collectively as good manufacturing management, operational discipline and consistency, and teamwork.

Womack et al. (1990:9) in the introductory pages to their report on the International Motor Vehicle Program stated:

> "Thus we devote our attention in the pages ahead to a careful explanation of the logic and techniques of lean production. We pay little attention to the special features of Japanese society - the high savings rate, near universal literacy, a homogeneous population, the often alleged inclination to subordinate personal desires to group needs, and the willingness, even the desire, to work long hours - which some observers credit for Japanese success, but which we believe are of secondary importance."

There is nothing culturally inherent in the JIT system (Schroeder, 1989:488). Accumulating experience shows that cultural factors are not pivotal contributors to continuous improvement systems; rather, management is the principal factor (Melcher, Acar, DuMont, & Khouja, 1990:30). Most of Japanese competitive advantage comes from the factory floor, the way they manufacture products; such competition cannot be avoided, so management should concentrate more on improving manufacturing capabilities (Suzaki, 1985:10). Sepehri (1986:14) said that the success of JIT is not the result of cultural, structural, or environmental factors but is rather from planned management action that any manufacturer can implement.

Mankin (1988:21-24), referring to the work of others, argued that specific management actions can affect productivity, sometimes dramatically. He used the example of just-in-time manufacturing and associated processes to point out that improvements in managerial inputs or technologies can lead to improved production performance even with labour and capital levels remaining the same.

Montagno, Tunc, and Ahmed (1990:13) concluded from their study that factors associated with JIT are ones controllable by management. Similarly, Main (1990) outlined how managers at a machine tool company increased sales faster than Japanese competitors by aiming at the one problem they could fix, namely, the management of manufacturing. Japanese factories work because Japanese managers have never stopped emphasizing the basics (Hayes, 1981:57). He concluded (1981:66): ". . . we must compete with the Japanese as they do with us: by always putting our best resources and talent to work doing the basic things a little better, every day, over a long period of time. It is that simple - and that difficult."

Evidence for the problem being mainly one of operations management at the plant level is provided by the experience of Japanese takeovers of plants in the U.S. as well as by Japanese transplant operations.

In the last few decades, a number of Japanese firms took over and operated American plants, with American workers under Japanese manufacturing management. They showed dramatic improvements in operation. A number of authors (Schonberger, 1982:74; Sepehri, 1986:13; Wantuck, 1989b:737; Wheelwright, 1981:67) reported the example of the Matsushita takeover of a Motorola plant in the U.S. in which the same employees, under Japanese management, doubled production, improved in-house quality 20-fold, and cut warranty bills 16-fold. Productivity increased 30% and the defect rate fell from 150 defects per 100 units to 4 per 100. As well, similar improvements followed Japanese takeovers by Sanyo of a television plant in Arkansas (Schonberger, 1982:75; Sepehri, 1986:13) and by Sharp of a television plant in Tennessee (Sepehri, 1986:14).

And the evidence from Japanese transplant operations makes the point even stronger. As Cusumano (1988:30) pointed out, efforts to explain Japanese success by reference to unique characteristics of Japanese employees fail because such approaches do not explain the success of Japanese transplants. Womack et al. (1990:87) concluded: "In general, we found that the best-performing companies in Japan run the best-performing transplants in North America, suggesting that most of the variation observed is due to differences in management." And, they also pointed out (1990:243), in reference to a particular transplant, that it was not that the managers were Japanese but that they collectively possessed many years of experience and know-how in making lean production work.

Firms with a Japanese system of management but American workers show impressive results and point out embarrassing contrasts between U.S. and Japanese capabilities to produce excellent quality goods while at the same time proving that productivity and performance are matters of management - not culture or worker background (Sepehri, 1986:14). Womack et al. (1990:87) found that, on average, the transplants they studied had quality comparable to Japanese plants and productivity lagging by about 25%, which they attributed to the transplants being early on the learning curve for lean production. Fukuda (1983:xxiii) pointed out that if the unique characteristics of

Japanese firms were the causes of successful management, then we would expect all Japanese firms to be efficient and profitable. As well, Voss (1987b:22) dismissed typical excuses by British firms for rejecting JIT, such as unreliable suppliers and an untrustworthy labour force by pointing out that the transplant firms he studied had no problems in these areas. As one example, the Honda plant in Marysville, Ohio is making cars with American workers and at least 70% domestic parts content. It is achieving quality comparable to that found in Japan and is exporting to Japan. The Honda Accord was the top selling model in the U.S. in 1989 and the only U.S. built car in the top ten imports in Japan (Mittelstaedt, 1990).

This superiority of the transplants was admitted in a statement (Globe and Mail, 1990) by the chief economist at General Motors: "The evidence so far is that on average the (Japanese) transplants produce a higher-quality car at a lower cost than the domestic makers." And, recently, J.D. Power and Associates, in a study of 33,000 vehicle purchases which were traced to the producing plants, ranked the Toyota plant in Cambridge, Ontario first in quality of auto manufacturing plants in North America (Globe and Mail, 1991).

These types of results would be impossible if the explanation for Japanese success lay with Japanese culture, the nature of Japanese workers, macroeconomic policy, marketing and financial initiatives, or the many other explanations which ignore the management of shop-floor operations at the level of the individual plant.

5 Research Questions

This thesis addresses two research questions:

(1) What explains how well firms are able to implement elements of JIT? and

(2) What explains the choices by firms to pursue particular elements and implementation sequences of JIT?

6 Outline of the Study

This dissertation is organized into six chapters followed by a number of appendices. Each is discussed in turn.

Chapter One. *The Research Problem.* The first chapter outlines the general research problem, discusses the advantages and benefits of JIT as well as Western experience with JIT. It presents arguments to show that the problem is an operations management problem worthy of management attention. Finally, it states the associated research questions.

Chapter Two. *Literature Review.* The second chapter reviews the literature which helps develop the research framework and guide the choice of methodology. In addition to literature cited in the first chapter, the review includes literature addressing the Toyota production system, definitions and viewpoints of JIT, elements of JIT, evidence of partial implementation of JIT, and explanations concerning partial approaches to JIT.

Chapter Three. *Research Framework.* The third chapter outlines the framework developed for this study. It describes each construct in the framework and outlines the propositions to be tested.

Chapter Four. *Research Methodology.* The fourth chapter begins with an argument for choosing a case-based methodology. It then discusses issues of validity and reliability. Following, it outlines the choice of sites for the study and outlines data collection concerns, including sources of data, operational definitions, and data collection procedures. The chapter concludes with an outline of the analytical procedures used.

Chapter Five. *Findings from Site Visits*. The fifth chapter reports the findings from each site visit, organized according to the categories outlined in the framework in Chapter Three. As well, it provides a summary table for each site.

apter Six. *Analysis And Discussion*. The sixth chapter provides the cross-site analysis. It summarizes and displays the findings in Chapter Five across the sites visited. Propositions are tested in light of the findings, results are discussed, and conclusions drawn. As well, it addresses implications of the study for future research and for management.

Appendix I.	*Interview Protocol.*
Appendix II.	*Interview Protocol for Improvement Projects.*
Appendix III.	*Manufacturing Practices Questionnaire.*
Appendix IV.	*General Situation Questionnaire.*
Appendix V.	*Operational Measures and Demographics Questionnaire.*

Chapter Two: Literature Review

1 Introduction

In the preceding chapter, I specified two research questions asking for explanations about various aspects of implementation of just-in-time (JIT) manufacturing. Each question appears easy to answer on the basis of common sense. Consequently, much has been written lately suggesting important factors and making normative suggestions for JIT success.

In this chapter, I review the main literature in the area. In particular, I consider JIT as represented by the Toyota production system, definitions and viewpoints of JIT, elements of JIT, evidence of partial implementation, and explanations for various degrees of implementation. I use the results of this literature review to help develop the research framework (Chapter Three) and guide the choice of research methodology (Chapter Four).

2 Just-in-Time Manufacturing (JIT)

2.1 The Toyota Production System

JIT is based on the Toyota production system, developed over many decades at Toyota (Cusumano, 1985; Monden, 1981, 1983; Ohno, 1988; Pegels, 1984; Shingo, 1988; Sugimori et al., 1977; Womack et al., 1990:Ch.3). The Toyota production system is concerned with producing top quality goods through continuous efforts to eliminate waste in the production process. Waste, in this sense, is anything that does not add value to the product or service, that is "... anything other than the minimum amount of equipment, materials, parts, and workers (working time) which are absolutely essential to production ..."

(Sugimori et al., 1977:554). At Toyota, waste reduction efforts are aimed at seven categories of waste, namely, overproduction, waiting, transporting, processing itself, inventory, movement, and making defective products (Ohno, 1988:19).

The structure of the Toyota production system is based on two key concepts, namely, the elimination of waste and the use of the full capabilities of workers (Sugimori et al., 1977:554). In turn, the first of these concepts, waste elimination, is based on "two pillars," just-in-time production and autonomation (jidoka), which refers to the autonomous control of defects (Monden, 1983:84). And the second concept, full utilization of workers' capabilities, is based on the elimination of wasted movement, consideration of workers safety, and self-display of workers abilities (Sugimori et al., 1977:557-558).

Unlike other Japanese auto firms, Toyota avoided copying foreign methods and concentrated on developing a productive system tailored to the needs of the Japanese market (Cusumano, 1985:Ch.5). The system was developed over many years, promoted mainly by Taiichi Ohno as he progressed through the ranks at Toyota, as well as being influenced by Shigeo Shingo, a consultant to Toyota. While Ohno was concerned with the overall system, Shingo concentrated more on industrial engineering techniques. In particular, Shingo is known for dramatic performance improvements in the two areas of setup time reduction (Shingo, 1985) and zero defects through 100% source inspection (Shingo, 1986). Much of this can be credited to Ohno who set such stringent objectives that Shingo and others had to find innovative solutions; they could not simply improve existing operations.

Most of the techniques used at Toyota were not new. Many were borrowed from early systems developed at Ford under Henry Ford. Many of Ford's principles in their purest form, are still valid and form the basis of the Toyota production system

(Krafcik, 1988:42). The main differences are: (1) Ford would never have attempted the type of flexibility in small-scale facilities achievable at Toyota and (2) the Toyota system has a worker span of control mid-way between the narrow span of the rigid Ford system and the wide span associated with a high-cost craft approach, combining the advantages of both (Womack et al., 1990:13). The unique contributions at Toyota combined the Ford techniques with novel approaches towards flow, quality and the workforce into an overall coordinated and consistent philosophy and system.

The Toyota production system was influenced by Japan's distinguishing features such as a lack of natural resources and a favourable concept of work (Sugimori et al., 1977:553). Much of the development was a result of trial and error in circumstances favourable to such a system, five of which were recounted by Cusumano (1985:Ch.5): First, Toyota was lucky to have Taiichi Ohno. One Nissan executive mused that devising and implementing the techniques required a "fanatic," something Nissan lacked. Second, Ohno did not have an automotive background, so did not feel constrained by American mass production approaches. Third, Japan had a small market that demanded variety, forcing a suitable response. Fourth, the Korean war led to a labour shortage, forcing Toyota to group machines into cells and develop mistake-proof devices so that one worker could tend multiple machines. The driving force for innovation in small group activities in Japan was "severe labour shortages" (Cole, 1985:567). Fifth, the unions at Nissan and Toyota were purposely broken in the early 1950s and replaced with company unions (Cusumano, 1985:Ch.3). Halberstam (1986:130) mentioned the irony of the enthusiastic support by Americans for the crackdown on Japanese leftist labour unions only to have them replaced by cooperative company unions which American firms could not match. Ohno himself had been a union leader and was still close to the membership; he considered his success at controlling the union to have been Toyota's most important advantage over foreign and domestic competition. The development of a system like the Toyota production system was not an inevitable consequence of the Japanese situation, however; it did depend on the efforts and viewpoints of particular individuals. Other firms, in particular Nissan, did not follow the same path.

2.2 Definitions and Viewpoints of JIT

The term just-in-time (JIT) is not well-defined and is poorly understood. It is one of the most misunderstood concepts to appear in decades (Saipe, 1984:41). Many authors simply refer to JIT without definition, greatly adding to the confusion. This confusion is unfortunate as it tends to distract us from understanding the true nature of the philosophy (Sepehri, 1986:26). Part of the confusion is reflected in the shift in the way the term has been used as it travelled from Toyota to the West. At Toyota, JIT is considered one of two concepts aimed at waste elimination, which, in turn, is one of two concepts within the Toyota production system (Sugimori et al., 1977:554). When Japanese managers use the term "just-in-time," they do so very strictly, preferring to speak of the Toyota production system (Westbrook, 1988:19).

In the West, JIT is typically viewed either very widely, describing an overall philosophy and set of techniques similar to the overall system at Toyota or very narrowly, referring to only one minor aspect of such an overall system, such as a superficial requirement for suppliers to make small and frequent deliveries. Hall (1983:19) provides two definitions for JIT, one in the narrow sense and the other in the broad sense and Chase and Aquilano (1992:258) make a similar distinction between "Big JIT" and "Little JIT." These various usages reflect common, but different, views of JIT, namely, JIT as: (1) mainly supply, (2) mainly a collection of industrial engineering techniques, (3) a kanban "pull" system, or (4) a complete philosophy and system. I discuss each in turn.

One popular misconception about JIT is that it concerns only supply (Saipe, 1984:41). However, JIT supply should be one of the last elements implemented in any JIT effort (Bicheno, 1987:203; Crawford, et al., 1988a:1567; Hall, 1983:282; Voss & Harrison, 1987:210; Voss & Clutterbuck, 1989:145; Walleigh, 1986:38). This is because a firm should be capable of controlling its own processes before demanding such performance from suppliers. A related misconception is that JIT supply requires single sourcing . However, this is not the norm in Japan (Voss and Clutterbuck, 1989:90; Womack et al., 1990:154) where, to ensure quality and reliability, there are usually two or more suppliers for each part or category of parts.

Another misconception is the view of JIT as simply industrial engineering in which physical layout and production control are seen as paramount, with little consideration given to human concerns. In one such approach, Gomes and Mentzer (1988:74) outlined a total systems definition of JIT but admitted that their "total system" ignores people and policy problems as well as implementation issues. This orientation strongly reflects the artificial / rational paradigm, so common in operations, outlined by Meredith, Raturi, Amoako-Gyampah, and Kaplan (1989:317).

A third misconception is the view that JIT is simply a kanban system, in which the pull system approach to production planning and control is given prominence. However, a number of authors (e.g. Monden, 1981:42; Shingo, 1988:388) pointed out that this view is incorrect. As Shingo noted: "These characteristics are highly superficial and indicate the observer's lack of understanding of the true essence of the Toyota production system." Voss and Clutterbuck (1989:89) indicated that using kanban was low on the list of priorities of Japanese companies in the UK.

For this study, I view JIT as a complete philosophy and system. Within this view, JIT is simultaneously a manufacturing system, an operation philosophy, and a corporate goal (Saipe, 1984:41), a philosophy which guides every aspect of operations management (Bicheno, 1987:191), or an approach to achieving manufacturing excellence based on the continuing elimination of waste and consistent improvement in productivity (Goddard, 1986:8).

Schmenner (1990:Ch.9) treated JIT as a complete system when comparing the Japanese manufacturing philosophy with the "received tradition" according to 17 precepts. Voss and Okazaki-Ward (1990:25) stated that both the literature and their field study in Japan support a broad view of JIT as a highly integrated production, sales, and distribution system leading to continuous flow through the whole supply chain. Westbrook (1988:7) warned that we should not adopt too rigid an interpretation of the Japanese approach, as our view of JIT is prescriptive and an extrapolation of Japanese reality. He suggested that perhaps it is time to forget just-in-time because it is not a system but rather a philosophy of manufacturing management, incorporating many elements, each meriting individual study.

According to Hall (1983:23), no name properly represents how "it" permeates every aspect of manufacturing. The acronym "JIT" fails to define the concept's goals of quality, reliability, productivity, and profitability as well as promoting confusion, hindering success, and camouflaging the improvement efforts often pursued successfully under other names (Dornan, 1987). Myers (1987:28) added that JIT is more than an acronym for just-in-time, which is but a small part of the total JIT strategy.

Although the use of the term JIT to refer to the entire integrated system can lead to confusion, it is now so widely used across disciplines that better, more precise, terms cannot easily be substituted; the label has stuck (Gomes & Mentzer, 1988:76; White & Ruch, 1990:16). Voss (1987a:preface) would have preferred more accurate terms such as continuous flow manufacturing but concedes, as well, that JIT is the most widely used term.

Thus, in this study, JIT means both an overall production philosophy aimed at the elimination of all waste in the production process with a corresponding set of techniques closely resembling those of the Toyota production system.

I use the definition provided by Suzaki (1987:6) in which JIT is:

> a management philosophy aimed at eliminating waste from every aspect of manufacturing and its related activities. The term JIT refers to producing only what is needed, when it is needed, in just the amount needed.

2.3 Elements of JIT

JIT cannot be defined simply by listing its major elements (Gomes & Mentzer, 1988:75). Nevertheless, it is useful to describe the constituent elements of JIT. They are interdependent and thus difficult to classify, so have been outlined in various ways by various authors. As well, not all authors use the term JIT but rather various labels such as the Toyota production system, non-stock production, zero inventories, world class manufacturing, lean production, or the new manufacturing, to name a few. But, they address the same basic system, namely, one aimed at continuous improvement in the production process in a manner sinular to the Toyota production system. Authors may offer simply a list of elements, a structure, or an implementation sequence.

Below, I briefly outline the JIT elements suggested in those sources in which some form of list or classification was attempted. Then I match the most frequently suggested elements with sources in Table 2.1.

Sugimori et al. (1977:554) considered the Toyota production system to be based on two concepts, the elimination of waste in production and the use of the full capabilities of workers. Within this, JIT was considered to be one of two concepts aimed at the first of these, waste elimination, the other being jidoka (i.e. autonomation or "automation with a human touch" (Ohno, 1988:4)). So, they considered the elements of JIT to be restricted to the flow-like aspects of withdrawal by subsequent processes, one-piece production and conveyance, greatly reduced setup times, levelling and mixing of production, and layout by process flow. Monden (1981) and Pegels (1984) outlined similar sets of elements.

Wantuck (1989b:736-754) outlined fourteen elements of Japanese manufacturing, grouped under the two fundamental concepts of elimination of waste and respect for people:

Elimination of Waste:

1. focused factory networks
2. group technology
3. jidoka - quality at the source
4. just-in-time production
5. uniform plant loading
6. kanban production control system
7. minimized setup times

Respect for People:

1. lifetime employment
2. company unions
3. attitude toward workers
4. automation / robotics
5. bottom-round management
6. subcontractor networks
7. quality circles

Hay (1988:12-14) classified JIT philosophy into three basic components, namely, flow, quality, and employee involvement, with the overarching theme being the elimination of waste. He further itemized the flow elements as (1) uniform plant load, (2) reduced setup time, (3) overlapping operations (machine cells or group technology), (4) pull system (linking operations), and (5) JIT purchasing.

Suzaki (1985) outlined nine components of Japanese manufacturing. These are: (1) bias for action, (2) rapid tool setting (i.e. setup reduction), (3) transportation (layout), (4) reduced machine utilization (5) autonomation and multimachine handling, (6) poka-yoke (i.e. mistake proofing), (7) lower work-in-process levels, (8) levelled and mixed production, and (9) a production control system (usually kanban).

Bicheno (1989) developed a two-stage framework for approaching the JIT goal, with Stage One being preparatory and Stage Two concerned with actual operations to meet the JIT goal. The eight elements in Stage One are (1) focus, (2) design, (3) total preventive maintenance, (4) total quality control, (5) small machines, (6) layout and group technology, (7) setup time reduction, and (8) people preparation. The eight Stage Two elements are (1) total people involvement, (2) visibility, (3) process data collection, (4) enforced (continuous) improvement, (5) flow scheduling, (6) inventory control, (7) buffer and lot size reduction, and (8) supplier and customer partnerships.

Voss and Robinson (1987:51-52) outlined fourteen elements of JIT. These are: (1) streamlined flow / layout, (2) smoothed line build rate, (3) mixed modelling, (4) setup time reduction, (5) work-in-progress (WIP) reduction, (6) kanban, (7) quality,

(8) product simplification, (9) standardized containers, (10) preventive maintenance, (11) flexible workforce, (12) organization in modules or cells, (13) continuous improvement, and (14) JIT purchasing.

Shingo (1988:403) provided a table entitled "Procedure and Schedule for Converting to the Toyota Production Method." On this he showed the elements being (1) the right atmosphere, (2) SMED (single minute exchange of dies) for setup reduction, (3) layout improvement, (4) one worker, multiple processes, (5) defect = 0 or poka yoke system with source inspection, (6) cushion inventory method, (7) small-lot production, (8) one-piece flow and full work control, (9) preautomation, (10) divided production method (levelling and mixing), (11) kanban system, (12) the right atmosphere at subcontractor plants, and (13) application at subcontractors plants. A similar table may be found in Shingo (1981:332).

White and Ruch (1990:12) outlined ten techniques that seemed to comprise the core of JIT, based on their review of the literature. These ten are (1) focused factory, (2) reduced setup times, (3) group technology, (4) total productive maintenance, (5) multifunction employees, (6) uniform workload, (7) just-in-time purchasing, (8) kanban, (9) total quality control, and (10) quality circles.

Piper and McLachlin (1990:2) outlined eleven dimensions of JIT claimed to be achievable in North America. These are: (1) employee involvement for continuous improvement, (2) setup time reduction, (3) small-lot transportation, (4) small-lot production, (5) equipment maintenance, (6) zero defect quality control, (7) in-house equipment, (8) levelling and mixing production, (9) autonomation, (10) withdrawal by subsequent processes, and (11) JIT supply arrangements.

Sakakibara, Flynn, and Schroeder (1990:10) outlined sixteen "core JIT components" as (1) setup time reduction, (2) small lot size, (3) JIT delivery from suppliers, (4) supplier quality level, (5) multifunction workers, (6) small group problem solving, (7) training, (8) daily schedule adherence, (9) repetitive master schedule, (10) preventive maintenance, (11) equipment layout, (12) product design simplicity, (13) kanban (if applicable), (14) pull system (if applicable), (15) MRP adaptation to JIT, and (16) accounting adaptation to JIT.

Although the suggested sets of JIT elements are different, there are a number of common threads. There is wide agreement (most authors) that the elements should include (1) setup reduction, (2) equipment layout improvements, (3) small lot sizes, (4) uniform plant loading, (5) a pull system, and (6) JIT supply arrangements. As well, there is reasonable agreement (three or more authors) that JIT should also include (7) autonomation, (8) overall quality or total quality control, (9) zero defects through source inspection, (10) preventive maintenance, (11) employee involvement, (12) multifunction workers, and (13) design simplicity. I match these thirteen most-mentioned elements against sources in Table 2.1. Other suggested elements received only a smattering of direct support so I do not consider them further.

3 Partial Implementation

In many firms, JIT was seen as the latest panacea, with the full extent of the changes required to achieve dramatic results not well understood. Rather than implement a complete system or philosophy, many firms in the West attempted to implement only particular aspects of JIT (Hall, 1983:23; Hanlon, 1985:48; Im & Lee, 1989:10; McLachlin & Piper, 1990:36; Voss & Robinson, 1987:51). Firms were addressing a subset of techniques which were easier to implement than the core techniques of JIT

Table 2.1

Most Frequently Suggested JIT Elements

Element / Source	1	2	3	4	5	6	7	8	9	10
Setup Reduction	x	x	x	x	x	x	x	x	x	x
Equipment Layout	x	x	x	x	x	x	x	x	x	x
Small Lot Size	x	x	x	x	x	x	x	x	x	x
Uniform Plant Load	x	x	x	x	x	x	x	x	x	x
Pull System	x	x	x	x	x	x	x	x	x	x
JIT Supply			x	x	x	x	x	x	x	x
Autonomation	x	x			x		x	x		
Quality			x	x		x	x		x	x
Zero Defects		x			x			x		x
Design Simplicity			x			x			x	
Preventive Maintenance			x			x		x	x	x
Employee Involvement				x		x	x	x	x	
Multifunction Workers	x		x		x				x	x

[1] Sugimori et al., 1977; Monden, 1981; Pegels, 1984
[2] Suzaki, 1985
[3] Voss & Robinson, 1987
[4] Hay, 1988
[5] Shingo, 1988
[6] Bicheno, 1989
[7] Wantuck, 1989b
[8] Piper & McLachlin, 1990
[9] Sakakibara, Flynn, & Schroeder, 1990
[10] White & Ruch, 1990

which were reported to produce the greater benefits (Voss & Robinson, 1987:51), which provided quick, tangible returns (Im & Lee, 1989:11), or which overlooked the "people policies" of the Japanese (Westbrook, 1988:19). Shingo (1988:3) said that, although the appearance of the Toyota production system in North America and Europe has stimulated some change, current manufacturing improvement is: "transient, superficial, and insubstantial." Lieberman (1989:230) stated that while the impact of JIT and human resource policies as practiced by Japanese firms is now widely appreciated, their competitors often fail to adopt comparable policies or implement them effectively. Westbrook (1988:19) also noted, quite correctly, that people policies were ignored in spite of the first English language article on the Toyota production system (Sugimori et al., 1977) having had a title which displayed the phrase "Respect-for-Human" as prominently as the phrase "Materialisation of Just-in-Time." He concluded (1988:20): "Just-in-time production is not really separable from the industrial engineering and people development aspects that are so crucial to Japanese companies." And, Bicheno (1987:199) said that his "Stage Two" JIT activities are detachable from earlier efforts; a firm may omit them if not yet willing to take the leap into full JIT.

Few explanations were offered for these observations aside from the suggestion that partial approaches don't entail a commitment to the "JIT concept" (Voss & Robinson, 1987:48) or that Western manufacturers "often see only the existing processes, rather than the multiple, painstaking steps that have preceded them" (Voss & Clutterbuck, 1989:37).

Voss and Robinson (1987) drew their conclusions from a survey of 123 British companies in which they found that the general awareness of JIT in the UK was high but with few companies (approximately 10% of respondents) making a major commitment to JIT. Similarly, Im and Lee (1989) based conclusions on a mail survey of 33 U.S. manufacturing firms (Im, 1986). McLachlin and Piper (1990) drew conclusions from field visits to thirteen plants in central Canada. And, Westbrook (1988) based his observations on a tour of nine companies in Japan.

A further example was given by Voss (1987b:23) in comparing a Japanese transplant firm in the UK to a UK company attempting to adopt JIT. He observed all of the Japanese manufacturing practices reported by Hayes (1981) as being of prime importance being used by the Japanese transplant and he did not see those dismissed by

Hayes as not too important (in particular, quality circles and robots). In contrast, the UK firm had adopted or considered these dismissed practices but had only partially adopted the set of Japanese practices reported by Hayes.

In summary, the initial message from Japan was balanced, but firms in the West have often ignored parts of it, such as the involvement of employees, and enthusiastically adopted other parts, such as the use of kanban "pull" systems.

4 Explanations for Various Degrees of Implementation

As mentioned, only Voss and Robinson (1987:48) offered a direct explanation for the partial implementation of JIT. Consequently, I sought further possible explanations in the literature by reviewing for (1) problems in JIT implementation, (2) factors or normative statements claiming to lead to JIT success, or (3) factors or normative statements commonly thought to lead to JIT success but which apparently do not.

The literature is mostly descriptive or normative but includes some empirical studies which are briefly described in Table 2.2.

The literature suggested a large number of factors as important for JIT implementation. Below, I ignore factors suggested in only a few sources and report only those suggested more frequently. I discuss each major factor, in turn, and then match the suggested factors with literature sources in Table 2.3.

Cross-Training for a Flexible Workforce. One frequently mentioned critical factor was cross-training for a flexible workforce. De Treville (1987:2-45) considered cross-training a major determinant of success with JIT. This is due to its influence on the way in which disruption of a system can be used to cause learning. Montagno et al. (1990:13) concluded that workforce flexibility was one of three factors significantly

Table 2.2
Empirical Studies

Source	**Description**
Schmenner, 1988a,b	two mail surveys of 265 and 128 factories in diverse industries plus interviews at 26 factories
Schmenner & Rho, 1990	three mail surveys composed of the two above plus one of 165 firms in Korea
Krafcik, 1988	a study of more than 50 auto assembly plants in many regions of the world as part of the MIT International Motor Vehicle Program (Womack, Jones, & Roos, 1990)
Celley, Clegg, Smith, & Vonderembse, 1987	a mail survey of 131 Automotive Industry Action Group (AIAG) members.
Cosenza, 1988	a mail survey of 59 firms in four industries
Crawford, Blackstone, & Cox, 1988a	a mail survey of 39 members of the Repetitive Manufacturing Special Interest Group within the American Production and Inventory Control Society (APICS)
Im, 1986; Im & Lee, 1989	a mail survey of 33 firms
Montagno, Tunc, & Ahmed, 1990	a mail survey of 171 firms
Sakakibara, Flynn, & Schroeder, 1990.	initial structured interviews at 12 plants, followed by a survey of 712 workers and managers at 38 randomly selected plants

affecting JIT implementation. And, a number of other empirical studies suggested this as important (Crawford et al., 1988a:1566; Krafcik, 1988:51; Schmenner & Rho, 1990:31). As well, other descriptive / normative material suggested cross-training and flexibility as important (Goddard, 1986:180; O'Brien, Chalk, Grey, White, & Wormell, 1987).

Education and Training. Education and training was one often-mentioned factor. Six empirical studies suggested this as important (Cosenza, 1988:81; Crawford et al., 1988a:1565; Im, 1986:134; Im & Lee, 1989:13; Krafcik, 1988:45; Womack et al., 1990:93) and one suggested it was not important (Inman, 1988:119; Mehra & Inman, 1992:168). Flynn, Flynn, and Schroeder (1990a:25) pointed out that world class manufacturers provided extensive training to their employees, both classroom and on-the-job. As well, a number of authors have made this suggestion in descriptive / normative literature (Harber, Samson, Sohal, & Wirth, 1990:26; O'Brien et al., 1987; Voss & Clutterbuck, 1989:124; Wantuck, 1989a:76). And, Adair-Healy (1989) made this her major consideration when she claimed that, if JIT education stresses "soft" issues, in particular, training a group to function as a team, success would be inevitable.

Employee Involvement. Employee involvement was suggested as a central factor in a number of empirical articles: Cosenza (1988:81) suggested it as one of five priority productivity improvement practices. Krafcik (1988:45) referred to employee involvement as the key to the kind of continuous incremental improvement that elevates a lean production system over its buffered counterpart. And, Im (1986:134) and Im and Lee (1989:13) found that employee involvement was second only to top management commitment as a critical factor in JIT implementation. Crawford, Cox, and Blackstone (1988b:25) found that employee involvement was part of all six of the JIT operations they visited. Other authors made similar suggestions in descriptive / normative literature (Fukuda, 1983:xxiii; Hanlon, 1985:48; Myers, 1987:32; Walleigh, 1986:52). And from a negative point of view, a document by the Canadian Auto Workers (1989:9) clearly indicated that this was a factor influencing the implementation of JIT; one statement in the article completely opposed the establishment of new partnerships with management based on the "ideology of competitiveness."

Employee Responsibility. The promotion of employee responsibility was another important factor (De Treville, 1987:2-14; Goddard, 1986:179; Krafcik, 1988:43; Myers, 1987:32; Schmenner & Rho, 1990:30; Voss & Harrison, 1987:212). Womack et al. (1990:99) considered transferring the maximum of tasks and responsibilities to those workers actually adding value to the car on the line to be one of two key organizational features of a truly lean plant.

Flow and Throughput Time Reduction. Throughput time reduction was highlighted as important in two empirical studies. Schmenner (1988b:14) strongly suggested a focus by management on reducing throughput as the key to productivity gain because it stimulates a host of complementary actions and tactics which, in turn, improve productivity. And, Schmenner and Rho (1990:21) concluded that one of three themes which stand out as most consistent in improving productivity is improved flow. A few descriptive / normative sources (Hall, 1983:72; Hay, 1988:Ch.2) suggested the importance of throughput time reduction. And, Westbrook (1988:20) concluded that the most common theme at the firms visited in Japan was a preoccupation with flow.

Good Employee-Management Relations. Another associated, often-mentioned factor was good employee-management relations (Cosenza, 1988:81; Flynn et al., 1990a:12; Fukuda, 1983:xxiii; Hanlon, 1985:48; Harber et al., 1990:25; Schmenner & Rho, 1990:30; Wantuck, 1989a:82). And, Walton (1985:83) said union-management relations was another of the five or so unresolved problems with a commitment strategy.

Group Performance Measures. Group performance measures were suggested as better than the negative influence of individual incentive schemes (Crawford et al. 1988a:1565; Flynn, Schroeder, & Sakakibara, 1990c:11; Wantuck, 1989a:85). Crawford et al. (1988b:30) stated that one principle in JIT performance measurement is that criteria must evaluate group, not individual, work. And Flynn et al. (1990a:26), citing other authors, said that rewards based on group performance led to improved performance compared to rewards based on individual performance. And, JIT was seen as inconsistent with individual incentives (De Treville, 1987:3-9).

Job Security. Another particularly interesting factor is the provision of job security. It was hardly mentioned in any of the empirical literature but was mentioned frequently in descriptive / normative literature (Goddard, 1986:59; Harber et al., 1990:25; Wantuck, 1989a:75). Walton (1985:79) considered employment assurance to be one of the five or so unresolved problems with a commitment strategy. And, Hanlon (1985:50), speaking of union relationships, said: "From the union perspective, the paramount issue is job security. There must be some measure of assurance that productivity gains will not result in wholesale reductions-in-force." Furthermore, Womack et al. (1990:102) suggested that management must ensure job security in order to make a lean production system work.

Plant Culture and Philosophy. A number of authors suggested plant culture and philosophy as important (Bates, Misterek, Schroeder, & Morris, 1990; Crawford et al., 1988a:1565; Ebrahimpour, 1986:86; Krafcik, 1988:47; Oliver, 1990; Sepehri, 1986:326). In particular, the working paper by Bates et al. made a very strong case for the importance of a clan-like culture for world class manufacturing and, by itself, offered enough evidence to consider plant culture and philosophy to be very important (discussed further in Chapter Three).

Quality. The importance of quality or total quality control for JIT was frequently mentioned in empirical studies (Celley et al., 1987:14; Cosenza, 1988:81; Crawford et al., 1988a:1566; Crawford et al., 1988b:25; Goddard, 1986:180; Im, 1986:134; Im & Lee, 1989:13; Schmenner, 1988b:13; Wantuck, 1989a:Ch.3; Womack et al., 1990:99), as well as in descriptive / normative literature (Harber et al., 1990:26).

Supplier Abilities for JIT. Supplier abilities for JIT was another factor mainly supported by the empirical literature (Celley et al., 1987:14; Crawford et al., 1988a:1566; Im, 1986:134; Im & Lee, 1989:13; Inman, 1988:118; Krafcik, 1988:45; Montagno et al., 1990:13).

Teamwork. Teamwork was also suggested as important. Cosenza (1988:81) had teamwork as a top priority in three of the four industries studied. Krafcik (1988:45) used the degree of teamwork as one of four items for measuring the degree of leanness in the production system, his key index at a plant. And Lieberman (1989:220) suggested teamwork as a human resource policy that encouraged the more rapid learning in Japanese companies. Womack et al. (1990:93) found a large difference between plants with Japanese parentage and those with American or European parentage with respect to percentage of the workforce in teams. As well, teamwork was suggested in some descriptive / normative sources (Adair-Healy, 1989; Goddard, 1986:180; Wantuck, 1989a:83). However, Womack et al. (1990:99) warn that merely changing the organization chart to show "teams" and introducing quality circles are unlikely to make much difference; management must show that it values skilled workers.

Top Management Commitment. Im (1986:133) and Im and Lee (1989:13) found that top management commitment was the most critical factor in JIT implementation. And, Montagno et al. (1990:13) concluded that top management commitment was one of three factors significantly affecting JIT implementation. As well, it was cited as important in a number of other empirical studies (Celley et al., 1987:14; Cosenza, 1988:81; Crawford et al., 1988a:1565; Crawford et al., 1988b:25; Im 1986:152) and suggested in some descriptive / normative sources (Fukuda, 1983:xxiii; Harber et al., 1990:25; Myers, 1987:29; Voss & Clutterbuck, 1989:123; Walleigh, 1986:52;

Table 2.3

Implementation Factors Suggested in Literature

Factor:	Sources:
Cross-training for Flexible Workforce	6,8,12,19,21,23,26
Education and Training	1,5,6,9,10,15,17,18,19,23,31,33
Employee Involvement	3,5,7,11,14,17,19,22,29
Employee Responsibility	8,12,19,22,26,28,33
Flow and Throughput Time Reduction	13,16,25,26,32
Good Employee-Management Relations	5,9,10,11,14,15,26,30,31
Group Performance Measures	6,7,9,10,31
Job Security Considerations	12,14,15,19,30,31,33
Plant Culture and Philosophy	2,6,19,24,27
Quality	4,5,6,7,12,15,17,25,31,33
Supplier Abilities for JIT	4,6,17,18,19,21
Teamwork	1,5,12,19,20,33
Top Management Commitment	4,5,6,7,10,11,15,17,18,21,22,29

[1] Adair-Healy, 1989
[2] Bates, Misterek, Schroeder, & Morris, 1990
[3] Canadian Auto Workers, 1989
[4] Celley, Clegg, Smith, & Vonderembse, 1987
[5] Cosenza, 1988
[6] Crawford, Blackstone, & Cox, 1988a
[7] Crawford, Cox, & Blackstone, 1988b
[8] De Treville, 1987
[9] Flynn, Flynn, & Schroeder, 1990a
[10] Flynn, Schroeder, and Sakakibara 1990c
[11] Fukuda, 1983
[12] Goddard, 1986
[13] Hall, 1983
[14] Hanlon, 1985
[15] Harber, Samson, Sohal, & Wirth, 1990
[16] Hay, 1988
[17] Im, 1986; Im & Lee, 1989
[18] Inman, 1988
[19] Krafcik, 1988
[20] Lieberman, 1989
[21] Montagno, Tunc, & Ahmed, 1990
[22] Myers, 1987
[23] O'Brien, Chalk, Grey, White, & Wormell, 1987
[24] Oliver, 1990
[25] Schmenner, 1988b
[26] Schmenner & Rho, 1990
[27] Sepehri, 1986
[28] Voss & Harrison, 1987
[29] Walleigh, 1986

[30] Walton, 1985
[31] Wantuck, 1989a
[32] Westbrook, 1988
[33] Womack, Jones, & Roos, 1990

Wantuck, 1989a:350). As well, Flynn et al. (1990c:7) stressed top management commitment as a predominant theme in the literature about quality management. One study claimed that management commitment is not required for successful implementation of JIT (Inman, 1988:114; Mehra & Inman, 1992:168).

I match the factors discussed above with sources in Table 2.3.

As well, a number of articles suggested factors which were not important for JIT implementation. Schmenner (1988b:12) said that high technology investments, class A MRP II systems, gain-sharing, conventional industrial engineering, geography, size, union status, age, and industry do not seem to influence productivity. One factor definitely not critical was investment in high technology without a suitable production management policy (Krafcik, 1988:45; Womack et al., 1990:94). And, Celley et al. (1987:12) concluded that JIT implementation is not influenced by the situational context in terms of size or process type.

5 Summary

The literature search revealed that JIT is a system for which there are widely different viewpoints. Nevertheless, the following set of elements received fairly consistent agreement among authors:

1. setup reduction
2. equipment layout improvements
3. small lot sizes
4. uniform plant loading
5. a pull system
6. JIT supply arrangements
7. autonomation
8. overall quality or total quality control

9. zero defects through source inspection
10. design simplicity
11. preventive maintenance
12. employee involvement
13. multifunction workers

As well, the literature consisted of many authors suggesting widely divergent sets of factors which each believed most influential for JIT implementation. Most of the factors mentioned seem to make sense, that is they "ring true." Those factors which received the most emphasis, based on the literature, are:

1. cross-training for flexible workforce
2. education and training
3. employee involvement
4. employee responsibility
5. flow and throughput time reduction
6. good employee-management relations
7. group performance measures
8. job security considerations
9. plant culture and philosophy
10. quality
11. supplier abilities for JIT
12. teamwork
13. top management commitment

I used these results as guides for developing the research framework (Chapter Three).

Chapter Three: Research Framework

In the first chapter, I outlined the research problem and questions, with some reference to the literature. In the previous chapter, I reviewed the literature concerning just-in-time (JIT) manufacturing with reference to the Toyota production system, definitions and viewpoints of JIT, elements of JIT, evidence of partial implementation, and factors apparently explaining implementation success. In this chapter, I develop the research framework and associated literature-derived propositions to be tested.

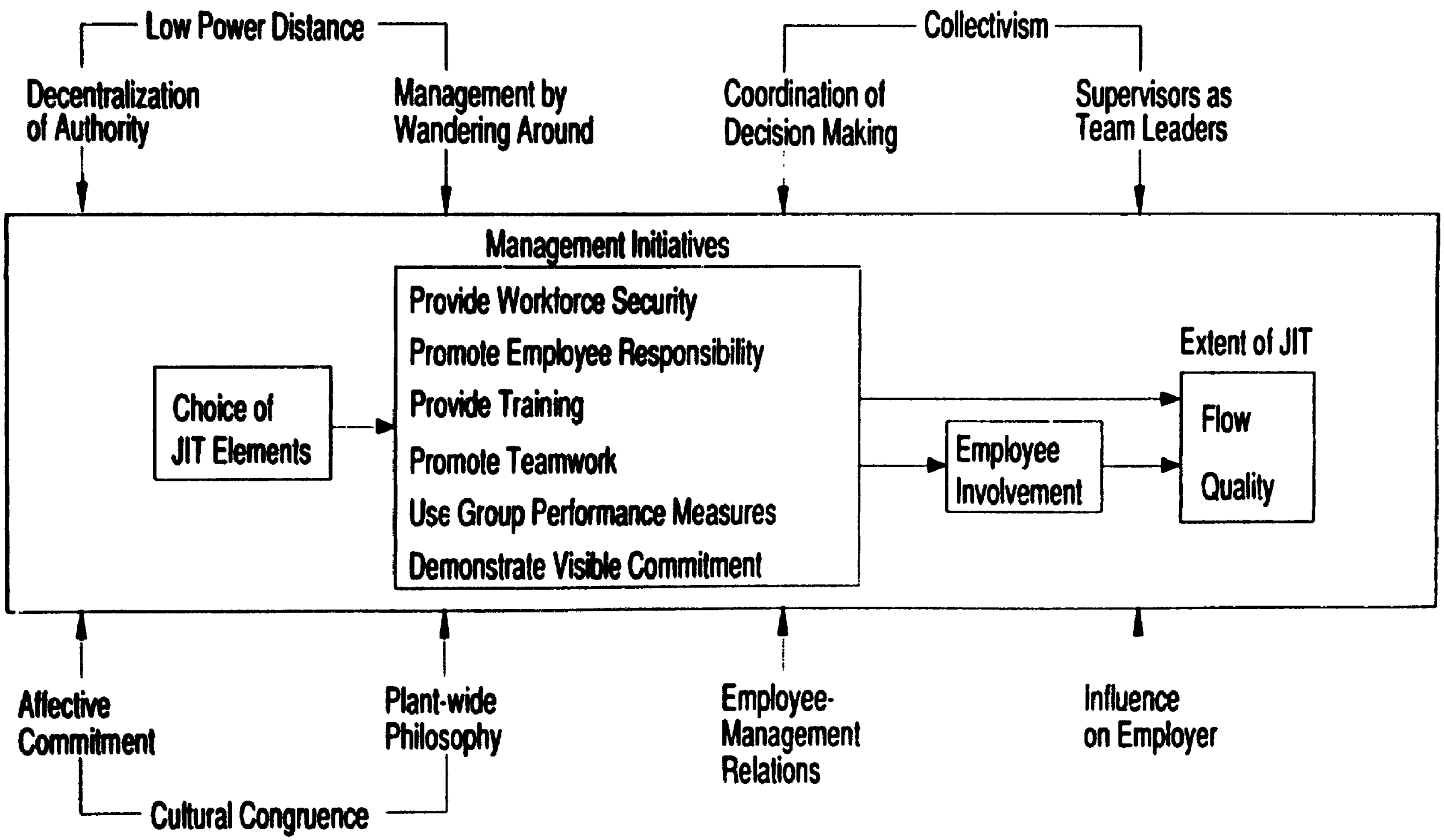
1 Framework

The framework for this research (Figure 3.1) is based on the literature reviewed in the previous two chapters. This literature led to the broad conclusions that plant-level characteristics such as the initiatives of operations managers, the involvement of employees, and the plant environment are keys to explaining the extent of JIT implementation. Thus, the unit of analysis for this research is the productive unit, defined by Abernathy (1978:48) as "... an integral production process that is located in one place under a common management to produce a particular product line."

Within each major part of the framework, such as management initiatives or plant environment, I could have included many other constructs. But, to keep the scope of this study manageable, I model only a selected set of constructs which I believe are most promising for explanation.

In figure 3.1, I show proposed relationships as arrows indicating that one construct is proposed as a necessary condition for another. To avoid cluttering the framework, I group some proposed relationships under one arrow. For

Figure 3.1
RESEARCH FRAMEWORK



example, one proposition is that the provision of workforce security is a necessary condition for employee involvement although the same arrow serves to indicate five other relationships as well. The complete set of propositions is outlined at the end of this chapter.

For this study, I represent employee involvement as an antecedent of JIT rather than as part of its definition. Although most authors state that some form of employee involvement is necessary for JIT, I do not treat it as an element of JIT itself. Rather, I model it as a facilitating condition for JIT. It is given a central place in the framework because of the emphasis it receives in the literature.

The relationships between the plant environment and other parts of the framework are not well understood, so I indicate these relationships with broken arrows. In other words, I model each construct of the plant environment as a modifier of the entire situation rather than a necessary condition for any specific construct. Thus, I suggest no direct relationships between plant environment constructs and others in the framework. Instead, I expect the plant environment to help explain conditions under which other relationships hold.

I do not extend the framework beyond considering the extent of JIT flow and quality. That is, I do not consider operations performance nor the next obvious measure, financial performance. As outlined in Chapter One, the link between JIT-like operations and good operations performance has been demonstrated by other researchers. As well, I assume that improved operations performance will naturally lead to improved financial performance. However, as financial performance is influenced by such a variety of non-operational factors, any attempt to draw such a link without making it a central concern of the research would be well beyond the scope of this study.

The framework is intended to focus the research effort without being restrictive. If other influences become important during data collection or analysis, the research methods (discussed in Chapter Four) are flexible enough to accommodate.

In the following discussion, I briefly outline each of the constructs of the framework. In Chapter Four, I outline more complete operational definitions for each of these.

1.1 Extent of JIT

As outlined in Chapter Two, there are many different schemes for representing JIT. For this study, I represent JIT with two broad categories, namely, the flow aspects and the quality aspects. When I operationalize these two categories, I further reduce them to individual elements, each measured with its own scale (Chapter Four).

1.1.1 Flow Aspects

This first of two broad JIT categories is oriented primarily to the notions of material flow as in "one-piece flow" or "once in motion, always in motion." It includes those elements commonly envisaged as JIT when JIT is seen strictly as material flow, such as, significantly smaller lot sizes, reduced setups, changes in equipment layout (typically into group technology cells), the use of uniform loading (a level and mixed schedule), some form of "pull" system for material control (typically using "kanban" cards), and supply arrangements aimed at frequent, small-lot deliveries.

1.1.2 Quality Aspects

This second broad JIT category is directed at those quality activities typically associated with JIT systems, the quality approaches of the Toyota production system being a good example. Quality activities include those directed at controlling the process such as statistical process control (SPC), as well as activities directed at preventing defects (typically with a goal of zero defects) such as the principles of 100% quality at the source using mistake-proof (poka yoke) devices. As well, this category includes efforts to improve the quality of suppliers.

1.2 Employee Involvement

Employee involvement refers to the degree to which employees in a given organization or department stay informed and make decisions about their work (Orsburn, Moran, Musselwhite, & Zenger, 1990:221). For this study, this means the active engagement of shop-floor employees in problem solving to improve the production process; it does not merely refer to employees being included in some aspects of plant activity, management granting some extra autonomy with a view to improving employee relations, or employees being asked periodically for some ad hoc input. It refers to the sixth level of employee involvement suggested by Orsburn et al. (1990:229) in which problem solving is integrated with daily job responsibilities.

1.3 Choice of JIT Elements

This construct addresses the "choices" or approach by management in terms of the extent to which a full JIT system and philosophy are pursued. Here I propose that the particular choices of JIT elements can lead to or act as constraints on further management initiatives. Thus, this construct acts much like an aspect of the plant environment except that I do not treat it as strictly exogenous, as I will attempt to offer explanations for these choices as part of the study.

1.4 Management Initiatives

The initiatives taken by management could have been modelled as being influenced by other constructs as well, such as "management strategy" or "knowledge of JIT." However, for this study, I do not model these; rather, I assume that all such influences are reflected as "management initiatives." In other words, I do not attempt to explain why managers may or may not act in certain ways; instead, I look at only the relationships between these actions, however influenced, and aspects of JIT. The only exception, as just mentioned, is that I have modelled "choices of JIT elements" as a potential influence on subsequent management action.

The framework reflects my central assumption, as outlined in Chapter One, that the initiatives of management, in light of specific plant environments, will provide the most fruitful answers to the two research questions. The knowledge, decisions, strategies, and policies of operations managers at the level of the individual plant should be reflected in the specific actions of managers and hold the key to JIT success. In other words, as the central thrust of this study, I focus on what operations managers actually do.

To limit the scope of the inquiry to manageable size, I model only six specific management initiatives, as "best bets" to guide the study. I chose these six because they were recurring themes in the literature and because they made sense to me. I briefly describe each of the six management initiatives in turn.

1.4.1 Provide Workforce Security

The provision of workforce security refers to the degree to which management commits to maintaining employment levels, especially in face of productivity improvements.

1.4.2 Promote Employee Responsibility

The promotion of employee responsibility refers to management efforts to move decision making responsibility down to lower levels in the organization, especially to the level of hourly workers.

1.4.3 Provide Training

The provision of training refers to management arranging for employees to be more knowledgeable about specific techniques, cross-trained, and able to engage in problem solving.

1.4.4 Promote Teamwork

The promotion of teamwork refers to management's efforts to make team approaches the dominant way of operating on the shop floor. This usually includes actions such as training people to operate in groups, arranging for team facilitators, and providing time for team meetings.

1.4.5 Use Group Performance Measures

The use of group performance measures refers to the extent to which management judges and rewards a group as a whole rather than using individual reward systems, in particular, piece rate incentive systems.

1.4.6 Demonstrate Visible Commitment

Management demonstration of visible commitment refers to management delivering a strong and consistent message that they are serious about making progress towards JIT objectives.

1.5 Plant Environment

A typical factory is a complex entity composed of many interrelated considerations like equipment, people and their behaviour, plant culture, power, finances, and competitiveness, to name a few. It is difficult and probably inaccurate to draw conclusions about a plant without placing them in context. This inability to separate various aspects of a plant from its context is the main reason this research employs a case-based methodology (discussed in Chapter Four). As Yin (1989:14) stated: ". . . the distinctive need for case studies arises out of the desire to understand complex social phenomena." By including the plant environment in the framework, I am trying to outline the "way things are" at the plant along a limited number of dimensions. This acts as the context for the JIT activities in this study.

I used a well-written working paper (Bates et al., 1990) as the primary source for constructs to model the plant environment. In it, the authors examined the relationship between organizational culture and manufacturing strategy. The paper treated organizational culture as being either "clan-like" or not, according to three dimensions: (1) power distance, (2) collectivism, and (3) cultural congruence. While based on the work of others, their measures were developed specifically for manufacturing practices. They found (1990:24) a strong relationship between a clan-style organizational culture and a world class manufacturing strategy.

Power distance is the extent to which authority is differentiated by position (1990:16). Low power distance is modelled by two constructs: (1) decentralization of authority or the extent to which employees may make decisions without consulting superiors and (2) management by wandering around or the visibility and involvement of management in day-to-day affairs.

Collectivism is the extent to which people work for the benefit of the group rather than the individual (1990:16). Collectivism is modelled by two constructs: (1) coordination of decision making or the extent to which different departments within the plant coordinate and communicate decisions and (2) supervisors as team leaders or the extent to which supervisors encourage workers to express their opinions and work as a team.

Cultural congruence (1990:17) refers to the extent to which there is a strong, distinct, internally consistent culture which fosters positive attitudes towards the organization in organization members. I model cultural congruence with two constructs: (1) affective commitment or employees' emotional attachment to, identification with, and involvement in, the organization and (2) plant-wide philosophy or the extent to which employees see their values as consistent with those of the plant.

As well, I decided to model "employee-management relations" and "influence on the employer" as other potentially useful explanatory constructs within a plant's environment. Employee-management relations refers to the extent to which management and employees (and/or their union) are able to operate in a constructive and cooperative atmosphere. And, influence on the employer refers to the degree to which employees influence their day-to-day work and working conditions.

Thus, eight constructs are used to model the plant environment. Each is discussed in turn.

1.5.1 Decentralization of Authority

Centralization refers to the degree to which employees at the plant must take direction from those higher in the hierarchy before implementing assigned tasks (Bates et al., 1990:17). As JIT implementation should be easier in more decentralized environments, I model this construct in the reverse sense, as "decentralization."

1.5.2 Management by Wandering Around

Management by wandering around refers to the extent to which management is visibly involved in day-to-day shop floor activity (1990:17).

1.5.3 Coordination of Decision Making

Coordination of decision making refers to the extent to which different departments in a plant coordinate and communicate decisions (1990:17).

1.5.4 Supervisors as Team Leaders

This construct refers to the extent to which supervisors encourage workers to express themselves and operate as members of a team (1990:17).

1.5.5 Affective Commitment

Affective commitment refers to one of two independent components of organizational commitment (Allen & Meyer, 1990:1). It is the degree to which an employee is emotionally attached to, identifies with, and is involved in the organization (commitment based on desire). It is the only component of commitment positively related to performance (Meyer, Paunonen, Gellatly, Goffin, & Jackson, 1989:152).

1.5.6 Plant-Wide Philosophy

This construct refers to the degree to which employees are believed to have values consistent with distinctive values operating in the plant and its environment (Bates et al., 1990:18).

1.5.7 Employee-Management Relations

This construct refers to the climate of the relationship between employees and management in the plant (Rosen, Greenhalgh, & Anderson, 1981).

1.5.8 Influence on Employer

The influence on employer construct refers to the degree to which employees influence their day-to-day work and solve work-related problems (Magenau, Martin, & Peterson, 1988:375).

2 Propositions

As mentioned, I propose no propositions for answering the second research question. The propositions to be tested for the first research question are based on the framework just outlined. The constructs representing the plant environment are not included in the propositions. They are intended as potential modifiers to and sources of explanation about various relationships when analyzing the second research question.

There are twenty propositions in total, each suggesting an association between two of the constructs in the framework. These propositions are grouped, in line with the framework, as (1) management initiatives and employee involvement, (2) management initiatives and the extent of JIT, and (3) employee involvement and the extent of JIT.

(1) Management Initiatives and Employee Involvement

01. Provision of workforce security is a necessary condition for employee involvement.
02. Promotion of employee responsibility is a necessary condition for employee involvement.
03. Provision of training is a necessary condition for employee involvement.
04. Promotion of teamwork is a necessary condition for employee involvement.
05. The use of group performance measures is a necessary condition for employee involvement.
06. Demonstration of visible commitment is a necessary condition for employee involvement.

(2) Management Initiatives and the Extent of JIT

07. Provision of workforce security is a necessary condition for JIT flow.
08. Promotion of employee responsibility is a necessary condition for JIT flow.
09. Provision of training is a necessary condition for JIT flow.
10. Promotion of teamwork is a necessary condition for JIT flow.
11. The use of group performance measures is a necessary condition for JIT flow.
12. Demonstration of visible commitment is a necessary condition for JIT flow.
13. Provision of workforce security is a necessary condition for JIT quality.
14. Promotion of employee responsibility is a necessary condition for JIT quality.
15. Provision of training is a necessary condition for JIT quality.
16. Promotion of teamwork is a necessary condition for JIT quality.
17. The use of group performance measures is a necessary condition for JIT quality.
18. Demonstration of visible commitment is a necessary condition for JIT quality.

(3) Employee Involvement and the Extent of JIT

19. Employee involvement is a necessary condition for JIT flow.
20. Employee involvement is a necessary condition for JIT quality.

3 Summary

In this chapter, I developed the research framework and propositions to be tested for the first research question. In the following chapter, I outline the research methodology, including the rationale for the method, the sites visited, and data collection and analysis procedures.

Chapter Four: Methodology

1 Introduction

In the previous chapter, I developed the framework for the study and stated the propositions, derived from the literature, to be tested in connection with the first of the two research questions. In this chapter, I explain my choice of a case-based research methodology, discuss issues of validity and reliability, discuss field sites and site selection, and outline data collection and data analysis procedures.

2 Choice of Method and Rationale

For this study, I use a case-based research methodology. Yin (1989:23) defined a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used."

I use this methodology to attempt to answer the research questions because (1) not enough is known about the range of factors which should be considered, (2) there are many misunderstandings about the nature of JIT and the role of management in its implementation, and (3) knowledge within a given plant about JIT typically does not reside with one person.

The appropriate methodology for any research depends on the current state of knowledge and the nature of the research problem. Yin (1989:15-20) outlined five research strategies, namely, experiment, survey, archival analysis, history, and case study. The appropriate choice depends on three conditions: (1) the form of the research question, (2) whether or not control is required over behavioural events, and (3) whether or not the research focuses on contemporary events. The relevant situations for different research strategies are shown in Table 4.1, from Yin (1989:17).

Table 4.1
Relevant Situations for Different Research Strategies

Strategy	Form of Research Question	Requires Control over Behavioral Events?	Focuses on Contemporary Events?
Experiment	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival analysis (e.g. economic study)	who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case Study	how, why	no	yes

Thus, for this research, case studies are the most appropriate because the questions I ask are "why" questions, I have no control over behavioural events, and the focus is on contemporary events.

Eisenhardt (1989:548) supported the use of case studies in situations where little is known about a phenomenon in the sense of little available previous literature or prior empirical evidence, clearly the situation here. And, Swamidass (1991:803) said that JIT implementation was one of the fuzzy, messy topics in operations management which are underresearched because they are unsuitable for deductive methods; rather, they are appropriate for empirical investigation.

However, a case-based approach does not mean that the research must be strictly qualitative (Yin, 1989:25). I use both qualitative and quantitative data. Glaser and Strauss (1967:17-18) took the position that there is no fundamental clash between the purposes and capacities of qualitative and quantitative data. The two types of data can be highly synergistic, as quantitative data help indicate relationships and qualitative and anecdotal data help with understanding (Eisenhardt, 1989:538).

3 Validity and Reliability

Whenever case-based research is undertaken, there are (or should be) concerns about the validity and reliability of the data. Many case-based approaches are silent on these issues. Yin (1989:40) outlined ways in which four logical tests for judging a research design may be applied to case research. These four tests are: (1) construct validity, (2) internal validity, (3) external validity, and (4) reliability. They are standards for social science research but are normally associated with more statistical approaches. Nevertheless, careful research design, data collection, and data analysis can provide rigour and counter some common, often valid, criticisms of case approaches. The case study tactics for the four tests are shown in Table 4.2, from Yin (1989:41).

Below, I consider each of these four tests by defining the test and discussing how Yin suggested it be handled for case research. As well, I point out how I followed each of these suggested tactics in this study.

3.1 Construct Validity

Construct validity is the extent to which we establish correct operational measures for the concepts being studied (Yin, 1989:40). I discuss, in turn, each of Yin's three tactics for enhancing construct validity in case study research, with reference to this study.

Table 4.2
Case Study Tactics for Four Design Tests

Test	Case Study Tactic	Phase of Research in Which Tactic Occurs
Construct Validity	use multiple sources of evidence	data collection
	establish chain of evidence	data collection
	have key informants review draft case study report	composition
Internal Validity	do pattern matching or explanation building or time-series analysis	data analysis
External Validity	use replication logic in multiple-case studies	research design
Reliability	use case study protocol	data collection
	develop case study data base	data collection

The first tactic is to use multiple sources of evidence. A major strength of case study data collection is the opportunity to use many different sources of information (Yin, 1989:96). The reason for this is the same as for statistical studies. That is, any operational measure of a construct contains information which taps both the construct of interest and unrelated information. By using the shared information from multiple sources, the researcher is able to converge more easily on the intended construct and disregard components not intended, a process of triangulation. The more dissimilar the sources, the more the irrelevant components are also dissimilar and the more the similarities reflect the construct intended (Kidder & Judd, 1986:53). One way to achieve dissimilar sources of information is to use a mixture of quantitative and qualitative measures. A good example of this is the way in which Eisenhardt and Bourgeois (1988:744) measured "power centralization." They used qualitative descriptions and various quantitative measures side-by-side to tap the construct. So, a number of measures, each imperfect, can provide validity in a way that a single measure cannot. For this study, I followed the suggestion to use multiple sources by measuring constructs with combinations of interview data, questionnaire data, company documents, and observations.

The second tactic suggested by Yin to enhance construct validity (as well as increase reliability) is to establish a chain of evidence. In other words, one should proceed in such a way that an external observer could follow the derivation of evidence from the initial research questions to the ultimate case study conclusions. I do this by reducing the data via a series of steps, beginning with the raw data and ending with summary values for each construct. That is, the raw data, both qualitative and quantitative, originally grouped by informant, is clarified, recorded electronically, coded with standard codes, grouped by construct category, reduced to summary statements and questionnaire results, and assigned a value.

The third tactic for enhancing construct validity is to have key informants review the draft case study report. For each firm in this study, I mailed a completed summary, organized by construct category, and asked that the document be reviewed for inaccuracies, misunderstandings, or violations of confidentiality. I made adjustments where necessary, although none of the key informants suggested major changes. The consensus was that my drafts were accurate, requiring only minor clarification.

3.2 Internal Validity

Internal validity is the extent to which we can establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships (Yin, 1989:40). It is "the approximate validity with which we infer that a relationship between two variables is causal or the absence of a relationship implies the absence of cause" (Cook & Campbell, 1979:37).

To enhance internal validity, Yin suggests that the researcher do "pattern matching" or "explanation building." (His third suggestion, time-series analysis is not appropriate for this study.) Pattern matching is used to test existing propositions, whereas explanation building (a special type of pattern matching) is d for explanations derived from the data. As I approach each of the two research questions differently, I use a pattern-matching approach to address the first research question and an explanation-building approach to address the second. Nevertheless, with each approach, the researcher compares observed patterns with patterns expected if certain propositions were true.

3.3 External Validity

External validity refers to the domain to which a study's findings or presumed causal relationships may be generalized (Cook & Campbell, 1979:37; Yin, 1989:41). The problem of external validity has been a major barrier in doing case studies, according to critics of a case-based approach. However, as Yin pointed out (1989:43):

> . . . such critics are implicitly contrasting the situation to survey research, where a "sample" (if selected correctly) readily generalizes to a larger universe. *This analogy to samples and universes is incorrect when dealing with case studies*. This is because survey research relies on *statistical* generalization, whereas case studies (as with experiments) rely on *analytical* generalization.

Elsewhere, he says (1989:38):

> A fatal flaw in doing case studies is to conceive of statistical generalization as the method of generalizing the results of the case. This is because cases are not "sampling units" and should not be chosen for this reason.

Glaser and Strauss (1967:62-65) also addressed this issue of theoretical versus statistical sampling. The purpose of theoretical sampling is to discover categories, their properties, and interrelationships, whereas statistical sampling is to obtain evidence for verification of distribution among categories. The notion of an adequate sample is very different for each type of research. Theoretical sampling only requires collecting data on categories, not sampling the whole group. Case selection should be based on theoretical sampling in which extreme cases are chosen to fill theoretical niches; it should not be based on representative random samples (Eisenhardt, 1989:537). For such sampling, it is advantageous to obtain opportunistic samples that differ as widely as possible from each other (Cook & Campbell, 1979:76).

Thus, with case research, generalization is from each case to a broader theory (analytical generalization), not from samples to populations (statistical generalization). Of course, the conclusions from any research may be improved by collecting more data. Nevertheless, with analytic generalization, it is possible to generalize from only one case (Yin, 1989:38) but, the generalization is not automatic (1989:44); the theory should be tested through replication which enhances both external validity and construct validity (Cook & Campbell, 1979:78).

Cook and Campbell (1979:80) also pointed out that external validity is likely enhanced more by many heterogeneous small experiments than by one or two large experiments.

Thus, the generalizability of this study is enhanced by replicating the case studies and by choosing cases for theoretical, not statistical reasons.

3.4 Reliability

Reliability is the extent to which a study's operations can be repeated, with the same results (Yin, 1989:41). This means that, if a later investigator were to conduct the same case study, exactly following the same procedures, the same results should be obtained. Yin suggests two tactics for enhancing the reliability of case research. Each is discussed in turn.

The first tactic is to use a case study protocol. For this study, I had two written protocols (Appendices I and II). However, I used them as guidelines of topics of interest to be covered; I did not follow them in strictly linear fashion. Nevertheless, another researcher could use them to help ensure that the same topics were covered.

The second tactic for enhancing the reliability of case-based research is to maintain a case study data base. This is a formal assembly of evidence distinct from the final report (Yin, 1989:84). The information should be stored in such a way that notes may be easily retrieved, although they need not be edited or presentable. This would allow another researcher to repeat the analytical procedures, beginning with the raw data. For this study, my data base consists of raw scribble notes and electronic files of interview source data and observations, electronic files reorganized by construct of interest, completed questionnaires, and documents.

And, although not listed in Table 4.2 as a tactic for enhancing reliability, Yin (1989:102) also points out that maintaining a chain of evidence (discussed earlier under construct validity) also enhances reliability.

4 Sites Visited for this Study

For this study, I visited six sites, in line with the previous discussion concerning analytical rather than statistical sampling. While there is no ideal number of cases for case study research, four to ten cases usually works well (Eisenhardt, 1989:545). In selecting sites, I was not simply trying to find the best or most well-known JIT plants in the region. To help promote external validity, I wanted a good cross section of plants, ranging from those known as relatively long-term JIT plants to those just beginning to attempt JIT implementation.

I had previously been maintaining a list of firms in the region known to be engaging in JIT-like approaches to manufacturing. Each firm as well as my potential access to each was different, so I used varied methods to gain entry. I approached most firms by making an initial phone call to the CEO, VP-manufacturing, or plant manager. This proved to be the most effective approach as it offered quick clarity: one either gained access or not after a brief conversation or two. In two cases, initial contact was through former students of my thesis advisor. In all but one case, I made a preliminary visit to clarify my request and set up a schedule.

Each site had, in some way, been represented as a plant engaged in JIT-like approaches to manufacturing. Each is located in central Canada, is engaged in repetitive manufacturing, employs 300 to 1000 people, has sales in the $70 million to $250 million range, and produces fabricated metal products, mainly on an assemble-to-order basis. As well, all but one has a U.S. parent and all but one is unionized. Two of the plants are original equipment manufacturers, belong to the same firm, and operate in similar industries. The other four are primarily suppliers and operate in completely different industries.

5 Data Collection

One should begin case-based research with a well-defined focus (Eisenhardt, 1989:536) but a framework should be used as a focusing and bounding device, not as a blinder or straightjacket (Miles & Huberman, 1984:29). Consequently, I used the framework outlined in Chapter Three as a guide to focus, but not restrict, the collection of data.

In the following sections, I outline the match between methods, informants, and information desired. I then outline the operational definitions I used for the constructs in this study. Finally, I discuss my data collection procedures.

5.1 Desired Information, Collection Methods, and Informants

In line with the framework, I concentrated data collection on the plant environment, management initiatives, extent of JIT, employee involvement, and the choice of JIT elements. As well, I collected some operational and demographic information. I attempted to collect information reflecting both the current situation and the situation before any introduction of JIT.

In line with Yin's suggestions (1989:95-98), I used more than one source of data, namely, interviews, questionnaires, observations, and documents. However, I did not follow a structured approach for the latter two. Rather, I took the opportunity to observe and collect documents whenever it was presented. I did not purposefully seek out particular information in this way except to request at least one plant tour. As for interviews, and questionnaires, I was more purposeful, collecting particular targeted information. Miles and Huberman (1984:28) argued that the degree to which a research design should be prestructured depends on the time available, how much is already known about the phenomenon under study, the instruments already available, and the analysis to be done. There is a tradeoff between loose designs which allow the researcher to explore local conditions and tight designs which make cross-site comparisons easier. I chose an intermediate approach in which I tried to cover each construct in the framework during the plant visit but did not demand responses for each construct from each respondent.

I used two different approaches for interviews (Appendices I and II), one a straightforward interview about the situation at the plant and the other a discussion of a particular improvement project (usually two projects per visit). Interviews under this latter approach often drifted quickly from the improvement project to more general topics. I allowed and even encouraged this to happen as it accomplished my main goal of being able to discuss various aspects of the research framework with different informants from different angles. I believe I received much more direct input, especially from hourly workers, than would have been possible with a more formal interview.

As well, I used three different types of questionnaires (Appendices III, IV, and V), each aimed at particular information from particular informants. The first type (manufacturing practices, Appendix III) aimed at collecting information on the extent of JIT, the extent of employee involvement, and the early choices and sequences of JIT elements. I gave it to only a small set of managers at each plant who were most informed about JIT, in the opinion of my main contact at the plant. For this data, I did not want broad opinion; I wanted the four or five people most knowledgeable about a plant's JIT activities. The second type of questionnaire (general situation, Appendix IV) concerned the plant environment. I gave it to all respondents as I wanted a broad set of responses about the overall plant environment. The final type of questionnaire (operational measures, Appendix V) concerned operational and demographic information. This, I gave to only the top manager (or designate) at each plant as this information could be best answered by one informed person.

The particular mix of informants at any plant depended on the doors that could be opened, the organization of the plant, and available time. Typically, the mix included the plant manager and immediate subordinates, some supervisors, some line workers, and the manager of human resources. It sometimes included others such as engineers or union representatives, as circumstances warranted.

With a case-based research methodology, there is no requirement to interview a standard mix of informants for each case, as each case is treated as a separate study leading to its own conclusions. Flexible and opportunistic data collection methods may be used (Eisenhardt, 1989:539; Yin, 1989:59) as they allow researchers to take advantage of emergent themes and unique case features. Such adjustments may include the addition of new interview questions, or the addition of new data sources, often opportunistically. This is referred to as an "investigative process" (Miles & Huberman, 1984:37) or "controlled opportunism," controlled in the sense that the "flexibility is not a licence to be unsystematic" (Eisenhardt, 1989:539). Such changes, if done appropriately, are legitimate because each case, using replication logic, is a stand-alone entity. The goal is to understand each individual case in as much depth as possible, not to aggregate summary statistics across a set of observations, as would be the case with a statistical approach (Eisenhardt, 1989:539). With replication logic, a definite set of conclusions is drawn for each individual case. Each proposition is examined for each case, not for the aggregate (Eisenhardt, 1989:542). It is the conclusions themselves, not the minor details of the data, which are compared across cases (Yin, 1989:57).

In Table 4.3, I show the match between desired information, collection methods, and informants.

Table 4.3
Desired Information, Collection Methods, and Informants

Desired Information:	Collection Method:	Informants:
the plant environment	open-ended interviews plus general situation questionnaire	all interviewees
management initiatives	open-ended interviews	all interviewees
JIT flow and quality and employee involvement	manufacturing practices questionnaire	selected set of those most knowledgeable about JIT efforts at the plant
	open-ended interviews	all interviewees
operational and demographic information	operational measures questionnaire	plant manager
choice and sequence of early JIT elements	manufacturing practices questionnaire, p.7	selected set of those most knowledgeable about JIT efforts at the plant
all of the above	observations	researcher
all of the above	collection of documents	all interviewees

5.2 Operational Definitions

In this section, I outline the operational definitions for each of the constructs shown in the framework. As I use two approaches to collecting data frcm informants, interviews and questionnaires, I use two approaches to operationalizing constructs.

For questionnaire data, I operationalize constructs with multi-item scales. Wherever possible, I chose to use well-developed quantitative scales that had been tested elsewhere and reported in the literature. By doing so, I could be reasonably certain of the validity and reliability of the measures.

And, for interview data, I operationalize constructs according to possible responses which I would consider evidence of a high value for the construct at a particular plant. It is not possible to outline a complete set of responses to serve as the operational definition of each construct. This was a major reason I initially chose a case-based methodology. Rather, I had to decide whether particular interview statements could be considered evidence for the existence of a construct in question. For example, a researcher would probably not operationalize a construct such as "management commitment to employee welfare" by including in its definition a visit to an employee's home, something that could easily be seen as interference, invasion of privacy, or abuse of position. Nevertheless, within a given context, such as the death of a spouse, such a visit might, in fact, be good evidence of management commitment to employee welfare. A researcher must make this type of judgement within the context of each case.

Given the impossibility of outlining a complete set of all possible responses in all possible contexts, I present examples of evidence I would expect to see in order to assign a top (or near top) rating for each construct. These examples are intended to be representative, not exhaustive. In any given context, only a few of these attributes could be sufficient for a top rating; they do not all have to be present.

Following, I discuss each of five areas of the framework, namely, the extent of JIT, employee involvement, choice of JIT elements, management initiatives, and the plant environment.

5.2.1 Extent of JIT

The extent of JIT for this study is represented by a number of elements based on an adjusted combination of two schemes (Piper & McLachlin, 1990; Sakakibara et al., 1990). The elements in these schemes correspond as shown in Table 4.4. I group them under headings of flow, quality, and miscellaneous.

Table 4.4

Elements of JIT

	Piper and McLachlin, 1990.	**Sakakibara, Flynn, and Schroeder, 1990.**
Flow:	Setup Reduction	Setup Reduction
	Small-lot Transportation	Equipment Layout
	Small-lot Production	Small Lot Size
	Levelling and Mixing Production	Repetitive Master Schedule
		Daily Schedule Adherence
	Withdrawal by Subsequent Processes	Kanban
		Pull System
	JIT Supply Arrangements	JIT Delivery from Suppliers
Quality:		Supplier Quality Level
	Zero Defects Quality	
Miscellaneous:	Equipment Maintenance	Preventive Maintenance
	In-house Equipment	
	Autonomation	Multifunction Worker
		Product Design Simplicity
		Training
		MRP adaptation to JIT
		Accounting adaptation to JIT

Although there are differences between the two schemes, there is a reasonable degree of consistency. The elements outlined by Sakakibara et al. have been thoroughly tested for reliability and validity. After initial site visits consisting of structured interviews at twelve plants, their instrument was tested with a sample of 712 workers and managers in 38 U.S. and Japanese plants in three industries (transportation, electronics, and machinery) in the United States. In a related article, Flynn, Sakakibara, Schroeder, Bates, and Flynn (1990b:267) state that, because of the difficulty in establishing reliability and validity, it is very useful for researchers in operations management to use scales whose reliability and validity have already been demonstrated. Thus, I decided to use their JIT elements (with permission) wherever possible.

However, I made a few adjustments to fit this study more closely: (1) I excluded three of their core JIT elements which I felt represented constructs which were facilitators and adjustments for JIT rather than "elements" of JIT. These three were "training," "MRP adaptation to JIT," and "accounting adaptation to JIT." (2) I eliminated the "multifunction worker" element because it had a low reliability measure (0.43) and because it could not be considered mainly a flow or a quality element, a distinction I wished to make in the analysis. (3) I included two well-tested quality elements outlined in a related working paper (Flynn et al., 1990c) to fill a gap in measuring quality. I did this because I use a definition for JIT in this research which is somewhat wider that theirs; mine includes quality, whereas theirs treats JIT as mainly the core flow-like characteristics, with quality being separate. These additional quality elements are "use of charts and feedback" and "statistical process control." (4) I added four elements identified by Piper and McLachlin (1990) as they were areas of interest not otherwise covered. These were "transfer lot size," "zero defects quality control," "autonomation," and "in-house equipment." (5) I added three extra questionnaire items to each of two of their established scales. These scales, "pull system" and "preventive maintenance," did not cover aspects of interest, namely, the signalling and inventory control aspects of a pull system and the issue of operator and staff responsibilities for maintenance. These extra items were not tested for validity and reliability except for face validity during pilot tests. Nevertheless, I decided it was reasonable to include them on the questionnaire as each would be simply an extra source of information about the construct of interest, not the sole source.

Also, as shown in the framework, I modelled employee involvement as a facilitator, not as part of JIT. Nevertheless, I included employee involvement as part of the manufacturing practices questionnaire using two scales, one from Sakakibara et al. (small group problem solving) and one developed for this study (employee involvement).

Each questionnaire element was measured using a multi-item scale. Most, but not all, elements proved useful during final analysis. The elements, sources for each scale, number of items in each scale, and reliabilities (Cronbach's alpha) are reported in Table 4.5. Some of the reliability values do not meet the 0.70 target recommended by Nunnally (1978:245) for hypothesized measures of a construct. However, Sakakibara et al. (1990:19), referring to a few other sources, argue that values of alpha as low as 0.44 are acceptable for exploratory research as alpha is conservative and acts as a lower bound to the actual reliability of a scale.

As well, for this research, questionnaire data is intended to augment, not replace, interview data. So, I consider these values to be good enough as each scale is one of a number of indicators for a given construct, not the entire measure of the construct. The questionnaire items which form each element are outlined in Appendix III.

Table 4.5
Elements on the Manufacturing Practices Questionnaire

Element	Source	Items	Reliability
Setup Reduction	[2]	4	.68
Equipment Layout	[2]	3	.60
Small Lot Size	[2]	3	.62
Transfer Lot Size	new items	5	
Repetitive Master Schedule	[2]	3	.54
Daily Schedule Adherence	[2]	3	.60
Kanban	[2]	4	.62
Pull System	[2]+new	4+3	.65 *
JIT Delivery from Suppliers	[2]	4	.63
Autonomation	new items	5	
Supplier Quality Level	[1],[2]	4	.73
Zero Defects Quality Control	new items	5	
Statistical Process Control	[1]	4	.77
Use of Charts and Feedback	[1]	5	.77
Product Design Simplicity	[1],[2]	3	.62
Preventive Maintenance	[1],[2]+new	5+3	.67 *
In-house Equipment	new items	5	
Small Group Problem Solving	[1],[2]	3	.71
Employee Involvement	new items	5	
		83	

[1] Flynn, Schroeder, and Sakakibara, 1990c
[2] Sakakibara, Flynn, and Schroeder, 1990
* The reliability figures refer to only the original items.

Looking ahead, not all elements included on the questionnaire proved useful for final analysis. Some lacked sufficient information due to limited interview time and some were better treated as subsets of other categories. In particular, I dropped "transfer lot size" and "preventive maintenance" based on lack of meaningful discussion, included "kanban" as a subset of "pull system" and "small group problem solving" as a subset of "employee involvement," and dropped "autonomation," "product design simplicity," and "in-house modification" because I could not easily consider each a distinct element of either flow or quality when developing overall ratings. So, in the following, I address only those constructs used in the final analysis, organized as to flow and quality elements. As mentioned, I indicate representative, but not exhaustive, interview evidence which might be used to assign a top rating for each construct.

Flow Elements:

(1) Setup Reduction:

Evidence for setup reduction could include the following: (a) changeovers are done in minutes rather than hours, (b) changeovers are eliminated completely, (c) there is use of video techniques and/or other forms of practice and learning, (d) special fixtures are developed to aide the setup, (e) there are special setup reduction teams and projects, (f) there is elimination of adjustments during setups, (g) operators do their own setups, and (h) the next setup is organized while the machine is still running.

(2) Equipment Layout:

Evidence for equipment layout could include the following: (a) there are cells with equipment arranged according to product flow rather than machine function, (b) there are ..yout changes to accommodate multiprocess handling, (c) the use of conveyors is reduced to short linkages or eliminated, and (d) full work control methods are used.

(3) Small Lot Size:

The criterion for evidence of small lot size is simply typical lot sizes which approach "one," but realistically are 100 or less.

(4) Repetitive Master Schedule:

Evidence for a repetitive master schedule could include the following: (a) there is a fixed and level schedule, (b) they produce the same mix of end items or families each day, and possibly each hour (to match daily demand rates), (c) there is a reduction in upstream inventory swings and panic reactions to schedule demands, and (d) there is little or no expediting.

(5) Daily Schedule Adherence:

Evidence for daily schedule adherence could include the following: (a) the schedule leaves time for fixing quality problems, attending meetings, and/or performing preventive maintenance, and (b) the production schedule is met exactly each day.

(6) Pull System:

Evidence for a pull system could include the following: (a) kanban or similar signals are used to authorize production at a workstation, (b) the schedule or production rates are issued to final assembly operations only, (c) a fixed number of standard containers are used for movement and storage of goods, and (d) there is strict control of work-in-process inventory levels.

(7) JIT Delivery from Suppliers:

Evidence for JIT delivery from suppliers could include the following: (a) there are long-term relationships with certified suppliers, (b) suppliers have a long-term schedule but deliver according to pull signals, (c) the plant makes fixed "milk runs" to pick up supplies from groups of suppliers, (d) suppliers are required to produce to a schedule rather than ship from finished goods, (e) there are restrictions on the type of allowable containers, (f) most suppliers are in proximity, (g) there are reduced inventory buffers for incoming goods, (h) incoming materials go straight to the point of use, (i) there are frequent, small-lot deliveries, and (j) the plant provides advance information and assures suppliers that they can believe the numbers.

Quality Elements:

(1) Supplier Quality Level:

Evidence for supplier quality could include the following: (a) there are long-term relationships with certified suppliers, (b) the plant promotes and encourages suppliers who can add value, (c) the plant minimizes the number of suppliers, (d) there is little incoming inspection, (e) personnel from the plant go to supplier plants to help improve suppliers' processes, (f) the plant requires suppliers to have particular programs (e.g. SPC), (g) there is an active supplier audit and certification program, (h) the plant provides some supplier training in the new methods, (i) suppliers are involved in new product development, and (j) suppliers are selected on the basis of quality more than price.

(2) Zero Defects Quality Control:

Evidence for zero defects quality control could include the following: (a) use of mistake-proof (poka yoke) devices, (b) operators perform 100% source inspection at the immediate workstation, (c) the operator who makes a part is responsible for its quality, (d) the time to discover defects is minimized, (e) there are efforts to eliminate the source of quality problems rather than simply address symptoms, and (f) the plant considers the acceptable level of defects to be zero.

(3) Statistical Process Control:

Evidence for statistical process control (SPC) could include the following: (a) much of the processing in the plant is represented as being subject to SPC, (b) SPC charts are evident and appear to be actively used, (c) many hourly employees have taken some SPC training, (d) there are well-documented procedures outlining what employees are expected to do whenever their SPC charting goes out of limits, (e) there are SPC instructions and sketches for the operators at each workstation, and (f) solutions to problems are attributed to the use of SPC (such as reduced complaints from subsequent operations).

(4) Use of Charts and Feedback:

Evidence for the use of charts and feedback could include the following: (a) information on current operations is visibly available to all employees, (b) there is an overhead "scoreboard" showing production targets (scheduled versus actual), typically by the hour, (c) there are quality boards, showing defect rates over time, and (d) there are other charts such as kanban markings, boards for incoming purchased parts, job skills of individuals in work teams, and charts of machine breakdown and maintenance, to name a few.

5.2.2 Employee Involvement

As mentioned, I represented employee involvement on the manufacturing practices questionnaire with two scales. One, "small group problem solving," from Sakakibara et al. (1990), contained three items, with a reliability of 0.71. The other consisted of five items I added in order to capture the process improvement aspects of employee involvement, whether or not via groups. The items used for these two scales are shown in Appendix III.

During interviews, evidence for employee involvement could include the following: (a) there are a substantial number of process improvement suggestions per employee, (b) employees take the initiative to resolve specific problems, (c) employees do extra work without extra reward, (d) there are indicators that hourly employees make frequent small process improvements, (d) there are a substantial number of group problem-solving teams, (e) employees volunteer for group activities and projects, (f) hourly workers are included on problem-solving teams, (g) there are indicators of improvements being made by teams, (h) hourly employees share knowledge concerning methods, and (i) team members' opinions are sought and considered.

5.2.3 Choice of JIT Elements

I operationalized this construct using the process change data collected on page 7 of the manufacturing practices questionnaire (Appendix III). This portion of the questionnaire was aimed at the efforts made towards JIT rather than results and thus is more indicative of choices to pursue certain JIT elements.

The JIT elements of concern for this study match the items on the process changes portion of the questionnaire as shown in Table 4.6. Where more than one category matched a JIT element, I averaged the process change data.

I considered an element to be actively pursued at the plant if, by subtracting 0.6 standard deviations from the mean, the value remained above 3.00 (the neutral point on the "0" to "6" scale). This approach gave credit to both a high average and consistency in responses. I chose the constant 0.6 simply because it worked by making distinctions which seemed "right" over a broad range of possible responses. Higher or lower values would have led to conclusions which did not fit common sense.

The use of a value much lower than 0.6 would give too much credit, via the mean, to slightly above average responses, leading to the acceptance of rather weak results. For example, a string of completely neutral responses along with a few slightly above the mean could lead to a conclusion that the JIT element in question was being actively pursued, hardly the conclusion desired in such a case. On the other hand, the use of a value much higher than 0.6 would give too

Table 4.6

JIT Elements versus Process Change Category

JIT Element	Process Change Category (p.7)
setup reduction	reducing setup times
equipment layout	organizing equipment so that successive operations are close together
small lot size	reducing production lot sizes
repetitive master schedule	making most models each day
	levelling production to a constant daily rate
daily schedule adherence	meeting a daily schedule
	scheduling at less than capacity to meet daily plan exactly
pull system	"pulling" material from the preceding workstation
	using "kanban" signals to obtain material
JIT delivery from suppliers	reducing purchased lot sizes
	arranging just-in-time supply
supplier quality level	insisting on improved supplier quality
zero defects quality control	using mistake-proof devices for source inspection
	using machines that automatically stop when there is a problem
statistical process control	using statistical process control (SPC)
use of charts and feedback	using visual charts and feedback
employee involvement	encouraging small-group process improvement
	encouraging employee involvement in continuous process improvement

much credit, via the variance, to outliers or unusual responses. This could lead to rejection of very strong evidence on the basis of one dissenter or, even worse, rejection on the basis of one booster. For example, an additional respondent who assigned a high value to an item could change an existing assessment that an element was being pursued to one saying it was not, even though the new information would clearly support the initial conclusion. This could happen because the new value would also increase the variance of responses.

5.2.4 Management Initiatives

I did not attempt to develop quantitative operational definitions for "management initiatives." Because of the wide array of possible management actions, I decided to leave this assessment for open-ended discussion during interviews.

For each of the six management initiatives, there were many patterns of interview data which could serve as evidence. Attributes which might provide strong evidence for a construct at a given plant are outlined below. As mentioned, these are representative, not exhaustive. That is, other indicators, not outlined below, could also be used as evidence; it is a matter of judgement.

(1) Provide Workforce Security

Evidence for provision of job security could include the following: (a) management indicates that there will not be layoffs as a result of productivity improvements, (b) there is a policy or corporate culture of retaining employees through economic downturns, (c) there are formal contract provisions which restrict layoffs, (d) management promises first-line supervisors and mid-level managers that new roles will not affect their employment, and (e) there are good severance packages in case of exigencies.

(2) Promote Employee Responsibility

Evidence for promoting employee responsibility could include the following: (a) management indicates it wants employees to take more responsibility, (b) inspector positions are eliminated, (c) operators are expected to perform basic maintenance, (d) operators interact with suppliers and/or customers, (e) operators are included on various project teams, (f) business information is shared with all employees, (g) hourly employees choose their own improvement projects, (h) operators, not a quality assurance department, are responsible for quality, (i) operators have the responsibility and authority to stop production, (j) operators do their own setups, housekeeping, problem solving, and/or scheduling, (k) hourly workers and supervisors have responsibility and authority for standards setting, (l) employees have mandates to implement process changes within their own work areas without formal approval, and (m) supervisors, mid-level managers, and staff become supporters and facilitators as well as perform tasks previously done by higher-level management.

(3) Provide Training

Evidence for provision of training could include the following: (a) there are ongoing rather than ad hoc training programs, (b) training is aimed at all employees, not just salaried employees, (c) training is aimed at more than purely technical skills, (d) there is cross-training for multiple skills, (e) typical topic areas for training include JIT, SPC, problem solving skills, quality, continuous improvement, setup reduction, maintenance, team approaches, or scheduling, and (f) there is extensive initial training upon hiring.

(4) Promote Teamwork

Evidence for promotion of teamwork could include the following: (a) higher management has made it clear that the plant is proceeding in the direction of using teams, (b) time is available for team meetings, (c) people are trained to operate in groups, (d) consultants are brought in to set up teams, (e) team approaches have clear management priority, (f) hourly employees are included on initial JIT teams, and (g) there are trained team facilitators.

(5) Use Group Performance Measures

Evidence for the use of group performance measures could include the following: (a) there are few individual incentives, (b) key indicators are aimed at items such as quality, throughput, and customer service for an entire team or department rather than for individuals, (c) there are few pay classifications, and (d) line workers are paid a day rate or a salary. As well, there could be negative indicators such as an existing individual incentive scheme (piece rates).

(6) Demonstrate Visible Commitment

Evidence for the demonstration of visible commitment could include the following: (a) management clearly supports those who stop production for quality (e.g. by refusing to allow defects to leave the factory regardless of short-term financial considerations), (b) managers are on the shop floor checking closely on progress, (c) managers try to help employees resolve problems, (d) employees are retained during tough times, (e) top management gives JIT a clear high priority, (f) continuous improvement is a central part of each manager's responsibilities, (g) management is clear about the results it expects from JIT efforts; the process is top-driven, (h) employees know that it is acceptable to make mistakes while trying to improve the production process, (i) employees clearly understand where management is headed, (j) management initiates, rather than simply supports, process improvement efforts, (k) management uses deliberate stress to gain continuous improvement (e.g. forced inventory reductions, tight linkages, conveying a sense of urgency), and (l) management takes action which is difficult to reverse (e.g. closing a warehouse).

5.2.5 Plant Environment

Plant environment constructs were included as potential modifiers to help explain the conditions under which a proposition developed during analysis of the second research question might hold true. It was not clear at the beginning whether these environmental constructs would be useful as modifiers. But, for this type of research, one should include quantitative scales for constructs that have potential explanatory power even if it is not clear that the construct being measured will have a place in the resultant theory (Eisenhardt, 1989:536). If subsequent analysis shows that a particular construct is important, it is much better to have already measured it in a valid and reliable manner.

I operationalized the plant environment according to the eight constructs shown in the framework in Chapter Three. As mentioned, most of these were part of measures of a plant culture which has been shown to be related to world class manufacturing (Bates et al., 1990:24) and were developed specifically for manufacturing environments. These had already been tested for reliability and validity in a manufacturing context. However, I replaced their measure of "loyalty" with another scale, affective commitment, developed by Allen and Meyer (1990). This latter scale offered the same level of information but concentrated directly on a particular type of organizational commitment

(commitment through desire), most salient for employee involvement in the organization, rather than commitment in general, which could include other considerations such as the high cost of leaving an organization.

As well, I included scales on employee-management relations and employee influence on the employer. There is reason to believe, from the literature, that the tone of employee-management relations will have a major effect upon the extent to which JIT can be implemented. And, the degree of influence by employees in a plant can reasonably be expected to affect JIT implementation.

Table 4.7 outlines the relationship between the plant environment constructs shown in the framework in Chapter Three and the scales used for their measure. The individual questionnaire items for each scale are outlined in Appendix IV.

For interview data, there were various patterns which I would consider evidence for each construct. Attributes which might establish these patterns are outlined below. As mentioned, these are representative, not exhaustive. Other indicators, not outlined below, could also be used as evidence.

(1) Decentralization of Authority

Evidence for decentralization of authority could include the following: (a) the plant is organized by product, (b) most personnel are assigned to a specific product line, (c) the number of reporting levels in the plant has been reduced, (d) the number of management levels has been reduced (de-layering), (e) each product line or family controls many of its own staff and support functions such as quality assurance, manufacturing engineering, purchasing, or human resources. (f) staff act as internal consultants to the line and employees report they can get help from these functions when needed, (g) employees have the responsibility and authority to make certain production decisions (such as stopping the line for quality problems) without consulting a supervisor, and (h) hourly employees and supervisors are responsible for former staff functions, such as quality assurance.

Table 4.7
Plant Environment Scales

	Established Scales	Items	Reliability	Sources
Low Power Distance	Centralization of Authority (-)	5	0.77	[3] based on [1]
	Management by Wandering Around	6	0.71	[3]
Collectivism	Coordination of Decision Making	4	0.74	[3] based on [4]
	Supervisors as Team Leaders	3	0.73	[3] based on [8]
Cultural Congruence	Affective Commitment	8	0.87	[2]
	Plant-wide Philosophy	5	0.71	[3] based on [6]
	Employee - Management Relations	8	0.93	[7]
	Influence on Employer	3	0.80	[5]

[1] Aiken & Hage, 1966
[2] Allen & Meyer, 1990
[3] Bates et al., 1990
[4] Georgopoulos & Mann, 1962
[5] Magenau, Martin, & Peterson, 1988
[6] Price & Mueller, 1986
[7] Rosen, Greenhalgh, & Anderson, 1981
[8] Taylor & Bowers, 1972

(2) Management by Wandering Around

Evidence for management by wandering around could include the following: (a) managers are frequently on the shop floor talking to employees (b) manufacturing engineers have offices near the shop floor, (c) the top managers do more than simply tour infrequently, and (d) the main operations manager spends much time on the shop floor.

(3) Coordination of Decision Making

Evidence for coordination of decision making could include the following: (a) different groups work together on projects, (b) design engineers work with manufacturing on various projects, (c) manufacturing and design are located in close proximity, (d) purchasing works with engineering on supply needs, (e) there are regular, daily production meetings which include various areas of the plant, (f) there are few "walls" between departments, (g) there is an absence of interdepartmental conflict, and (h) managers are able to communicate and make joint decisions.

(4) Supervisors as Team Leaders

Evidence for supervisors as team leaders could include the following: (a) supervisors act as coaches or facilitators, to train and develop teams, (b) there is a group orientation to a supervisor's job, (c) supervisors make the assumption that hourly employees know the most about their own jobs, (d) supervisors allow and encourage hourly employees to make and act on decisions, and (e) supervisors hold regular team meetings.

(5) Affective Commitment

Evidence for affective commitment could include the following: (a) employees make positive statements about the company, (b) employees view the company as more than a place to earn money, (c) employees express a sense of attachment and belonging for the company, (d) there are expressions of high morale, (e) the rate of absenteeism is low, (f) employees volunteer for extra, often unpaid, duties, and (g) employees volunteer to join quality circles or similar teams.

(6) Plant-wide Philosophy

Evidence for a common plant-wide philosophy could include the following: (a) there is a dominant view, typically with an internal acronym or well-known overall theme, (b) hourly employees can explain, in broad terms, the mission of the plant, (c) employees see themselves as a special type, and (d) well-known stories are recounted about accomplishments of other employees.

(7) Employee-Management Relations

Evidence for good employee-management relations could include the following: (a) managers and workers state that relations are generally good, (b) there is obvious friendly interaction between managers and workers while on plant tours, (c) employees make positive statements about management efforts, honesty, etc., (d) managers make positive statements about the union and/or employee cooperativeness, etc., (e) a union organizing drive fails, (f) there is a general perception that hourly workers are treated fairly, and (g) there are no bitter contract disputes.

(8) Influence on Employer

Evidence for influence on the employer could include the following: (a) employees take actions without checking much with management, (b) employees feel they can affect how work-related problems are solved, (c) groups choose their own problems to work on, (d) employees feel free to approach and speak their minds to anyone in upper management, and (e) employees have influence in how their day-to-day work is performed.

5.3 Collection Procedures

In this section, I describe the procedures I followed for collecting data. I first discuss pilot tests and then site visits.

5.3.1 Pilot Tests

I consider site visits and interviews conducted mainly in the summer of 1989 at some fifteen plants (Piper & McLachlin, 1990) to have been initial pilot studies, at least in the sense of testing interview procedures and types of questions. After each such visit, I reviewed notes and general impressions for clues to modifying the framework, questions, or approaches. The procedure was simply to reflect on each visit as it related to the current framework using whatever information was at hand (i.e. memory, notes, brochures, etc.). Pilot studies may be much looser in approach and broader in scope than envisaged for subsequent case studies (Yin, 1989:81). Previous comments about the legitimacy of making certain adjustments during the conduct of case study research apply even more forcefully to adjustments resulting from pilot cases.

As well as the visits in Summer 1989, I visited, in Fall 1990, two plants known to have adopted JIT extensively. Here, I tested the interview protocols and questionnaires. I asked informants to provide critical comments on the procedures, the questionnaires, and the protocols, rather than simply answering the questions directly for their plants. The purpose of the pilot tests was to gain useful feedback on the logistics of the study and to test measuring instruments, not to run a pre-test in the sense of a "dress rehearsal" (Yin, 1989:80).

At one plant, I conducted separate one-hour interviews with each of three people who had been involved in previous JIT efforts. Each provided comments on the manufacturing practices and general situation questionnaires, with one manager also providing comments on the operational questionnaire. They found no major problems with the questionnaire items but provided many helpful suggestions to improve clarity. Each informant took the time to carefully review each item, point out areas where the meaning was not clear, and suggest alternatives. I incorporated most of these suggestions into the questionnaires, although I ignored some which clearly applied mainly to their plant.

At another plant, I had a one-hour interview with a manager who had been involved in JIT efforts. He provided general approval of the three questionnaires. He concluded that managers at his plant would have had no trouble completing the questionnaires or dealing with the interview protocols. He also confirmed that his general manager would have had no difficulty providing all of the operational data requested, without a need to call on others or dig through files, as all information would be either known or readily available. Furthermore, he confirmed that there would be no problem setting a "before-after" date, as respondents should easily remember the "event" leading to a switch to JIT. As well, he said that second-level managers would have had little trouble in providing dates (by year) for the start of efforts to implement each of the process changes suggested in the questionnaire, although they would probably have to guess the exact month. I also learned that I would be pressed for time, so should arrange to have questionnaires completed after, rather than during, each interview. These could then be collected before leaving the site. On the questionnaire itself, I removed one item and changed a few others as a result of this pilot.

However, as already mentioned, I later decided to use the scales developed by Sakakibara et al. (1990) in place of the majority of these items. Nevertheless, the process of pilot testing proved valuable as I received good feedback on the procedures and timing for interviews and more confidence in the scales and items which I did retain.

And, in addition to the above, I did a third pilot test at a Japanese transplant firm. Given limited access time, my purpose during this visit was to check some of my expectations based on the literature against a top JIT firm, rather than to test procedures. I did one-hour interviews with each of three managers (the general manager of manufacturing, a materials manager, and a quality manager). My major conclusion was that both my questions and expectations from the literature about JIT were reasonable as this plant was successfully pursuing most of the JIT elements outlined in the literature.

5.3.2 Site Visits

Each site visit lasted at least four days. I arranged interviews in advance, via my main contact at each plant. I suggested the type of visit I would like with respect to informants, improvement projects, tours, and so forth. Circumstances at each plant differed and schedules could not always be followed. I conducted interviews whenever and wherever I could. However, this was not a problem as I always managed to obtain a full set of source data by the end of the visit.

Despite differences between sites, a typical site visit proceeded as follows: First, after a short meeting with my main contact, I was taken on a plant tour and then spent time recording my observations. Next, I began a series of interviews, usually interspersed with ample time to write and reflect on the preceding and upcoming interviews. Each interview was either with a manager or with someone involved with one of two improvement projects chosen as a focus for discussion. In a few instances, I interviewed more than one person at a time about an improvement project.

As each interview proceeded differently, I had to be flexible in order to collect the desired data. I treated the protocols (Appendices I and II) as guides, not schedules (Miles & Huberman, 1984:46). Nevertheless, a typical interview, whether general or aimed at an improvement project, went as follows: I began with an explanation of the purpose of the study, the general areas to be explored, and procedures. I answered any questions and addressed any concerns about confidentiality and my intended use of the data. I conducted the interview in a fairly open-ended fashion, while still attempting to cover the categories of interest. Invariably, the discussion would drift and I allowed it to do so provided I was receiving information of value to the overall research. I wanted to let each informant inform me rather than simply provide answers to standard questions. Accordingly, I recorded data in free form, as it was presented during the interview, rather than attempt to fill in categories, as this would have been too stilted for an open discussion.

I asked for copies of documents as opportunities presented themselves. And, at the end of each interview, I left the informant with one or two questionnaires, as outlined previously in Table 4.3. I asked each informant to complete all items on the questionnaires with the exception of the process change items on page 7 of the manufacturing practices questionnaire. For these, I asked for answers to only those items about which the informant had direct knowledge. Near the end of the site visit, I collected the questionnaires, leaving enough time to "arm twist" a few people into completing before the end of my visit. Inevitably, I had to leave self-addressed envelopes with a few respondents (but managed later, with a few phone calls, to retrieve all but one of them).

6 Analytical Procedures

Yin (1989:109-120) outlined a number of dominant modes of analysis for case study research. I approached each of the two research questions in a different way and, thus, used a slightly different mode of analysis for each.

For the first research question, I based data analysis on the "pattern matching" procedures outlined by Yin (1989:109-113). If, for a single case, it can be shown that actual data patterns match proposed patterns, then there is good evidence for a given proposition. If these patterns can be replicated in similar cases (literal replication), the confirmation becomes stronger. And, if patterns can be shown not to hold for understandable reasons for dissimilar cases (theoretical replication), then the confirmation becomes stronger yet. Miles and Huberman (1984:239) also referred to the use of replication as the way to avoid the "holistic fallacy" in which a researcher interprets events as being more patterned and congruent than they really are.

For the second research question, I based data analysis on "explanation building" (Yin, 1989:113-115), described as a special form of pattern matching and similar to approaches outlined by Glaser and Strauss (1967) for exploratory studies aimed at hypothesis generation. For this question, I posed no propositions from the literature; rather, I attempted to explain the choices of JIT elements according to propositions developed directly from the data. However, once a proposition is stated, the overall matching procedure is the same as for the first research question.

Miles and Huberman (1984:16) pointed out that the central difficulty with using qualitative data is that methods of analysis are not well formulated, a situation they attempt to remedy with their book. They consider analysis of qualitative data to consist of three concurrent flows of activity: data reduction, data display, and conclusion drawing / verification (1984:21). These activities occur both during and after data collection. The analysis and data collection occur concurrently and inform each other. And, Glaser and Strauss (1967:71) stated that the three procedures of collecting, coding, and analyzing data should go on simultaneously to the fullest extent. The procedure is not constrained, as with survey methods, to first collecting data and then making the best of whatever analysis is possible, given the data collected. Rather, the researcher may focus on particular questions and approaches for upcoming site visits or devise new questions and procedures to fill gaps and further test propositions. As well, quantitative and qualitative data should be kept together throughout data analysis so that the meaning inherent in qualitative data is not lost whenever quantitative measures are manipulated (Miles & Huberman, 1984:21).

The procedures described below are primarily based on advice found throughout Miles and Huberman (1984), but including, Glaser and Strauss (1967), Eisenhardt (1989), and Yin (1989).

6.1 Procedures After Each Interview

As soon as possible, after each interview, ideally in the time scheduled between interviews, but never more than 24 hours later, I filled-in and clarified the original "scribble notes." This worked fairly well. There was not enough time during each interview to be complete but it was easy to provide a reasonably complete account of the scribbled field notes. As well, I added my own observations as circumstances required, but clearly identified these as mine so not to contaminate the original data. These observations might concern such items as my judgement of the reliability or knowledge of an informant, notes to myself to explore certain avenues with other informants, or comments on possible themes.

Then, I transcribed the notes to electronic form, usually the evening of the interviews. But, unlike the imperative to round out the scribble notes, it was not quite so critical to do this immediately. Nevertheless, the earlier, the more clarification I could confidently add to the written notes. Next, I coded the electronic field notes using a standard set of codes I developed for this study, following suggestions of Miles and Huberman (1984:54-64). These codes were based on the research framework but adjusted for usefulness as the study progressed. They are outlined in Table 4.8.

Table 4.8 - Standard Codes

Code	Category
CENTRAL	(De)centralization
MGMTVIS	Management by Wandering Around
COOR	Coordination of Decision Making
SUPV	Supervisors as Team Leaders
COMMAFF	Affective Commitment
PHIL	Plant-Wide Philosophy
RELATIONS	Employee-Management Relations
EMPINFL	Influence on Employer
SECURE	Employment Security
RESP	Employee Responsibility
CAP	Capability Enhancement (Training)
TEAM	Teamwork
MEAS	Performance Measurement
VISCOMM	Visible Commitment
EI	Employee Involvement
SETUP	Set-up Reduction
LAYOUT	Equipment Layout
SMLOT	Small Lot Size
RMS	Repetitive Master Schedule
DAILY	Daily Schedule Adherence
PULL	Pull System
JITDEL	JIT Delivery from Suppliers
SUPPQUAL	Supplier Quality Level
ZQC	Zero Defects Quality Control
SPC	Statistical Process Control
CHARTS	Use of Charts and Feedback

6.2 Procedures After Each Site Visit

As already pointed out, I treat each individual case as a whole study leading to definite conclusions, with the conclusions themselves, not the individual variables or patterns, being the object of replication (Yin, 1989:57).

After each site visit, I: (1) used the coded field notes to develop a new electronic file, sorted by category (i.e. code) rather than data source, (2) used the questionnaire data to include quantitative measures of various categories, (3) reduced the qualitative and quantitative information to verbal and numerical ratings along with a summary paragraph for each category, and (4) placed the condensed information in a summary display for the plant. Thus, I followed suggestions by Miles and

Huberman (1984:21) to: "Keep the numbers, and the words you used to derive the numbers, together in your ensuing analysis. That way, one never strips the data at hand from the contexts in which they occur."

As well, I used the "process change" information on the seventh page of the manufacturing practices questionnaire (Appendix III) to operationalize the choices and sequence of JIT elements, as described earlier.

6.3 Procedures After All Site Visits

The analytical procedures differed slightly for two research questions, as the analysis for the first question addressed literature-derived propositions whereas the analysis for the second derived propositions from the data. These procedures are described in turn.

For the first research question: "What explains how well firms are able to implement elements of JIT?," I used the summary displays from the individual cases (Chapter Five) to produce a cross-site display of summary ratings for each category of interest for each site (Chapter Six). The purpose of producing this display was to put all summary site information in one place for cross-site analysis. I then considered each proposition in turn, testing each on a case-by-case basis. That is, I accepted or rejected the proposition according to just the one case under consideration at any one time. The criteria here were quite severe. Any one case which is clearly counter to a proposition is good enough evidence to reject the proposition, regardless of the results from the other cases. This fits nicely with the notion that theories should be falsifiable in order to be useful (e.g. Swamidass, 1991:805).

For the second research question: "What explains the choices by firms to pursue particular elements and implementation sequences of JIT?," I represented the "choices" construct by both the number of JIT elements pursued and the sequence of their pursuit. I attempted to explain similarities and differences in JIT efforts by considering first similarities and differences in plants' environments and then considering other plausible factors.

Similar to procedures for the first research question, I considered each case, in turn. However, with this explanatory approach, I modified each proposition, as required, according to the data in each case and in light of the most recent state of the data-derived proposition. And, each modification had to satisfy all cases considered to that point (Yin, 1989:115). When a specific site does not fit the model, the researcher must change the model to accommodate the inconvenient information, not ignore it (Miles & Huberman, 1984:195). I examined subsequent cases in light of the proposition, as modified.

7 Summary

In this chapter I outlined the research methodology, the rationale for using a case-based research approach, the sites visited, data collection methods and analytical procedures. In the following chapter, I report the results and provide a summary table of findings at each individual site.

Chapter Five: Findings from Site Visits

In this chapter, I report the findings from each of the site visits. I provide summary descriptions and ratings for categories outlined in Chapter Three, using the data reduction techniques outlined in Chapter Four.

I use the following rating scheme to indicate the extent to which a particular construct was evident at a particular site: None (0), Marginal (1), Some (2), Partial (3), Considerable (4), Substantial (5), and Extensive (6). Operational definitions were outlined in Chapter Four with representative patterns which would indicate extensive evidence of a construct. A summary table for each plant is provided at the end of each of the following six sections. And, a summary of the ratings for each category for all plants is provided in Chapter Six (Table 6.1).

1 Plant A

Plant A is located in central Canada, is unionized, and currently employs over 300 people. It is a branch plant of a U.S. parent. It has three main product lines. One of these has just been moved from a sister plant resulting in a workforce increase of roughly 80%. It is mainly a supplier to original equipment manufacturers, delivering about 60% of its material on a JIT basis. Its operations are 40% repetitive assembly, 40% batch, and 20% job shop. It operates in a niche market on an make-to-order basis, with a typical order size in the hundreds. The product is reasonably complex with about five levels in the bill of materials and, in total, over 2000 different part numbers.

1.1 Management Initiatives

1.1.1 Provide Employment Security (Rating: Marginal (1))

There are no promises of job security and it is not currently a negotiating issue for the collective bargain. As one respondent reported: "There is no protection for improvements. Management is trying to automate and cut positions. People know that they are not safe." However, the current management is more aggressive at getting new business and employees see this as a form of security.

1.1.2 Promote Employee Responsibility (Rating: Some (2))

At the level of managers and, to some extent, supervisors, the general manager assigns goals and leaves it to the assignees to determine how to meet them. There are no organization charts. This is done purposely to empower managers and supervisors and means their responsibilities become blurred. But, there is no doubt at the plant as to who is in charge. As one respondent put it: "The general manager calls the shots here."

In spite of these efforts to "empower" people at the managerial level, there is very little in the way of promotion of employee responsibility at the hourly level. In general, hourly workers are treated as being limited in scope, in particular with respect to time horizon and difficulty of the tasks they can handle. The short cycle times on the line mean that, although responsibility has been passed down because of the de-layering of the plant, hourly workers are still only responsible for limited, repetitive tasks.

As stated by one respondent: "Management must stop looking at blue collar workers as dummies. There are still some top managers within this plant who think that the only function of blue collars is to get out the work." And according to another: "We're not dummies. Somebody has to work in the factories. This doesn't say you're 'no-brains.'"

Employees have neither the authority nor responsibility to stop the line for problems. Feedback on defects comes via others on reject analysis sheets, not from employees being made responsible. One respondent confirmed: "The operator doesn't have control. An operator would not stop production on her own."

1.1.3 Provide Training (Rating: Marginal (1))

Overall, there is very little training being done to enhance the capabilities of the workforce. The capabilities of the people are addressed during the screening of job applicants but not much after that.

There are, for all practical purposes, no training initiatives. Currently, there is not enough time for training so the best they can do is some on-the-job help but the helper typically has to run to other duties, as well. As a respondent noted: "We're pushed into getting production and pushed into efficiencies." Training for a person rotated to a new position would consist of 15 to 30 minutes of help from a supervisor with a few check-ins during the day. This lack of training was confirmed by a fair number of respondents.

As well, In the particular case of training for Statistical Process Control (SPC), a number of sources confirmed that there was little to none, in spite of a fairly extensive use of SPC charts. As one respondent reported, the employees will not have the theory, just the rote actions.

There has been some training in the past but now there is no time or money for it. The reported attitude from head office does not support training, preferring "de-skilling" instead.

The thrust to operate with minimal training is evidenced by doubling up workers at workstations and having the tasks split so that half of them require very little skill or training. This makes it easy to increase volume quickly by pairing each employee with a temporary employee.

1.1.4 Promote Teamwork (Rating: None (0))

There is no evidence of management promotion of teams, although there are nominal teams on the new line. There have been informal efforts by one supervisor but everyone is too busy right now.

This lack of any effort to promote teamwork was confirmed by one manager who said: "Once the big operations problems are out of the way (i.e. when 99% of the items are good first time), we can look at throwing problems out to the groups." And, the general manager views teams as unnecessary if lead times and cycle times can be reduced enough.

When asked about quality circles, one respondent said: "We never, ever had quality circles. The previous people did not believe in them. I never participated in a quality circle."

1.1.5 Use Group Performance Measures (Rating: Marginal (1))

Employees work to standards set by the manufacturing engineers. But, there are no piece rate incentives; it is strictly hourly-rated jobs. The only incentive is to make rate within 30 days in order to keep the job.

At present, the corporate parent is insisting that they return to measuring daily individual efficiencies and daily machine utilization. This goes against recent management attempts to use a form of group-oriented measure for an entire line where the main measure had been units per manhour. Consequently, there will be no group measurement in the foreseeable future.

1.1.6 Demonstrate Visible Commitment (Rating: Some (2))

There is no reported commitment whatsoever from headquarters for anything which might resemble JIT-like manufacturing. However, the managers and supervisors at the plant are committed to throughput reduction and the associated layout changes, although not committed to implementing other JIT elements. Employees understand that management is determined to proceed in a given direction, namely, continue to with the "progressive line" approach.

1.2 Employee Involvement

1.2.1 Employee Involvement (Rating: Some (2))

There is little employee involvement in continuous improvement except for the few employees who discover better ways on their own initiative. For example, one employee found a way to run his machine so to avoid a following operation but used this knowledge to allow extra breaks, not to help the plant improve. As well, there is no employee involvement in setting standards. Input is not typically solicited from workers; the managers just come up with ideas and put them in place.

There were instances of employee involvement such as dramatically improving the percentage of parts requiring a patching operation from 100% to only 2.4%

and a reaming operation from 100% to 0%. However, the investigation and analysis of root causes was all done by quality assurance personnel, not operators. Two of them were assigned the job of bringing rejects down over a six-month period. Problems were easy to find but getting solutions was more difficult because operators would blame vendors or other areas of the plant rather than admit that the problem might be in their own areas.

One interviewee explained that there used to be a suggestion system which paid for suggestions up to a maximum of $2000. However, it was apparently not run fairly, with some people chosen regularly for rewards, so it died. This is confirmed by operational data in which the average number of improvement suggestions per employee per year is reported as nil.

As well, there was some small group problem solving in the past. However, there is absolutely none now. This is unlikely to change in the near term, given the recent directives from the head office. One respondent noted that there was no time for group activities because of production requirements. And another said that there are no quality circles and never have been.

In arriving at an overall assessment, I am discounting the questionnaire data for employee involvement (before: 1.700; now: 2.933) and the extent of group problem solving (before: 1.667; now: 2.556) in favour of evidence from the interviews.

1.3 Flow

1.3.1 Setup Reduction (Rating: Some (2))

There were a few examples of single-minute setups, but these are not the rule.

There is no major effort towards any overall setup reduction program. Existing efforts are machine-based and do not involve teams.

Setup reduction is not being seriously pursued. One interviewee said: "Our machines are old, and we're slow in changeovers. For example, today we had four or five changeovers. Each took about one hour. Then we would run about 250 parts for 20 minutes and changeover again."

The questionnaire data confirms this assessment with low ratings both before and after the recent changes (1.375 and 1.917).

1.3.2 Equipment Layout (Rating: Considerable (4))

They have done a fair amount of work on linking operations. The new product line has processes linked and low levels of WIP. There is no use of "cells" as the new line is sequential or "progressive" and the old lines were not set up with cells in mind.

Their main emphasis is on throughput and this is supported by the sequential layout. The throughput time is now down to less than five days on one line and 45 minutes on the sequential line. They approached work-in-process reduction by taking out rework and then, when down to value-added activities, asking what it was logical to link. One respondent said that linking operations was "a real plus," the biggest thing the general manager did.

The questionnaire results also indicate that equipment layout is the most emphasized of the JIT elements considered in this study (before: 3.167; now: 3.889).

1.3.3 Small Lot Size (Rating: Partial (3))

They have fairly small batches (usually in the 250 to 500 range) because of the nature of the business (i.e. a custom producer). However, they run a complete order before changing to another, so are not really aiming at implementing small-lot production.

They are producing in larger batches on one product line and in the fabrication areas. According to one interviewee: "We are still mired in the batch mentality."

The questionnaire results indicate a fair degree of small-lot production (before: 2.667; now: 3.667). Nevertheless, I am discounting this here because the lot size is still above 100 and there are no attempts to reduce it.

1.3.4 Repetitive Master Schedule (Rating: Marginal (1))

There is no mixing of models because of the nature of a custom, make-to-order business. They must batch in the fabrication areas because they cannot level the schedule. Simultaneous work on different products at different workstations is the closest they get to mixing. The questionnaire results confirm this, with low ratings for a repetitive master schedule (before: 2.333; now: 1.556).

1.3.5 Daily Schedule Adherence (Rating: None (0))

They are currently attempting to produce as quickly as possible to deal with the backlog, so there's no effort at all to adhere to a daily schedule, and certainly not in the sense of stopping production early for, say, maintenance or meetings if a schedule is met before the end of a shift. The questionnaire confirms this (before: 1.500; now: 1.889).

1.3.6 Pull System (Rating: Some (2))

The only evidence of a "pull" system is the new line which is organized sequentially with limited room for work-in-process. There is no evidence of any pull or kanban-like signalling aside from the operation of the sequential line itself.

The evidence from the questionnaire shows ratings of 2.438 before and 3.063 now. These may be broken into those items from Sakakibara et al. (before: 2.700; Now: 3.600) and those items which I added (before: 2.000; now: 2.111). The difference can be partially explained by noting that the items in the former scale include "layout" as part of the measure for a "pull" system whereas the items I added concern the signalling aspects of a pull system, with the production rates being delivered only to final assembly, both of which are clearly not operating here. This, in turn is confirmed by the low ratings (before: 1.000; now: 1.000) on the "kanban" portion of the questionnaire.

1.3.7 JIT Delivery from Suppliers (Rating: Some (2))

There are no indications of daily shipment and delivery and few weekly deliveries. The general manager spoke of working on vendors in the future to obtain two-week lead times. In many cases, suppliers are large firms with a long lead time on raw materials. There are some small-lot deliveries but these are typically drawn on consignment from a larger batch shipment. The questionnaire shows ratings of 1.625 before and 2.333 now.

1.4 Quality

1.4.1 Supplier Quality Level (Rating: Partial (3))

Supplier certification is still in the planning stage. There are plans to establish partnerships but nothing has been done so far.

There have been a few attempts to begin this process such as hosting a vendor day. But, there have few been efforts at supplier qualification or audits. Changes in management led to the process dying.

The next tasks, according to one respondent, are to do supplier certification and work on partnerships. As well, trying to help improve suppliers' processes is seen as something for the future.

However, there is a form of certification in which some suppliers guarantee results, so they are not required to undergo incoming inspection.

The questionnaire results confirm the above, in that they indicate neutral levels for supplier quality efforts, namely, before 2.250, and now 3.333.

1.4.2 Zero Defects Quality Control (Rating: Considerable (4))

Overall, this plant does not do zero defects quality control in the sense of doing 100% source inspections immediately at the operators' workstations with the aid of mistake-proof devices. However, they do some things which aim in this direction. They do 100% testing at the repair station, mainly for noise and vibration, and again at final audit.

They must do 100% inspection because of CSA regulations but choose to do more, as well. They are also trying to open up the feedback loop from the repair and testing area to the operators. So, there is some feedback to the source, even though this process is not operator controlled and not being done directly at the workstation. One respondent said they have "foolproofed all the final parts coming into assembly so it's impossible to make bad parts."

They have had hourly employees doing 100% source inspection in the past but these efforts have been dropped because of the workload. However, these past efforts clearly did not include any mistake-proof devices. One interviewee pointed out that they have someone on repair to build up shortages (i.e. to make up for bad quality after an order is finished). Another respondent commented on a lack of source inspection: "Production normally runs and sorts. That is, they don't stop for problems."

The questionnaire reflects the improvements in source inspection, with values of 2.000 before and 3.667 now.

1.4.3 Statistical Process Control (Rating: Partial (3))

The plant is engaging in some SPC. As one respondent pointed out: "We have SPC on some critical areas, but a very small percentage." As well, in some places, the overall variability of mated parts is being reduced by measuring and matching the parts to obtain critical dimensions.

A tour of the plant revealed apparent extensive SPC activity. However, from the operators point of view, it is just rote action, not analysis. Employees, do not know the theory behind SPC, are not trained in SPC techniques, and do not know how to follow up when there are problems. They simply record the data and, if the points are out of bounds, they call a quality assurance person. As one interviewee said: "People don't understand the reasons for SPC charts. They think you're checking up on them. For example, one guy's chart was always 'right down the middle.' He finally resigned. He thought we were charting him."

One interviewee commented on the the overall SPC effort by saying: "Some of the problems are our fault for putting charts all over the place without asking ourselves if we're doing the right things."

The questionnaire results (before: 1.250; now: 3.250) support the increase activity in SPC as well as the notion that SPC activity now is, at best, neutral.

1.4.4 Use of Charts and Feedback (Rating: None (0))

There is no use of charts and feedback for communication. The only evidence of charting had to do with SPC which is not addressed under this category as it is aimed at overall communication. The questionnaire results (before: 0.700; now: 1.333) confirm the low rating.

1.5 Plant Environment (Context)

1.5.1 Decentralization of Authority (Rating: Partial (3))

Overall, the plant is neither highly centralized nor highly decentralized but has indications of both. The centralized elements concern the extent to which the certain managers and employees can make certain types of decisions. The decentralized elements concern the number of management layers between the general manager and the hourly employees.

The organization has been flattened, with one layer removed. For example, there are now four supervisors supervising 300 hourly workers. Nevertheless, hourly employees do not necessarily make more decisions or more demanding decisions simply because of de-layering. They are still faced with simple tasks with no input into major decisions.

The thrust in the organization is to reduce cycle and throughput times such that hourly employees can handle tasks without much supervision. This also means that there is little need for them to handle the increased responsibility which might typically occur when an organization decentralizes. The same does not apply to managers and supervisors.

The general manager does not believe in organization charts; he wants to empower the managers and supervisors to sort out problems, take a few risks, and show their capabilities.

As well, the data from the questionnaire rates the degree of decentralization as neutral, both before and after recent changes, with no significant difference between the two ratings (before: 2.933; now: 2.833).

1.5.2 Management by Wandering Around (Rating: Considerable (4))

Management is reasonably visible on the shop floor. On a number of visits, the various managers could usually be seen on the shop floor. The appearance was always one of managers who were there for specific reasons and were comfortable doing so, as opposed to simply making a tour.

One manager reported spending about 80% of the time coordinating production, either out on the floor, in meetings, or expediting. And, the general manager reported spending about 20% of his time on data collection of various sorts, about 40% with people or machines trying to understand modifications of the current system, and about 40% trying to implement changes based on the above.

However, in the past, the manufacturing engineering function had been located on the shop floor but had moved back to the office, about five years ago, to be closer to the designers.

The questionnaire indicates a more neutral level of management by wandering around (before: 2.944; now: 3.028).

1.5.3 Coordination of Decision Making (Rating: Some (2))

The coordination between departments is not good. There are new demands being made of supervisors and managers which require more interaction and initiative. However, interviews revealed a fair number of instances where different areas of the plant were in disagreement or operating at cross purposes. These include problems between manufacturing and marketing and between quality assurance and engineering. One interviewee reported "lots of backstabbing." And there were a number of indications of friction between people responding positively to the "looser" form of organization and those who would prefer more structure.

The main form of departmental coordination seem to be through the weekly meetings and the subsequent actions taken by the managers and supervisors.

The questionnaire results (before: 3.042; now: 1.917) indicate that the level of coordination was neutral in the past and is now at a lower level.

1.5.4 Supervisors as Team Leaders (Rating: None (0))

Bluntly, supervisors are not asked to nor do they act as team leaders. This is because the general manager does not believe supervisors are that necessary. The reasons, in turn, for this point of view have to do with a thrust to reduce cycle and throughput times. This was confirmed by comments from one interviewee who said: "But, the general manager does not think supervisors are needed on the floor."

The general manager also said: "We picked a different way. We decided to compete on time. So, you shrink tasks to one week and this eliminates the need for supervisors because the hourly people are capable of the one-week time horizon. The supervisor is more a materials handler and someone to fill in rather than a coach."

There would be no time for other activities anyway as the supervisors reported being very busy, even before the new line. One interviewee reported that the employees do not tend to go to supervisors and the supervisors do not seem to and probably do not have time for them.

The results of the questionnaire indicate that the role of supervisor as a team leader was not that high before and has dropped significantly since the recent changes (before: 3.444; now: 2.500).

1.5.5 Affective Commitment (Rating: Partial (3))

There are few indicators of loyalty to the firm. Loyalty and morale have dropped somewhat recently, although people are more frustrated than alienated. One respondent said that the attitude of the people on the floor is really bad, one of frustration.

As confirmed by a number of managers, employees' main, and usually sole, reason for showing up is for the paycheque. One respondent said that there was a small number who were loyal, many there for their paycheque, and 5% who were problems.

The comments obtained during interviews make the situation seem worse than indicated by the questionnaire which indicated that there had been affective commitment (or loyalty based on desire) and that this has now dropped to a more neutral measure (before: 4.062; now: 3.354).

1.5.6 Plant-Wide Philosophy (Rating: Some (2))

There was a more common plant-wide philosophy before the recent changes. At present, a number of forces are pushing in different directions. Employees are trying to accommodate to the more flow-like methods but not always by "climbing on board." There are areas of disagreement over what is to be done and why. There is no sense of an organization in which the majority of managers and employees are pulling in the same direction.

One major difference in philosophy concerns the view of the corporate parent versus that of management at the plant with respect to what to measure and what to pursue. The parent company was reported as very traditional with respect to job design, cycle times, and training. Until recently, they had been successful, operating primarily on low wages. Currently, they are reacting to financial difficulties by insisting that the plant revert to traditional approaches such as building to inventory, measuring efficiencies, and concentrating on quarterly performance. These differences are also reflected within the plant, as some respondents agreed with recent new approaches and some preferred the more traditional approaches now being insisted on by the parent.

There are also differences in plant-wide philosophy over the sequential or "progressive" nature of the new line. Some interviewees did not understand why management was so insistent on running things this way. One commented: "...there are always new managers. We must change our style all the time. One guy leans in this direction, the other in another. It's difficult to adjust to new management. Each has his own philosophy."

The results of the questionnaire indicate that the degree of plant-wide philosophy has dropped (before: 3.560; now: 2.760) to a less than neutral level.

1.5.7 Employee-Management Relations (Rating: Partial (3))

The main sense of employee-management relations is one of employees and management getting along but with certain growing frustrations at the same time as walls between them decline. There is no apparent hostility, rather people appear resigned to somewhat tedious jobs.

There is no bad history of employee-management relations but there had been a real wall between hourly and salaried workers. It's not so bad now, but it's still there. According to one respondent, they are "not a close knit family."

There is frustration by employees over classification, apparent unfairness in the treatment of employees, apparent dishonesty, and apparent violation of the contract rules. As one respondent said: "Managers here don't treat people like the Japanese do. We have good union relationships, but you must treat people properly." And, according to another: "If the union wasn't there, management would screw the workers." However, there are no major union-management negotiating issues. They report receiving about six grievances per year.

Another said: "There are lots of people who are scared to speak to the boss. If the boss said to paint the floor purple, they would do so even if they knew it was wrong. The bosses like it that way."

The questionnaire reflects this frustration by showing a drop from reasonably good employee-management relations in the past (3.812) to the neutral zone currently (2.792).

1.5.8 Influence On Employer (Rating: Some (2))

The questionnaire results indicate that employees have very little real control over work-related problems. The levels in the past were below a neutral position and they have dropped to a lower level since (before: 2.889; now: 2.167).

There were no indicators that hourly employees feel that they have any real influence. Some degree of influence is exercised via the union, but not much.

1.6 Summary

In the following table, I summarize the findings by category for Plant A:

Table 5.1

Summary - Plant A

Management Initiatives		
Provide Employment Security	Marginal (1)	There are no promises of job security. However, the current management is more aggressive at getting new business and employees see this as a form of security.
Promote Employee Responsibility	Some (2)	For managers and, to some extent, supervisors, the general manager assigns goals and leaves it to the assignees to determine how to meet them. In general, hourly workers are treated as being limited in scope, in particular with respect to time horizon and difficulty of the tasks they can handle.
Provide Training	Marginal (1)	Overall, there is very little training being done to enhance the capabilities of the workforce. The capabilities of the people are addressed during the screening of job applicants but not much after that.
Promote Teamwork	None (0)	There is no evidence of management promotion of teams, although there are nominal teams on the new line. There have been informal efforts by one supervisor but everyone is too busy right now.
Use Group Performance Measures	Marginal (1)	At present, the corporate parent is insisting that they return to to measuring daily individual efficiencies and daily machine utilization. This goes against recent attempts on their part to use a form of group-oriented

		measure for an entire line where the main measure had been units per manhour.
Demonstrate Visible Commitment	Some (2)	There is no commitment whatsoever from headquarters for anything which might resemble JIT-like manufacturing. The managers and supervisors at the plant are committed to throughput reduction and the associated layout changes; however, they are not committed to implementing other JIT elements.
Employee Involvement	Some (2)	There is little employee involvement in continuous improvement except for the few employees who discover better ways on their own initiative. There was some small group problem solving in the past. However, there is absolutely none now.
Flow		
Setup Reduction	Some (2)	There are a few examples of single-minute setups, but these are not the rule. There is no major effort towards any overall setup reduction program. What efforts there are are machine-based and do not involve teams.
Equipment Layout	Considerable (4)	They have done a fair amount of work on linking operations. One of the new product lines has linked processes and low levels of WIP. Their main emphasis is on throughput and this is supported by the sequential layout.
Small Lot Size	Partial (3)	They have fairly small batches (usually in the 250 to 500 range) because of the nature of the business (i.e. a custom producer). However, they run a complete order before changing to another,

		so are not really aiming at implementing small-lot production. They are producing in larger batches on one product line and in the fabrication areas.
Repetitive Master Schedule	Marginal (1)	There is no mixing because of the small orders and the nature of a custom, make-to-order business. They must batch in the fabrication areas because they cannot level the schedule.
Daily Schedule Adherence	None (0)	They are running flat out to get as much production as possible to deal with the backlog, so there's no effort at all to adhere to a daily schedule, and certainly not in the sense of stopping production early for, say, maintenance or meetings.
Pull System	Some (2)	There is no evidence of any sort of pull system except that one of the lines is organized sequentially with limited room for WIP. But there are no standard pull system rules.
JIT Delivery from Suppliers	Some (2)	There are no indications of daily shipment and delivery and few weekly deliveries. There are small-lot deliveries (30% to 40%) but these are typically drawn from a larger batch shipment.
Overall JIT Flow	(2.00)	
Quality		
Supplier Quality Level	Partial (3)	Supplier certification and partnerships are still in the planning stage. There are plans to establish partnerships but nothing has been done so far. However, there is a form of certification in which some suppliers guarantee results so are not required to undergo incoming inspection.

Zero Defects Quality Control	Considerable (4)	They do not do zero defects quality control in the sense of doing 100% source inspections immediately at the operators' workstations with the aid of poka yoke devices. However, they do things which aim in this direction, such as 100% testing at the repair station and attempts to feed defect information back to the source.
Statistical Process Control	Partial (3)	There is SPC on some critical areas. However, from the operators' point of view, it is just rote action, not analysis. Employees, however, do not know the theory behind SPC, are not trained in SPC techniques, and do not know how to follow up when there are problems.
Use of Charts and Feedback	None (0)	There is no use of charts and feedback for communication, only that having to do with SPC.
Overall JIT Quality	Some (2.50)	
Plant Environment (Context)		
Decentralization of Authority	Partial (3)	The organization has been flattened with one layer removed but hourly workers are still faced with simple tasks and no input into major decisions.
Management by Wandering Around	Considerable (4)	Management is reasonably visible on the shop floor, spending time dealing with production and other problems.
Coordination of Decision Making	Some (2)	The coordination between departments is not good. They are still sorting out many new roles, so there is a fair amount of conflict between departments.

Supervisors as Team Leaders	None (0)	Supervisors are not asked to nor do they act as team leaders. This is because the general manager does not believe supervisors are that necessary.
Affective Commitment	Partial (3)	There are few indicators of loyalty to the firm. Loyalty and morale have dropped somewhat recently. Employees often show up just for the paycheque but are more frustrated than alienated.
Plant-Wide Philosophy	Some (2)	Forces are pushing in different directions. There are many areas of disagreement over what is to be done and why.
Employee-Management Relations	Partial (3)	There is no bad history although there were walls between employees and management. They "get along", with walls declining, but with certain frustrations over apparent unfairness in the treatment of employees.
Influence on Employer	Some (2)	Employees have very little real control over work-related problems except for some degree of influence exercised via the union.

2 Plant B

Plant B is a branch plant of a U.S. parent, located in central Canada, and a sister plant of Plant D. It is unionized and currently employs about 750 people. There are three main product lines. It has been involved in team approaches to production and quality circles for the past decade. Recently, it has been changing from a make-to-stock to an assemble-to-order operation.

It is an original equipment manufacturer, delivering to a number of major retailers, among others. Its products are reasonably complex, with bills of material about six levels deep, and a total of about 2600 parts.

At present, it delivers about 45% of its units on a direct shipment basis, loading directly into a truck destined for a particular customer. Its operations are about 2/3 repetitive assembly and 1/3 batch. Its typical order size is in the hundreds of units.

2.1 Management Initiatives

2.1.1 Provide Employment Security (Rating: Marginal (1))

At Plant B, there are no specific employment guarantees and there is some insecurity as a result of some recent layoffs. One interviewee stated that it was well known that there are too many people, so people, including middle managers are insecure. As well, the number of supervisors has been reduced. This produced insecurity in the supervisors and, in turn, was seen as a factor in reducing the security and morale of the hourly workers.

However, there are indications that management is doing what it can to minimize the harm. They retained 25 employees for special projects rather than laying them off. This was reported by a fair number of respondents and provides some measure of management's good intentions.

There are no indicators that increased sales are around the corner. However, one respondent pointed out that this is all that would be needed to provide a sense of confidence, in his opinion, among people in the plant. One respondent pointed out that management shows sales and cost figures to employees; they do not hide anything. One manager said that they are trying explain to employees that they are attempting to increase volume but it has not happened yet. Consequently, there are still problems. Overall, however, employees seem to understand that survival is based on productivity and participation.

2.1.2 Promote Employee Responsibility (Rating: Extensive (6))

There is a strong, consistent message that management wants hourly employees to take ownership and responsibility. Recent decentralization being promoted by management also has the effect of pushing employee responsibility further down in the organization. As well, they have used and promoted quality circles for the past decade. This has had the effect of encouraging responsibility on the part of employees.

There are numerous examples of efforts to increase employee responsibility, including: (1) eliminating inspector positions, (2) having operators perform basic maintenance, (3) sending operators to suppliers and bringing suppliers to talk to operators, (4) including operators on initial analyses for setup reduction, (5) providing employees the same business information as managers receive, (6) arranging contacts between operators and dealers and service people, (7) putting kanban markings on the floor and then remaining there with employees at that point until it was clear that employees understood it was their responsibility to control materials, and (8) promoting quality circles in which hourly workers choose the projects to work on. These, and other examples, were pointed out by most of the people interviewed and are clearly central to the organization.

Supervisors and middle managers clearly see their role as one of "coaching." They provide the overall goals and guidance rather than simply command. There is much evidence of operators taking on and solving problems themselves. For, example, one manager set the challenge of reducing the cycle time but the employees took it from there and solved their own problems in order to meet the challenge. Another manager commented that the employees know the priorities, namely, the company goals which he's made clear, but they decide how to meet them.

Also, as a manager explained, one reason they do not do incoming inspection is that line workers are responsible for the quality of incoming parts, so, if there is a problem, the supplier will hear about it quickly.

2.1.3 Provide Training (Rating: Substantial (5))

There is a strong emphasis on planned ongoing training at Plant B. One manager reported a positive feedback effect between training and participation. That is, the more employees got of one, the more they wanted the other.

Another manager outlined five types of training programs, namely, technical training, a training the trainers program, hands-on training, global training, and interaction training.

Training includes intensive sales training for customer service, numerous special courses, JIT and TQC courses, a program aimed at "permanent culture improvement" based on the three zeros (zero inventory, zero delays, and zero defects), preventive maintenance, cross-training, kanban training, ergonomics, leadership efficiency, and various technical courses.

A manager mentioned that one of the operators' problems is fear of not being able to express themselves when they want to get their facts across, so they also show operators how to get their facts across using SPC graphics.

2.1.4 Promote Teamwork (Rating: Extensive (6))

In spite of lesser emphasis recently, management has been actively promoting teamwork for the last decade. They have done so by facilitating the efforts of hourly employees, mainly through quality circles. The volunteer rate on quality circles has been more than 30%. They were one of the few plants to succeed with quality circles for more than three years, and the teams are still functioning. As one manager said: "At other plants, there was no management commitment. But we were committed; we believed, and we gave quality circles priority." However, he added that they have slowed down lately in paying attention to quality circles. They are now re-emphasizing this with a push to semi-autonomous groups.

Management promotes teamwork in a number of ways, including, (1) making time available for meetings, often by having floaters cover for attendees, (2) training people to operate in groups, (3) bringing in consultants to set up teams, (4) giving quality circles clear management priority and (5) encouraging teamwork in work cells.

One manager said he tries to avoid one-on-one coaching because it counters the team approach, leading employees to think there are favourites. Instead, he tries to meet employees as a group and suggest things to the group, never just to one.

2.1.5 Use Group Performance Measures (Rating: Partial (3))

The company operates according to some group measures and some individual piece rates. The whole company is measured on fill rate or the percentage of time they meet their "agreed" time targets from the receipt of an order to a customer's receipt of the goods. As well, they have a measure for service call rates.

But, they still have piece work in some areas. They are trying to break piece rates as well as move towards fewer job classifications. Trades have gone from 10 or 12 down to one classification but, in assembly, there are still too many.

They have piece rate incentives on one of the assembly lines and in some fabrication areas. The particular assembly line is still on piece work because it is the only line which has not had major changes lately. Unless they change equipment significantly, they must keep the piece rates the same, according to the contract. But on other lines and in other areas they are on "measured day work." There was a proposal to replace piece rate incentives with gainsharing, but the vote did not yield a large enough margin.

2.1.6 Demonstrate Visible Commitment (Rating: Substantial (5))

There are a number of signs that management is visibly committed to JIT-like approaches.

One example concerns having auditors responsible for acting as consumer representatives. As one manager pointed out, if there is a major problem, the auditors have the authority to stop the loading of the truck. Quality was lost as a priority for awhile because of the pressure for the truck to be loaded (as part of a "make and ship to order" initiative). But now, the policy is to make changes on the spot, if an auditor stops the loading. Only when the problems are fixed can the truck leave. As well, they have three rover inspectors who make sure that production is consistent with the bill of materials for new models and so forth.

Also, one respondent told of the former plant manager, described as always making a point of being on the floor each morning. Another manager is either on the floor or in meetings, but never in his office. He explained that they concentrate on cycle time, so he must be on the floor to try to help employees resolve their problems.

Another example of visible commitment concerns the way they retained the 25 employees for special projects rather than lay them off in face of the recession. This was noted by others and a common point of discussion during interviews.

The only negative comment was from one respondent who felt they had a bad tendency to try to rake in benefits too early, when they should have more patience.

2.2 Employee Involvement

2.2.1 Employee Involvement (Rating: Substantial (5))

Group problem solving centres around quality circles which have been used here for the last decade. Quality circle meetings are held for one hour per week. The groups choose their own problems and call others as needed. At present, there are at least 33 volunteer quality circles, comprising about 25% of the workforce.

As well as quality circles, some other involvement activities are reported, such as working on service call rates, preventive maintenance, and kanban (most groups have kanban teams).

One good example concerns the employees, mentioned earlier, in a feeder area who exhibited a great degree of influence. They dealt with the threat of jobs being contracted out to Mexico by proceeding to improve the process so much that the work was saved along with half of the jobs (rather than lose them all). They had been told by management that they were losing money on the parts. Rather than accept this, a few of them told management they could do something about it. They did some trials and worked on solutions for two to three months, without direction from management. They worked out a new process with a low enough cost that the work was brought back in. They seemed quite proud (and should be) of these efforts.

The results of the "group problem solving" items on the questionnaire (before: 3.667; now: 4.571) indicate that there had been a considerable degree of group problem solving in the past and that this level has increased since. This is also indicated for the employee involvement items (before: 2.560; now: 3.771) which aim more at individual rather than group involvement. The number of individual improvement suggestions has remained constant, going from one suggestion for ten employees per year to one in nine.

2.3 Flow

2.3.1 Setup Reduction (Rating: Considerable (4))

The questionnaire results (before: 1.812; now: 3.850) show a big improvement in setup time reduction. A number of examples of simple and effective, operator-inspired changeover improvements were offered during interviews, as well as during plant tours.

One example concerned a changeover for different lengths of wire coil. Previously, each changeover took about ten minutes. The operator now had a simple fixture which allowed him to do either length, as required, thus eliminating the setup.

Another example, also observed on a plant tour, concerned an operator-inspired invention for changing the colour of wire being painted without stopping to changeover. The operator did so by using the various cans of paint as separate basins, eliminating the need to stop and clean the former permanent basin at each changeover.

A third example also concerns the elimination of setups. A situation where there had been seven models, requiring setups, has been changed to one in which operators can respond instantly to the model presented.

As for setup reduction techniques, a number of approaches were reported, including the use of videos for analysis, getting ready during external time, and concentrating on solutions requiring organization rather than funding.

2.3.2 Equipment Layout (Rating: Considerable (4))

The questionnaire results (before: 1.733; now: 4.286) indicate a large thrust towards improvements in equipment layout. This is confirmed by interviews and observations on plant tours.

On the tour, I saw many group technology cells, typically with three to six people per cell. Many of the cells have people building entire units by walking around. Many others, although U-shaped, have people sitting at fixed positions.

One example consisted of a U-cell for doing point-to-point wiring. Each operator was doing two or three wires, depending on the particular model being presented, at fixed positions around a U-shaped movable conveyor. Next to this was an area where old batch methods were still used for five lower-volume models.

One interviewee said that, in one of the focused factories, they try to use cells as they are just like kanban. That is, they simply produce within a cell according to whatever is missing on one of four conveyers, rather than work to a schedule.

2.3.3 Small Lot Size (Rating: Extensive (6))

The questionnaire results (before: 1.800; now: 4.619) reflect a dramatic change in lot sizes. This reflects the overall thrust of the recent assemble-to-order initiative.

In the old days, everything was done in batch mode whereas now they have relatively small lot sizes. Currently, there are many areas of the plant capable of handling a lot size of one, if one counts each option arrangement as a different model. If one counts major changes, the typical lot size is in the order of 50 to 100. As one manager reported, lot sizes were large before, in the range of 120 to 200. Now there are lot sizes of one, according to option, but some option changes require fairly substantial changes such as changing from a fixed unit to one which is on rollers.

One respondent, commenting on the effect of the former batch system in his area, said that it was easier in those days to rush a new job than to try to find what they needed in inventory. Another respondent commented that there used to be large lots but, since going to an assemble-to-order environment, they produce 25 to 30 models per day. This translates into a lot size of about 25. This particular area is capable of lot sizes of one but the minimum lot size is constrained by other operations in other areas.

2.3.4 Repetitive Master Schedule (Rating: Considerable (4))

Because they are operating in a assemble-to-order environment, they do not have a strict repetitive master schedule. However, they have developed their assemble-to-order approach around the idea of "model families," so they are able to have a close approximation of a repetitive schedule. They enjoy the benefits of a repetitive master schedule in that they can have a level load and operate roughly the same mix of "model families" within a given day. They know from historical data that models and options will fluctuate but families stay fairly consistent.

As well, they are working on an assemble-and-ship-to-order approach in which units for larger customers are scheduled with priority codes so that they are produced for direct loading onto trucks. This implies even more mixing of the daily schedule. As one interviewee explained: "We are pushing direct shipment and bypassing the warehouse for big customers. So, for [these customers], the order is received on day one, it is scheduled for day two, and it is out in the truck at the end of day two."

Another respondent pointed out that they had been doing several models per day, but had not been mixing models, only doing each model once each day. But now, certain models are mixed if they are to be loaded directly onto different trucks.

The questionnaire results (before: 2.800 Now: 3.667) confirm this thrust to a more repetitive master schedule.

2.3.5 Daily Schedule Adherence (Rating: Partial (3))

They always meet a daily schedule, within each family. If necessary, some units go to stock rather than stop if there are no orders. However, there is no regular scheduled time during the day for meetings nor for preventive maintenance. This lack of scheduled time for meetings is reflected by the fact that having the 25 people on special projects rather than laid off meant that they no longer had to use overtime for quality circle meetings. However, this also confirms that there had been no regularly scheduled time for meetings.

The lack of scheduled time for maintenance is indicated in a statement from one manager that they always seem to find reasons not to do preventive maintenance. This would not be so if it were part of the daily schedule.

The questionnaire results indicate values of 3.400 before and 3.238 now.

2.3.6 Pull System (Rating: Substantial (5))

The firm operates a pull system using kanban concepts; most areas have kanban teams. According to one respondent, the toughest problem is maintaining discipline, but, if a group wavers, someone else will point out that they are violating the kanban rules.

One supervisor of a component area told of how he was terrified when they started kanban because he was used to six weeks of inventory which he considered safe. But now he is confident because he knows what his group can do.

They have established three types of kanban: containers, cards, and "fax-ban." With suppliers, they use just an annual schedule and kanban; there is no weekly schedule.

The questionnaire reveals a number of indicators of the "pull" system. The overall results (before: 2.781; now: 4.350) are a strong indicator, as is the "kanban" scale (before: 1.050; now: 4.571). As well, the signalling items which I added show ratings of 2.267 before and 4.000 now, with the scale from Sakakibara et al. indicating ratings of 2.900 before and 4.280 now.

2.3.7 JIT Delivery from Suppliers (Rating: Considerable (4))

The results of the questionnaire (before: 1.500; now: 3.893) show that the level of JIT delivery from suppliers is high. Currently, about 15% of suppliers are on kanban according to two of the managers. The average inventory for kanban suppliers is about 1.7 days, compared to 9 days previously.

Quite a number of things associated with JIT delivery have been done including using kanban signals, using an annual schedule for planning along with pull signals for delivery, insisting that suppliers stay within production limits and not ship from finished goods, making fixed "milk runs" to groups of suppliers, and being restrictive on types of allowable containers.

As well, one manager said that there is no more receiving inspection on all suppliers, and he confirmed that he meant all. And the number of suppliers has been reduced from about 1200 to about 500, with a long-term goal of about 200. As an example of reducing the supply base, they recently took business away from a supplier who had orders for only a few parts and gave it to a supplier already supplying a large number of parts.

Another example of JIT supply arrangements concerns items shipped from a neighbouring province. The plant decided that they could not send cards and containers for daily pickups so they send fax messages twice a day and pick up once per day. This routine allows the supplier to begin loading the truck on the first signal, to be left with only the last half to load on receiving the second signal.

2.4 Quality

2.4.1 Supplier Quality Level (Rating: Considerable: (4))

The results of the questionnaire (before: 2.200; now: 4.286) indicate a strong emphasis on supplier quality. Quite a number of approaches associated with JIT supplier quality have been undertaken. These include developing long-term partnerships with suppliers, promoting "value-added" suppliers, going to suppliers' plants to help with process improvement, and minimizing the number of suppliers.

Although receiving inspection has been removed, incoming quality is still ensured because the line workers are responsible for quality of incoming parts, so will make sure the supplier is notified quickly if there is a problem. As well, the quality engineers are encouraged to go out to the supplier's site rather than dealing with incoming inspection.

As well, they require suppliers to have an an SPC program for critical parts. They do not do much, however, in the way of supplier audits and certification, mainly because the certification of American suppliers was being handled by the U.S. parent. Some Canadian suppliers are certified, with others still to be done.

If there is a defect on the line, they react immediately by doing a temporary fix (rework, sort) and then telling the supplier to arrive quickly to sort or do whatever is required as well as ensure that the correct material is provided on the next shipment, which could be by air.

As an example, they changed suppliers for a particular hose. The hose, although within specifications, was on the high side, so was very rigid. They had used 100 already but decided not to produce any more. They called the supplier and said they had a problem even though the supplier was within specifications. They asked if the supplier could deliver 125 the next day. In this case, there was a good reaction from the supplier, the problem was solved. This would have been impossible without a JIT-like partnership.

2.4.2 Zero Defects Quality Control (Rating: Partial (3))

Aside from indirect indicators, three respondents were asked about the extent of the use of mistake-proof devices for quality control. Their common answer was that there is some effort at developing and using these, but not a lot. One, for example, commented that there were no efforts in this direction by teams, whereas another said that the quality circles are trying to develop poka-yoke devices but do not call it that. The third respondent said that they invent such things only if there is a problem in a specific area. He offered the example of 200 units built with pieces upside down, leading them to now look at devices to prevent a recurrence.

Another respondent pointed out that there had been no real source inspection before. At that time, the attitude had been that a part was good if the inspectors did not see it. The operators would not do anything if they saw a problem; it was considered an inspectors' job. Two other respondents indicated that they now are looking at "quality at the source" but encountered difficulties by moving too quickly in asking people to stop whenever there was a problem.

The results from the questionnaire (before: 2.250; now: 3.000) also support this assessment of some effort in this direction but nothing major.

2.4.3 Statistical Process Control (Rating: Partial (3))

One respondent said they installed an SPC quality control plan at each workstation which included instructions and sketches for the operators. He said they have done plenty of SPC and that people are proud of their participation in it. He mentioned one line having about ten critical points for SPC.

Another manager commented that they have done SPC on a lot of critical areas, but have not tried to reduce the variability. Rather, they simply set the control limits and left them as they were.

The results questionnaire (before: 2.000 Now: 3.107) indicate some efforts at SPC but, again, nothing major.

2.4.4 Use of Charts and Feedback (Rating: Considerable (4))

This was not discussed during the interviews. However, there was much evidence of visual approaches around the plant, ranging from quality boards, to SPC charts, to kanban markings of all types, to boards for incoming purchased parts. As well, there is a large overhead "scoreboard" showing production targets by the hour (scheduled and actual).

The questionnaire results (before: 2.160; now: 3.771) support these observations.

2.5 Plant Environment (Context)

2.5.1 Decentralization of Authority (Rating: Considerable (4))

Most of those interviewed pointed out that the organization has become more decentralized recently. They have restructured the plant from a functional organization to one organized as four product divisions. These are sometimes referred to as focused factories although they do not use the term extensively. There are four levels in the organizational structure, down from five previously.

One respondent explained that each focused factory has its own maintenance and process engineer, industrial technician, quality engineer, product engineer, stock analyst, purchasing manager, and human resources trainer (responsible for employee involvement). Another explained that some global functions are still at the staff level for external reasons but inside decisions, including training and maintenance, lie very much with each product division. And another pointed out that now, if stuck with a problem, he can get an engineer to help because of their assignment to a specific product line. In the old days, he might have had to live with the problem. As a somewhat extreme example, one group apparently did away with their team leader, as they felt the leadership function was no longer required.

The questionnaire results showing decentralization increasing (before: 2.908; now: 3.933) and the number of reporting levels decreasing (3 to 2) confirm this move to a more decentralized organization.

2.5.2 Management by Wandering Around (Rating: Considerable (4))

When asked if managers are seen much on the shop floor, one interviewee responded: "Yes, we see them all on the floor. The plant manager talks to all. So, employees will stop him and explain problems, etc. At least once per week, the big boss is seen. People like to see him on the floor; he talks to people." Another added that the visual feel is important because the employees then believe they can talk to the plant manager. He added: "Then, the gentle dedicated people will come out of their cocoon." These comments are confirmed by the questionnaire results (before: 2.931; now: 3.571).

2.5.3 Coordination of Decision Making (Rating: Considerable (4))

There is a fairly high degree of coordination of decision making between various units. An example is the employees mentioned earlier who saved their jobs from being contracted to Mexico. In this instance, there was good coordination of decision making as employees from different areas in the plant got together and worked out a solution.

There were also outside sessions with other units of the firm aimed at various improvements, such as reducing warranty cost. One session included engineers, service technicians, employees from a sister plant in another city, head office people, and so forth. As one manager explained: "Workers will then have other contacts besides management. They can deal directly. People on the floor and engineers need to know what the service technicians are dealing with vis-a-vis customers."

Not all units coordinate well, however. One respondent reported that designers still do not talk enough to operators on design.

The results from the questionnaire (before: 2.808: now: 4.133) indicate that the level of coordination of decision making is high.

2.5.4 Supervisors as Team Leaders (Rating: Substantial (5))

The plant manager said that there has been a drastic change in the role of supervisors, with the whole issue being one of empowerment. Supervisors are now expected to develop, rather than manage, teams by letting the teams work and backing them up. Some supervisors have trouble making the switch to being a coach or facilitator.

This theme of supervisors as coaches or facilitators was confirmed by a number of other respondents. As one supervisor noted: "We will change to more than supervisors. We will be coaches. We must now train employees and group leaders. Later they may call the position captain, leader, or something. They won't need me then but we have no choice. We're working to eliminate our own jobs. But, I will have something else to do when that happens."

The results of the questionnaire (before: 2.744; now: 4.400) indicate a high degree of supervisors acting as team leaders.

2.5.5 Affective Commitment (Rating: Considerable (4))

The level of loyalty or commitment was quite high in the past. Recent events, including the reorganization, layoffs due to the recession, and the introduction of new technology are cited as reasons for declining morale. Managers are concerned about employee frustration and declines in morale; they know the advantage of employee commitment and do not want it lost. However, the overall level of commitment is still reasonably high.

One manager reported being worried that trust has diminished even though employees understand that recent layoffs were because of the recession. He was concerned about employee participation after moving teams around as a result of the layoffs.

Another manager added that there has been a loss in the level of commitment and pointed out that, in the past, employees were even going home to work on problems at night. And, he continued: "There were even two cases where we laid off people but two members still came to participate in quality circle meetings without pay. And they did not know if they would be called back."

Another respondent pointed out that, while some workers are there for only the pay, there are many volunteer quality circles, indicating that people are proud to work for the firm.

Although frustrated with the situation, employees did not seem as disaffected as managers thought. Rather, they were simply worried. One respondent reported that many employees were frustrated over the layoffs. However, another added that the number one thing that would restore his confidence would simply be more available production. He was certain that attitudes in the plant would change back if production were to go up.

Another manager reported low morale, as well, but also pointed out that employees understand the need to proceed in the new direction. And another reported some difficulty with morale but added that morale is beginning to turn around.

The questionnaire (before: 4.019; now: 4.033) and absenteeism rates of 8.3% and 9.5% indicates that the degree of affective commitment (or loyalty) has not changed much. However, these absenteeism rates are quite high, so the high level of affective commitment is not being translated into attendance at work.

2.5.6 Plant-Wide Philosophy (Rating: Considerable (4))

There is a mixture in the plant of about half the people "buying in" to roughly the same plant-wide philosophy and the other half not, although there is no indication of any serious opposition to the general thrust. This mixture is confirmed by the questionnaire results (before: 3.580; now: 3.585).

One interviewee, commenting on employees and cultural change said that about 15 to 20% are "avant-guard" (i.e. want to move ahead), about 10 to 15% do not care and do not want to know, and the rest are in the middle. As well, a number of respondents pointed out that some employees will accept change and some will not (it is about 50% of each in the plant) and that mentalities are different in different areas in the plant.

Another respondent said that the employees know that productivity means survival. And another said that people are aware of the recession, so they accept the management view that the recession is the main cause of the recent problems.

A few respondents were not in complete agreement with the recent direction of the plant. They were concerned about all the reorganization and lack of direction resulting from changing managers.

In spite of a few comments above, a common plant-wide philosophy is clearly more extensive here than for most other plants in this study.

2.5.7 Employee-Management Relations (Rating: Considerable (4))

Employee-management relations are generally quite good at Plant B. This view was confirmed by an hourly worker: "I have no complaint with management," a supervisor: "There are good relations here," and by a manager who described relations as "cordial."

As well, this was evident during plant tours. There were numerous employees who would meet one's eye without apparent hostility or resignation. And, most employees seemed to interact well with the tour guide and were pleased to answer questions and explain things, something that often does not happen in other plants.

One of the managers stated that the union even won a government award for union-management relations. The company has received two awards and the union one, for their ability to work together. Another manager added that the union is open to ideas because they understand the business and the need for flexibility, and they know it is the only road to survival. He said, in the last six or seven years, management has changed and now wants the union to provide input and participate.

The questionnaire results (before: 3.038; now: 4.192) also indicate that employee-management relations are fairly good and have improved since the recent changes.

This does not mean, however, that employees and management always agree. There was a vote on gainsharing which was defeated even though management thought it would pass.

2.5.8 Influence on Employer (Rating: Substantial (5))

Within the plant, there is a sense that employees are able to make changes and are encouraged to do so. Hourly employees do feel that they can talk to the plant manager. Employees will take ownership of problems with quality circle members choosing their own problems to work on. As well, regular weekly quality circle meetings only involve others, such as a supervisor or engineer, when required.

Again, a good example concerns the employees, mentioned earlier, who saved the jobs almost contracted to Mexico by taking direct initiative and changing management's mind.

The questionnaire (before: 2.923; now: 4.422) confirms that employees at Plant B have considerable influence over their immediate job situations.

2.6 Summary

In the following table, I summarize the findings by category for Plant B:

Table 5.2

Summary - Plant B

Management Initiatives		
Employment Security	Marginal (1)	There are no specific employment guarantees. There is some insecurity as a result of the recent layoffs. There are indications that management is doing what it can to minimize the harm, for example by retaining 25 people for special projects. There is no sense yet that there will be increased sales.

Employee Responsibility	Extensive (6)	There is a strong message that management wants hourly employees to take ownership and responsibility. The recent decentralization has pushed employee responsibility further down in the organization. There are numerous examples of efforts my management to increase employee responsibility.
Training	Substantial (5)	There is a strong emphasis on planned ongoing training. There are numerous examples of types of training and specific courses aimed at increasing worker capabilities.
Teamwork	Extensive (6)	In spite of lesser emphasis recently, management has been actively promoting teamwork for the last decade in a number of ways. They have done so by facilitating the efforts of hourly employees, mainly through quality circles. They are now re-emphasizing this with a push to semi-autonomous groups.
Performance Measurement	Partial (3)	The company operates according to some group measures and some individual piece rates. There was a proposal to replace piece work incentives with gainsharing but it was voted down.
Visible Commitment	Substantial (5)	There are a number of indicators of management being visibly committed including, among others, auditors with the authority to stop the loading of an urgent shipment, managers being on the shop floor to help resolve problems, priority being given to quality circle activities, and the highly visible retention of 25 employees who would have otherwise been laid off.

Employee Involvement	Substantial (5)	There was a fair degree of group problem solving in the past, with the level increasing substantially since. The majority of employee involvement is group-based. The number of individual improvement suggestions has remained constant, going from one suggestion for ten employees each year to one in nine.
Flow		
Setup Reduction	Considerable (4)	There is a considerable emphasis on and a major improvement in setup time reduction. Examples include the elimination as well as the reduction of setup time.
Equipment Layout	Considerable (4)	There is a major thrust towards improvements in equipment layout. There are many group technology cells, typically with three to six people per cell.
Small Lot Size	Extensive (6)	There has been a dramatic decrease in lot sizes, reflecting a recent assemble-to-order initiative. Currently, there are many areas of the plant capable of handling a lot size of one, if each option is counted as a different model. Otherwise, the typical lot size is about 50 to 100 units.
Repetitive Master Schedule	Considerable (4)	In the assemble-to-order environment, they do not have a truly repetitive master schedule. However, because they schedule by "model family," they are able to to have a level load and operate roughly the same mix of "model families" within a given day.
Daily Schedule Adherence	Partial (3)	They always meet a daily schedule, within each family. If necessary, some units go to stock rather than stop if there are no orders. However, there is no

		regular scheduled time during the day for meetings nor for preventive maintenance.
Pull System	Substantial (5)	The firm operates a pull system using kanban concepts. Most areas have kanban teams concentrating on purchased parts, with about 15% of purchased parts now on kanban. With suppliers, they use just an annual schedule and kanban; there is no weekly schedule.
JIT Delivery from Suppliers	Considerable (4)	There are many things associated with JIT purchasing being done, including using kanban signals, using an annual schedule for planning along with pull signals for delivery, insisting that suppliers stay within production limits and not ship from finished goods, making fixed "milk runs" to groups of suppliers, and being restrictive on types of allowable containers.
Overall JIT Flow	(4.29)	
Quality		
Supplier Quality Level	Considerable (4)	Quite a number of things associated with JIT supplier quality have been done. These include developing long-term partnerships with suppliers, promoting "value-added" suppliers, going to suppliers' plants to help with process improvement, and minimizing the number of suppliers. They do not do much, however, in the way of supplier audits and certification.
Zero Defects Quality Control	Partial (3)	There is some effort towards mistake-proof (or poka yoke) devices but not much. One respondent said there are no efforts by teams, whereas another said that the quality circles are

		trying to develop poka-yoke devices but do not call it that. A third said that they invent such devices only if there is a problem in a specific area. As well, there are still problems in trying to implement "quality at the source."
Statistical Process Control	Partial (3)	They have done plenty of SPC on a lot of critical areas, people are proud of their participation in it, but they have not tried to reduce the variability.
Use of Charts and Feedback	Considerable (4)	There was much evidence of visual approaches around the plant, ranging from quality boards, to SPC charts, to kanban markings of all types, to boards for incoming purchased parts. As well, there is a large overhead "scoreboard" showing production targets by the hour, scheduled and actual.
Overall JIT Quality	(3.50)	
Plant Environment (Context)		
Decentralization of Authority	Considerable (4)	The organization has become more decentralized recently. It has been restructured from a functional organization to one organized as four product divisions. Each focused factory has its own staff positions.
Management by Wandering Around	Considerable (4)	The managers are all seen regularly on the shop floor. And, at least once per week, the big boss is seen and talks to people on the floor.
Coordination of Decision Making	Considerable (4)	There is a fairly high degree of coordination of decision making between various units. There are also outside sessions with other units of the firm.

Supervisors as Team Leaders	Substantial (5)	There is a fairly high degree of supervisors acting as teams leaders. Supervisors are now expected to develop, rather than manage, teams.
Affective Commitment	Considerable (4)	Managers are concerned about employee frustration and declines in morale after recent layoffs but the level of affective commitment remains reasonably high. Although frustrated with the situation, employees are more worried than disaffected.
Plant-Wide Philosophy	Considerable (4)	There is a mixture in the plant of about half the people "buying in" to roughly the same plant-wide philosophy and the other half not, although there is no indication of any serious opposition to the general thrust.
Employee-Management Relations	Considerable (4)	Employee-management relations are generally good at Plant B. Employees generally do not have complaints and there is little apparent hostility on the shop floor. There have been government awards for good union-management relations at the plant. The union is open to ideas and understands the requirements for survival.
Influence on Employer	Substantial (5)	Employees will take ownership of problems; quality circle members choose their own problems to work on and their meetings only involve others when required. Hourly employees feel that they can talk to the plant manager. One group of employees took the initiative to improve their processes enough to convince the employer not to contract certain operations to Mexico.

3 Plant C

Plant C is a branch plant of a U.S. parent, located in central Canada. It is non-union and currently employs about 700 people. It has three main product lines and has been involved in JIT approaches to production for the past decade.

It is mainly a supplier to other suppliers (70%) as well as to original equipment manufacturers (30%). Its products are not too complex, with bills of material about four levels deep.

Roughly 70% of its deliveries are JIT deliveries. Its operations are about 40% repetitive assembly and 60% batch.

3.1 Management Initiatives

3.1.1 Provide Employment Security (Rating: Some (2))

There are no specific employment guarantees. The general manager pointed out that security comes about from attrition, a general increase in volume, and the habit of head office sharing growth in the division. He tells his people: "If we have a quality product at a competitive price, they cannot close us." He makes the point that those in the plant will dictate their own future by providing good customer service and a quality product.

As well, management is attempting to develop a group of clearly temporary workers which would provide a message to core employees they would not be hurt by coming new technology.

Another respondent said that they seldom had big layoffs and were always able to take market share. So, people are not threatened by layoffs.

And, a group of employees involved in an improvement project were consistent in agreeing that the typical employee was not worried about job security (at least in a major way which would prevent employee involvement in continuous improvement). The perception was that you would be transferred to another area if you found a way to work your way out of your job.

Thus, although there are not specific provisions for employment security, there is currently little concern about security.

3.1.2 Promote Employee Responsibility (Rating: Substantial (5))

There is a major attempt to promote more employee responsibility. A number of respondents reported that management decided to move responsibility down one level in the organization as part of their revival of a stalled JIT effort. They did so by eliminating some middle management positions.

The best example concerns responsibility for quality. One respondent said that the quality department had had an image of an old police role. Then in the early 1980s, they gave the operators responsibility for quality. They got operators to take ownership of quality and to realize that it is the needs of the assembly area which run them, not management. Operators have the authority to stop and hold product, initiating a chain of events. In assembly, a board lights up to tell supervisors and the mechanic where the problem is.

And, a manager cited an example of an employee who used to scream at him over decisions he made. One day he told the employee that he trusted him and to let him know how he solved the problem. The employee just went ahead and solved problems and it made things better for both of them.

As for improvement efforts, another respondent said that, at the beginning, employees picked their projects but management now gives more direction. The QI Story is a good vehicle for getting employees to take responsibility for process improvements. This is a method (developed at Florida Light and Power) of approaching problems aimed at identifying a current situation and analyzing to get at the root cause. It is a central vehicle for encouraging employee involvement in continuous improvement. They use it to reduce the "cost of poor quality," such as scrap, rework, and inspection.

In another example, they decentralized some of the stores areas by establishing seven satellite stores. Now, a supervisor can decide to order locks, leave things open, issue keys to ten people, or whatever else seem appropriate. The responsibility now lies with the supervisor.

However, the general manager said that, although management is trying to move responsibility down, he's not sure employees are taking advantage of the chances.

3.1.3 Provide Training (Rating: Extensive: (6))

They engage in all sorts of training, reported to be 2 to 3% of total hours for hourly employees and 10 to 12% for professionals.

Examples from recent years, as outlined in conversations with a number of managers and employees, include SPC, gauge capability, design of experiments, scatter diagrams, math and English refreshers, employee involvement, interaction skills, Pareto analysis, total quality control (TQC), quality circles, Pareto analysis, fishbone diagrams, Juran methods, multiprocess handling, and multiskilling.

And they added training in the QI Story methods. One respondent said that training was the key for making it work.

One early problem they had with training was to give employees the tools and then turn them loose to choose their own projects. As one respondent noted: "We gave them training and said: 'way to go.' But the biggest problem is getting from the classroom to the floor. We did not do a superb job of spelling out expectations." Another respondent said that they had once applied control charts on a vendor product where they had no control. However, now management sets more direction and tells employees they want projects aimed at the 35 or so key characteristics the firm wants most to control.

3.1.4 Promote Teamwork (Rating: Substantial (5))

One informant pointed out that there are two types of teams at the plant, quality circles and quality teams (or SPC teams). Quality circles are volunteer efforts with guidelines for people to make improvements in their own area. For example, when orders are assigned to new machines, there is a problem having the correct repair parts nearby. A quality circle designed a station to control this activity and made a presentation to managers who approved the funds to build the station. On the other hand, a quality team or SPC team works on specific projects. So, each area works on specific improvements aimed at one or more key characteristics (e.g. pitch, angle, hardness) the firm wants most to get under control. Teams may work on key characteristics directly or on getting the process under control. But, as one respondent said: "When you start out measuring parts, you end up measuring the process."

Teams members could come from any level of the organization. One interviewee pointed out that one of their early mistakes was not to include hourly workers in early JIT efforts. Another said a typical team consisted of a supervisor, an engineer, a setup person, and an operator. And, another said the typical composition was a supervisor, two or three volunteer hourlies, and the JIT manager as a short-term facilitator. A further respondent added that there is a suggestion system but they do not do anything with it because they work as a team to solve problems.

3.1.5 Use Group Performance Measures (Rating: Substantial (5))

There are no individual incentive schemes. Most measures are aimed at the group or product area. Key indicators are reviewed monthly, with some reviewed weekly, and include measures of (1) quality (cost of poor quality, number of defects, and key characteristics in control), (2) JIT (throughput and customer service), and (3) financial (cost per unit, work-in-process, and output rate). As well, there are a few individual measures, aimed at assessing employee involvement, namely, absenteeism and number of teams.

As one respondent noted, with respect to productivity, they now measure the overall group, not just direct labour. Each supervisor measures his own area in terms of output per hour. The overall measure includes all activities of the functions reporting to a particular production manager, including engineering, purchasing, and quality.

3.1.6 Demonstrate Visible Commitment (Rating: Considerable (4))

The CEO of the corporation made a decision to go the JIT route and sent a group of managers to Japan in late 1981. He determined that, if the corporation were to be effective in JIT, JIT should get a high priority. He gave it this priority by setting up inter-division and inter-plant conferences. At these, each plant made presentations concerning their JIT efforts. This made it clear that top management was committed to the JIT effort. The term JIT is used at Plant C to describe the flow aspects of such a system, distinct from related concepts of quality and employee involvement.

Later, at the plant level, there was a hiatus in visible commitment to efforts concerning the flow aspects of JIT. They decided to focus on quality after finding they could not make further JIT progress without a substantial quality improvement. The general manager said that dropping JIT completely to focus on quality was a big mistake on his part. In hindsight, he knows he should have, at least, kept some JIT side-projects.

The commitment to JIT has recently been revived and they are now aiming for a revitalization of previous JIT efforts. These commitments are made clear through regular and frequent meetings on JIT efforts. Quality will continue to receive commitment as well.

One respondent stated that there is nothing new today from 25 years ago. The advantage now is that it is organized and driven from the top down. He said that, where there is management commitment. Managers are looking for results, so they must provide funds.

Another stated: "Training is the key. This is true for the total company. One of the good things is it works from the top. It would not work any other way. You must give people the freedom to jump in; they cannot do this without top support. The biggest obstacle is individuals. But training and philosophy from the top down are key."

3.2 Employee Involvement

3.2.1 Employee Involvement (Rating: Substantial (5))

Employee involvement is a recent phenomenon at Plant C. Nevertheless, it has taken hold in a major way, once encouraged by management. There has been much evidence of involvement over the past decade at the management and supervisory level but only recently have hourly workers been involved. As the general manager said: "We made a mistake when we first got into JIT in that teams did not include hourly workers."

Another respondent confirmed that hourly employees first became involved as volunteers on projects in the summer of 1990. He added that, in the early days, the firm concentrated on industrial engineering, with little involvement from the shop floor but now their philosophy has changed to one of employee involvement. Another stated that employee involvement has done more good than anything else.

And another said people will usually work in groups when asked, although sometimes there is a negative reaction. He stated that, on the other hand, some employees think things are not moving fast enough. He added that it takes time and training on employee involvement is continuing.

A team of supervisors and hourly employees confirmed that the QI Story approach is standard at the plant and most employees would have some training or awareness about, say, the use of fishbone diagrams for problem solving. As an example, this team did a Pareto analysis using data on scrap rates and found that the main reason for scrap had been destructive testing required to ensure that spot welds were strong enough. The team followed the QI Story methods and concluded that the main area for improvement was the method of testing itself. The team outlined four possible solutions and concluded that the best option would be non-destructive testing via ultra-sound. They made a presentation to management and convinced them to provide funds for new equipment. Now, operators randomly select units and do their own tests using the ultra-sound equipment. This gives more accurate results as well as saving all of the former scrap costs.

In another example, members of a quality circle were the instigators of efforts to convince a supplier to go to twice daily deliveries because the circle found that their efforts to reduce work-in-process levels for a particular in-house part were being stalled by the outside bottleneck.

The questionnaire confirms the previous comments, showing a dramatic increase in the involvement of employees. The before and after measures for group problem solving are 1.333 and 5.000 and, for employee involvement, 1.850 and 3.771.

3.3 Flow

3.3.1 Setup Reduction (Rating: Considerable (4))

They have been improving setup times over most of the last decade. I observed a couple of setups in which changing some fairly heavy dies took only about 20 seconds. For both, they used high pressure air to make it easy for the operator to slide one die out and the other in. Then six to eight clamps were easily inserted and the die was secure with no time-consuming adjustments necessary.

The general manager explained that they attempted quick die change as their initial JIT task because he had been impressed with the less than ten minute die changes he saw in Japan. Upon returning, he set up a team in spite of scepticism from his engineering manager. For one operation, the team reduced setups from about four nours to 1 minute and 43 seconds. One informant explained that single minute exchange of dies (SMED) was easy for them because they are knowledgeable tool and die makers.

The questionnaire results (before, 1.625; now, 3.250) do not show setup reduction to be quite as strong as indicated by the above comments and observations. On this, I am discounting the questionnaire and relying on observations and discussions which indicate, at least, a more than neutral level.

3.3.2 Equipment Layout (Rating: Considerable (4))

In the assembly area, final assembly was neatly laid out in a number of cells. There were, however, some good examples of cells and tighter layouts. In one product area, processing had previously been done on four machines with four operators and with a buildup of work-in-process inventory between each. Now there are short conveyors between the four closely-spaced machines, with one operator doing the work of the previous four. There is system of full work control such that a buildup of inventory on a conveyor will cause the previous machine to cease producing, keeping the inventory between machines to a minimum. They are about to extend this to a fifth operation, with others planned for later.

There were also instances of layout changes to accommodate multiprocess handling. In each case, a machine that had previously been located somewhere else in the plant was moved close to an operator who would tend to the machine when he or she would otherwise have been idle while another machine performed various automatic operations.

However, one respondent explained that they previously had cells but got into people problems. He said it could be done in Japan, but here people could not get along side-by-side in tight cells because of body smells and so forth. He added that with cells, they ran into classification problems because they needed three or four different skills in a cell.

The questionnaire (1.889 before and 3.800 now) supports an assessment of more emphasis on more flow-oriented layouts.

3.3.3 Small Lot Size (Rating: Partial (3))

Over the years, the plant has certainly reduced its inventory and is running smaller batches. However, they do not emphasize small-lot production.

The reason for this is the tradeoff they face between the desire to run small lots and the need to run batches because of limitations due to physical properties of the steel. This manifests itself in the heat treat operation. One respondent explained that the bottlenecks were in the heat treat operation where they could not guarantee the outcome of a small lot.

The above comments are supported by the questionnaire results, namely, virtually no small-lot production before JIT efforts (0.889) but only neutral levels now (3.000).

3.3.4 Repetitive Master Schedule (Rating: Partial (3))

They have some form of repetitive master schedule in that there are a number of independent final assembly workstations, each responsible for a certain portion of the total product line. So, in this sense, there is a daily mix. However, they do not make the same mix each day at each station. As one interviewee reported, they were assigned a variety of branded products as a result of the closing of a sister plant about five years ago. The transfer of its operations to Plant C along with the requirement for larger batches in their heat treat operation meant they had to schedule weekly orders.

The questionnaire bears out this lack of repetitive master schedule, with measures of 1.889 before and 2.800 now.

3.3.5 Daily Schedule Adherence (Rating: Partial (3))

There was no direct discussion of this category during interviews. The questionnaire (before, 1.417; now, 3.238) reveals that they are relatively neutral on scheduling time to make up for production and quality problems, scheduling time to cover for machine breakdowns or production stoppages and meeting the production schedule each day.

3.3.6 Pull System (Rating: Some (2))

A pull system is used with some suppliers but there is not much evidence of its use internally. One respondent explained that they use kanban cards with suppliers along with blanket orders.

For internal operations, they once used kanban and it worked well as long as they were making mainly one product. But, now they schedule weekly orders for reasons outlined above. For some parts, they do daily counts and pull the requirements but they do not use kanban-like signals.

The questionnaire results are quite interesting and confirm the interview data. For those items from Sakakibara et al., there appears to be a considerable amount of "pull" in the system (before, 2.533; now, 4.120). However, a closer examination shows that these items are more oriented to control of the production process by workers, in the sense of being able halt production rather than whether the system is push or pull. The three items which I added to the questionnaire (concerning triggering, rates issued to final assembly only, and maximum inventory levels) reveal very little in the way of a pull system (before, 2.111; now, 2.222). As well, the items directed at the use of kanban cards reveal little such use (before, 1.250; now, 1.650).

3 [illegible].7 JIT Delivery from Suppliers (Rating: Considerable (4))

The questionnaire results (before, 0.938; now, 3.708) show a definite move to JIT delivery. Over eight years, the number of suppliers has been reduced from 1000 to 400 even though sales volume is up by 67% over the same period. Contracts are now typically long-term. As well, outside purchases have doubled while safety stock has been cut to 25% of previous values. They deal with contract carriers at a maximum radius of 500 miles so they can do overnight shipments. Most steel suppliers are located within a 500 mile radius and deliveries are next day. To obtain a contract, a vendor must have the right computer, provide required information, and be in the geographic region. All of this is consistent with a JIT style of supply delivery.

One example concerns stationary supplies in which the number of suppliers has been reduced from five to one. Inventory, once at $5000, is now virtually nil. And the number of purchase orders has gone from about 200 per year to none. This supplier packages material for individual requisitions and delivers to a central area where orders are picked up by each department. In another case, printed supplies are delivered directly to the user.

3.4 Quality

3.4.1 Supplier Quality Level (Rating: Substantial (5))

There is quite a strong emphasis on improving supplier quality levels. Two years ago, they developed a suppler quality assurance system, based on similar programs in the auto industry. But, they made some modifications, as they felt the auto companies were too pushy and adversarial. As the purchasing manager said: "We always try to develop our present suppliers unless they do not show continuous improvement toward our quality targets." His main approach was to insist on being shown some progress.

They do a number of things at suppliers' plants such as promoting the use of SPC and working with them on improvements based on Plant C's identified key characteristics. As well, they will bring suppliers in to train them.

Their goal is to reduce and eliminate incoming inspections but they still do pure incoming inspection because they do not trust suppliers who have no systems in place. Receiving inspections are now about 70% of total incoming material, down from 80%.

Price is only part of their supplier assessment; they evaluate suppliers as a total package. The purchasing manager said it was important to have trust and long-term commitments with suppliers of the same frame of mind.

The questionnaire results confirm this concentration on supplier quality with a measure of 1.812 before and 4.458 now.

3.4.2 Zero Defects Quality Control (Rating: Considerable (4))

The questionnaire (before, 1.650; now, 3.971) indicates considerable use of mistake-proof (poka yoke) devices. They have reason to concentrate on this as they have problems with many different, but very similar, small parts being produced each day.

One example concerns a detailed operation in which 9.5 million small parts are assembled into about 55 similar products daily, leaving much potential for error. They developed a system centred around a number of mistake-proof devices. Each assembly cell has a computer terminal with many sensors to tell when something is wrong. For example, if material is 0.5 thousandth too heavy, slightly too thick, upside-down, missing, or misaligned, the devices will sense it, stop the assembly, and flash an immediate message on a computer screen to the operator outlining the source of the problem. The operator then corrects the problem before beginning assembly again.

As well, they have a mistake-proof system for a critical grinding operation before a part goes to assembly. This system senses problems due to many things such as improper alignment, successive items being simultaneously selected by the machine, dirt in the track, tightness of the chute, tightness of holes, items slightly off centre, and the operator having to remember that the first item after a start-up will not be processed properly, to name a few.

3.4.3 Statistical Process Control (Rating: Substantial (5))

The questionnaire results show a dramatic change in the use of SPC (from 1.312 to 4.607). There were numerous examples of the use of SPC. Some of these were noticeable on plant tours, including charts to measure critical cutting angles, critical insertion of hardened material into a unit, and a wide number of variables in their heat treat area.

The heat treat area had been a major headache for them until they did extensive "design of experiments" leading to a process now under control with regular SPC checks. They also do SPC checks on the gauges used for their regular SPC checks. The same person will do this for about a month to reduce variability by person. And, they have well-documented procedures outlining what employees are expected to do whenever their SPC charting goes out of limits.

One respondent said SPC began about five years ago and had saved them. He said that, before SPC, assembly operators were extremely frustrated with complaints but now there are never complaints. Another pointed out that they did have a previous SPC program which went to 1985, followed by a lull, in lieu of a concentration on quality. He said that before that, there was no SPC, no design of experiments, and no Pareto analysis.

However, another interviewee pointed out that he often had to defend SPC in face of enthusiasm for mistake-proof devices. He said that some people were forgetting that the use of poka yoke devices assumes that your processes are already stable.

There has been a fairly high emphasis on SPC training, with all managers and about half of hourly employees receiving 32 to 40 hours of classroom training.

3.4.4 Use of Charts and Feedback (Rating: Partial (3))

There was little discussion of this category. On the tour, I did not notice any particular emphasis on the use of charts, aside from those used for SPC (which are not contemplated by this category). They do, however, use charts effectively as part of the QI Story approach to continuous improvement. The questionnaire indicates values of 1.733 before and 3.400 now.

3.5 Plant Environment (Context)

3.5.1 Decentralization Of Authority (Rating: Considerable (4))

A few respondents indicated that they eliminated middle management five or six years ago and gave lower levels more responsibility. For example, before there was an engineering manager to whom all engineers reported. Now, engineers are assigned to particular product lines. And a product line manager stated, "Reporting to me are all manufacturing [for my product], the supervisors, engineering, one production maintenance department, and tooling." Now, ten or eleven positions report to the general manager. As well, they have eliminated some supervisors so that now, one supervisor has about 100 people reporting.

According to the questionnaire, the firm is more decentralized than before JIT efforts began, going from a state of centralization (2.300) to partial or slight decentralization (3.250). As well, there has been a reduction in reporting levels between direct workers and the general manager from five levels to three (i.e. to an organization chart with four levels). I am discounting the questionnaire results, in light of other stronger evidence that the degree of decentralization is, at least, greater than neutral.

3.5.2 Management by Wandering Around (Rating: Considerable (4))

There was not much discussion of management visibility during interviews. The questionnaire results (before, 3.010; after, 3.816) indicate a strong degree of management by wandering around, representing the extent to which various managers and manufacturing engineers spend time on the shop floor and converse directly rather than by memo.

One respondent, however, portrayed current top management as being too dominated by finance and marketing types and only showing up to do "white glove" tests before important tours. The former top managers were portrayed as being more production oriented, in the sense of being on the floor and understanding the problems. The respondent said that there used to be more of a family atmosphere in the old days but added, in fairness, you could not expect the same in a plant of 700 people.

3.5.3 Coordination Of Decision Making (Rating: Considerable (4))

One respondent said that reports go to all departments, supervisors will talk, and then engineers will get involved. They have a daily production meeting which includes the supervisors for each area of the plant. Each area has a pre-meeting and then they go through and discuss the schedule so the whole group knows what is happening. As well, there are meetings each month to look at measures, training, key characteristics, obstacles, and so forth. As well, managers were jointly studying Shingo's book on the Toyota production system. Over several weeks, they first read it on their own and then discussed it together. The questionnaire shows an increase in coordination (from 3.118 to 4.048).

3.5.4 Supervisors As Team Leaders (Rating: Substantial (5))

The questionnaire shows a healthy increase in the extent to which supervisors act as team leaders. The value increased from a less than average 2.632 before to a strong 4.524 now.

One respondent said there had been tremendous changes. He said that, whereas the old timers used to just give orders with little input from the floor, the emphasis had changed. Another reported that they always said quality was the operators responsibility but the supervisor was the decision maker. Then, in the early 1980s, they truly gave the operators responsibility. Now the assumption is that the floor people know the most about their jobs so the emphasis is more group oriented with more supervisors in the role of coach.

The process is not complete, however, as they have had training sessions for supervisors and are talking about them becoming coaches and facilitators, but, as one respondent noted, it is hard for some supervisors to change.

3.5.5 Affective Commitment (Rating: Considerable (4))

There was not much direct discussion of affective commitment or employee loyalty. However, the questionnaire revealed a rating which has improved from

3.287 to 3.706. The absenteeism rate has dropped from about 6% to 3%. As well, during both plant tours, the working atmosphere was noticeably easy with no particular tension in the air.

3.5.6 Plant-Wide Philosophy (Rating: Considerable (4))

A number of managers and employees mentioned that the plant runs according to the Toyota production system, using Shingo's recently revised book as a bible. They have developed a condensation of this book to use as a quick reference training manual. They are guided by an overall theme of three circles of activity, composed of just-in-time, quality, and employee involvement.

A philosophy of continuous improvement and waste reduction is in place, as reported by a number of interviewees. One pointed out that there's no magic; you just do things one at a time. They did little things which did not all pay off at first. But, he believes that the reason they are healthy today is due to the pains of past years. Many employees are involved in formal continuous improvement activities through the vehicle of the Quality Improvement (QI) Story, adapted from Florida Power and Light.

As one respondent said: "We had to start somewhere. We started with rigid Toyota rules. But it is really the philosophy of the seven wastes that's important. I tell my people, we think we must be world competitors."

The questionnaire results offer confirmation of the above comments with ratings of 3.400 (before) and 3.950 (current).

3.5.7 Employee-Management Relations (Rating: Substantial (5))

The questionnaire revealed that employee-management relations have been and still are very good (before, 4.096; now, 4.450). This was confirmed by a number of sources. First, the general tone in the plant is relaxed and friendly, with many employees interacting with my tour guides, always a good sign. Second, unions have made a number of drives over the years and have all failed; this would not have been the case if relations were bad. One respondent stated that people are treated fairly and there is much promotion up through the ranks.

There were some problems when they tried to set up a core workforce, using temporaries as swing workers. The perception was that temporaries were being treated unfairly. And there was some anxiety and bad feeling during the recent union drive. But, overall, relations are quite good.

3.5.8 Influence On Employer (Rating: Considerable (4))

There is a sense that employees can and do have influence in the plant. This is shown on the questionnaire in which the rating went from a score of 2.807 to one of 4.206. As well, there are a number of other indicators. One employee mentioned that one nice thing about working at Plant C is you can speak your mind to anybody.

Over and above a general open-door policy, there is a vehicle in place for employees to have input. Each month, the general manager meets for two hours with volunteers from various areas of the plant. Here, they discuss issues in common, anything except wages. Employees prepare their own agenda and will often meet without management.

Another respondent told of how they had convinced management to obtain a nice green carpeted aisle. He reported that one sceptic said: "If we get it, I'll eat off the floor." The others had fun ordering his pizza.

3.6 Summary

In the following table, I summarize the findings by category for Plant C:

Table 5.3

Summary - Plant C

Management Initiatives		
Employment Security	Some (2)	There are no explicit employment guarantees. Employees did not feel threatened, however, because of the ability of the firm to take market share and past actions of the firm in transferring employees to other jobs when necessary.
Employee Responsibility	Substantial (5)	Management decided to move responsibility down one level. Then in the early 1980s, they truly gave responsibility to operators. Operators now take ownership of quality and improvement projects.
Training	Extensive (6)	The firm engages in all sorts of training. Training is 2 to 3% of total hours for hourly employees and 10 to 12% for professionals. And they added training in the QI Story, a central vehicle for encouraging employee involvement in continuous improvement.
Teamwork	Substantial (5)	There are two types of teams at the plant, quality circles and quality teams (for specific projects aimed at key characteristics). Team members can come from any level of the organization.

Performance Measurement	Substantial (5)	There are no individual incentive schemes. There are some key measures, most of which are aimed at the group or at an entire product area.
Visible Commitment	Considerable (4)	The corporate CEO gave JIT priority by setting up conferences at which it was made clear that top management was committed to the JIT effort. At the plant level, commitments are made clear through regular meetings on JIT efforts.
Employee Involvement	Substantial (5)	Involvement of hourly employees is a recent phenomenon at the plant. Nevertheless, it has taken hold in a major way since being encouraged by management. Employee involvement in continuous improvement via the Quality Improvement Story approach is standard and common at the plant.
Flow		
Setup Reduction	Considerable (4)	They been reducing setup times for many years. Some setups now take only about 20 seconds for some fairly heavy dies. Setup reduction was easy for them because they are knowledgeable tool and die makers.
Equipment Layout	Considerable (4)	They had had cells but got into people problems. Nevertheless, there are some good examples of cells and tighter layouts. Final assembly was neatly laid out in cells.
Small Lot Size	Partial (3)	They have reduced inventory and are running smaller batches. However, they do not emphasize small-lot production. They schedule weekly orders, mainly because of constraints at one operation, requiring larger batches.

Repetitive Master Schedule	Partial (3)	There is a daily mix in the sense that there are a number of final assembly workstations each responsible for a certain portion of the product line. However, they do not make the same mix each day at each station. Since they were assigned new products due to the closing of their sister plant, they must now schedule weekly orders.
Daily Schedule Adherence	Partial (3)	They are relatively neutral on scheduling time to make up for production and quality problems, scheduling time to cover for machine breakdowns or production stoppages and meeting the production schedule each day.
Pull System	Some (2)	The main place in which a pull system is used is with some suppliers; there is not much evidence of its use internally. They now schedule orders on a weekly basis.
JIT Delivery from Suppliers	Considerable (4)	The number of suppliers has been reduced by 60% even though sales volume is up by 67% over the same eight year period. And safety stock has been cut by 75% while total outside purchases doubled. Long-term contracts are typical. They deal with contract carriers at a maximum radius of five hundred miles.
Overall JIT Flow	(3.29)	

Quality

Supplier Quality Level	Substantial (5)	There is quite a strong emphasis on improving supplier quality levels. They do go to suppliers' plants to help them with process improvements and they bring them in for training. They evaluate on a total package, not just price. They have developed a supplier quality assurance program.
Zero Defects Quality Control	Considerable (4)	There is considerable use of poka yoke devices to individually detect whether millions of small parts per day are slightly too heavy, slightly too thick, upside-down, missing, or misaligned
Statistical Process Control	Substantial (5)	There were numerous examples of the training for SPC and the use of SPC. They have managed to get a number of critical processes under control since beginning ongoing SPC efforts.
Use of Charts and Feedback	Partial (3)	There is some use of charts and feedback, other than for SPC, but not to any great degree.
Overall JIT Quality	(4.25)	

Plant Environment (Context)

Decentralization of Authority	Considerable (4)	Reporting levels between direct workers and the plant manager have been reduced from five to three. Now, ten or eleven positions report to the president. About 100 people report to one supervisor.
Management by Wandering Around	Considerable (4)	The various managers and manufacturing engineers spend a good deal of time on the shop floor as well as converse directly rather than by memo.

Coordination of Decision Making	Considerable (4)	They have a daily production meeting, and monthly meetings to discuss training, key characteristics, measures, and so forth. Managers currently study and discuss the Toyota production system together.
Supervisors as Team Leaders	Substantial (5)	In the early 1980s, they truly gave responsibility to the operators. responsibility. The emphasis is now more group oriented with more supervisors in the role of coach.
Affective Commitment	Considerable (4)	The absenteeism rate has dropped from about 6% to 3%. As well, during both plant tours, the working atmosphere was noticeably easy with no particular tension in the air.
Plant-Wide Philosophy	Considerable (4)	They operate according to the Toyota production system, using Shingo's book as a bible. There is an overall theme of three circles of activity, just-in-time, quality, and employee involvement. A philosophy of continuous improvement and waste reduction is in place.
Employee-Management Relations	Substantial (5)	Overall, relations are quite good. The general tone in the plant is relaxed and friendly. A number of union drives have failed and there is much promotion up through the ranks. There were some problems when they tried to set up a core workforce with temporaries as swing workers.
Influence on Employer	Considerable (4)	Employees can and do have influence in the plant. They generally feel that they can speak to anybody about problems. Each month the general manager meets with volunteers to discuss issues in common.

4 Plant D

Plant D is a branch plant of a U.S. parent, located in central Canada, and a sister plant of Plant B. It is unionized and currently employs about 800 people. There are two main product lines. It has only recently been involved in JIT and team approaches to production but has been moving quite rapidly in this direction. As part of this process, it has been changing from a make-to-stock to an assemble-to-order operation.

It is an original equipment manufacturer, delivering to a number of major retailers, among others. Its products are reasonably complex, with bills of material about five levels deep, and a total of about 2500 parts.

Its operations are about 90% repetitive assembly and 10% batch. Its typical order size is one hundred of units or less.

4.1 Management Initiatives

4.1.1 Provide Employment Security (Rating: None (0))

There is no provision for employment security and no sense that increased sales will help without other changes. The only hope for employment security is for the plant to do a very quick turnaround and produce much more efficiently than in the past.

As one respondent noted, they tell employees that the more secure the company is financially, the more secure employees will be but they cannot guarantee employment because of the realities of the market for their product which was down about 13.5% each of the last two years. This means, even if they pick up market share, they cannot guarantee jobs.

Another respondent commented that he would not want to think of the position they would be in without the recent improvements. He added that there will be a layoff shortly because of the efficiency of their new assemble-to-order policies. It is now common knowledge that they need fewer people for the same number of units. One tempering phenomenon is that manpower turnover is common in their region of the country, so they can expect to handle reductions through attrition.

4.1.2 Promote Employee Responsibility (Rating: Considerable (4))

There has been a strong move to push responsibility down to lower levels in the organization. The goal is the empowerment of hourly workers. However, this has not had time to filter to the hourly level; it is still being worked out at the level of middle management.

This push is evident in that the number of management positions has been reduced while the number of group leader positions has been increased. However, there is union resistance to moving responsibility down to the level of workers. This means that, currently, supervisors are having responsibility pushed from the top but cannot push it further down themselves. Another respondent added that they wanted to get employees to understand that they should not come to supervisors with problems they could handle themselves. A few others said that eventually hourly workers will be the problem solvers and will determine how to arrange their work.

One supervisor said that he gave his people two weeks of formal training and then let them go. The hardest thing, he said, was to let them go. Their first improvement was the most costly, but when they knew they could get the money, they started to think about saving more. He added that they usually find the answers they need. Another respondent offered an example about an edict that there could be no hourlies working the late shift without a salaried supervisor. They now simply ignore it and tell the hourlies to go ahead. A supervisor is on call if they need one.

4.1.3 Provide Training (Rating: Partial (3))

Training is reported as unfocused, unplanned, sporadic, and poorly done, especially for hourly workers, but not much better for supervisors and managers. One interviewee pointed out that they were at the very beginning stages for training hourly workers and management training is not linked to the needs of the business. Most training of hourly workers is on-the-job training. The plant manager cites training for participation as his top concern at present. There is a needs assessment being done now.

There is training in SPC, with about 30% of hourly workers having taken a lengthy course. There was JIT training for everybody (one day for hourly employees and three days for those on salary).

There have been disagreements between management and the union over government sponsored training. The union wants it to be more universal (i.e. transferable to other employers) but management wants it to be a combination which is firm-based as well.

The plant manager reported that they have not had a coordinated training plan for supervisors, especially one that addresses participative management and people skills. It has been sporadic, not planned. He said that one supervisor was an exception but that this simply points out that they have not done their job with training.

4.1.4 Promote Teamwork (Rating: Partial (3))

At the management level, there is much evidence of teams and coordination between functions, which is very different than before. Currently, each product line is managed by a team.

At the level of hourly workers, it is the responsibility of each supervisor to decide how teams are organized and structured. Only one supervisor has promoted teams in any substantial way. One respondent reported that the supervisors were supposed to set up the teams but some do not and simply meet among themselves. However, another said that recently lots of teams have begun. And, yet another said that they started quality teams recently and the end-of-line acceptance rate shot up. This was attributed to the team efforts and supervisors taking ownership.

Another interviewee reported that there had been teams set up with union agreement but the agreement was since been withdrawn. Supervisors will form teams for specific purposes, but the plant has had little success with on-going teams.

4.1.5 Use Group Performance Measures (Rating: Marginal (1))

Overall, management is measured on fill rate and service call rate. However, there is little evidence of group measurement at the shop floor level; employees are measured on an individual basis. As one respondent said: "It's on an individual basis. There are no work cell measures, etc. Most areas have a day rate, that is, a quota of how many pieces to make. When they hit rate, they stop."

Managers are now being measured more on non-financial yearly objectives than in the past, but the measures are still based on individual performance.

4.1.6 Demonstrate Visible Commitment (Rating: Considerable (4))

As one respondent reported, internal company auditors told the president that there should be model families. So, the push for the recent assemble-to-order, model family approach came from the top down. The president gave the directive and assigned senior people to head up the initiative. One manager explained that the assemble-to-order approach was spearheaded by a manager at headquarters after being given the corporate mandate. It is well understood by the managers and most employees that the firm is moving strongly in the assemble-to-order direction. Whether or not they agree, they understand that this is where the plant is headed.

As well, the strong insistence by management that responsibility be moved down in the organization demonstrates a strong and visible commitment to JIT-like approaches.

Also, one respondent outlined how a new plant manager was brought in after the strike a few years ago. He showed demonstrated management commitment to putting the plant back in control with respect to discipline, absenteeism, fighting, and so forth. However, he was removed shortly after establishing this level of control, apparently because of a lack of commitment to the assemble-to-order approach. As one respondent explained, the move to model families stalled because there was no full commitment, at that time, from the plant-level managers. They got what they wanted but did not know how far they wanted to go.

Another respondent said that a current common problem is moving too fast. The managers tend to walk away after some initial efforts rather than staying and being seen to support initiatives.

4.2 Employee Involvement

4.2.1 Employee Involvement (Rating: Considerable (4))

The questionnaire reveals a high level of employee involvement according to two measures. However, these results must be tempered for two reasons. The first is that the managers and supervisors are being asked to increase their level of involvement very quickly so their responses probably reflect relative rather than absolute levels. Second, the responses of managers and supervisors likely indicate their newer, stronger involvement rather than involvement by hourly employees. And third, the workers who did fill out the questionnaire all report to the one supervisor known for obtaining involvement. Nevertheless, the results still indicate a considerable move towards involvement. The measures are 1.278 (before) and 4.810 (now) for group activity and 2.367 (before) and 4.033 (now) for employee involvement.

One respondent offered evidence of ad hoc involvement during a promotion day for a special customer in which 95% of employees wore the special T-shirts, with the other 5% being the major union representatives. He said everyone pitched in and cleaned and so forth. He added that employee involvement was working because, unlike before, if an employee were to ask a staff person to do something, the staff person would now follow up and make sure.

Other evidence offers a more muted assessment. For example, one informant, when questioned about a project which had been touted as a good example of employee involvement, said that there were no hourly workers involved at all on the project. Rather, two engineers studied, designed, and did the project, consulting with supervisors and group leaders but not with hourly workers. As well, he pointed out that standards are set without worker input and minimal input from coordinators when doing assembly line balances.

4.3 Flow

4.3.1 Setup Reduction (Rating: Some (2))

There is little effort directed towards to setup reduction. The questionnaire reveals values of 1.036 before and 2.893 now. There is no evidence of the type of setup reduction typical under a JIT approach, namely, employee involvement in analyzing changeovers, practising, developing fixtures, reducing adjustments, and so forth. Instead, they were either acquiring better equipment capable of quick changeovers or not bothering.

One setup example concerned changes by one operator at a computer terminal whenever material sizes changed. The setup was automatic and done by simply typing in the code for the desired part.

Another example concerned one group modifying a computer numerical control (CNC) machine to do drilling operations as required for one-piece flow (although there were bottlenecks elsewhere preventing one-piece flow).

4.3.2 Equipment Layout (Rating: Partial (3))

There is not much in the way of layout changes for efficient flow, except that there are definite product flows. There are some cells set up, but not many. As one respondent said: "From the point of view of material flow, we're still in our infancy."

One example of this concerns some sub-assembly operations which had once been performed close to the final line but have since been moved to a separate area of the plant. The units are now moved to the line via carts in lots of about fourteen.

The questionnaire confirms this lack of emphasis on layout with ratings of 1.619 before and 3.286 now.

4.3.3 Small Lot Size (Rating: Extensive (6))

With the recent assemble-to-order initiative, there has been a drastic reduction in lot size. This is confirmed by the questionnaire which shows values of 1.190 before and 4.857 now.

As one respondent said: "We want a situation where Mrs. Smith orders on Monday, we produce Tuesday, and it's shipped by Wednesday. We would like to think we can do "one pers." This is a complete change from three years ago. Then, there were lot sizes of at least 200, with 500 being more comfortable." And another added: "Two years ago, we ran 15 models per week at about 200 units per run; now we run 60 models per week at about 50 units per run." Another respondent said they were running lot sizes of about 20 or 30 with respect to minor pattern but lot sizes of about 100 per model.

This existence of small-lot production without corresponding setup reduction explains other statements made about how small-lot production would have been impossible with a mixed line, how a formerly mixed line was split in two, and so forth. They have reduced lot sizes but they do not do the corresponding quick changeovers; rather they tend towards dedicated lines.

4.3.4 Repetitive Master Schedule (Rating: Considerable (4))

They operate on an assemble-to-order, fixed, three-day schedule. So, although they do not have a repetitive schedule in the sense of building the same mix every day, they do build roughly the same mix of model families each day. They know from historical data that models and options will fluctuate but families stay fairly consistent. They have about nine families for one product line and about five families for the other. So, in this sense, with lot sizes of about 50 and daily production of about 700, they do have a repetitive master schedule ((9+5)*50=700). As one interviewee pointed out: "We found that "like" groups had consistent sales patterns even though the individual models fluctuated." They have moved from six-month schedules to one month and now to three days.

Another respondent said that the assemble-to-order approach has also cut out the wild swings in inventory. It takes out the shock waves and they do not get panic phone calls as often. There is less expediting, special setups, and special deliveries. These signs are all consistent with a repetitive master schedule even though theirs is not strictly repetitive.

The questionnaire does not seem to support the above comments, with ratings of 1.857 before and 3.381 now. However, the items in the scale do not properly account for the type of assemble-to-order situation here. For example, these items inquire about the same mix of products and models from hour-to-hour and day-to-day, which is not strictly true when the mix is by family. For this reason, I am discounting the questionnaire slightly and relying more on interview data.

4.3.5 Daily Schedule Adherence (Rating: Some (2))

There was not much discussion of this category. The questionnaire results (before, 2.095; now, 2.381) indicate a low level in terms of daily adherence to the schedule. In particular, there was little evidence of scheduling in which time would be set aside for activities such as employee meetings or scheduled maintenance.

4.3.6 Pull System (Rating: Partial (3))

There is little in the way of a pull system. Most operators determine what to produce next via a schedule or via a supervisor. There are some isolated instances of pull arrangements and there are some related activities such as the use of standardized containers.

There is some evidence of pull signals such as filling the positions in a carousel, when depleted. And, one feeder line fills certain racks with parts and then stops, if full. One respondent said that there are three or four main uses of kanban in fabrication areas in which they simply fill empty carts when returned. But, these are isolated cases. Other areas still work to schedule. They are now making efforts to get more feeder departments operating via pull systems.

For about ten different situations, while on plant tours, I asked my guide how a particular operator knew what to do next. The answer was always that the signal came via the schedule or the foreman. There was no hint that anyone was responding to pull or broadcast signals. As well, they are not yet at the stage of pull signals to vendors, although they are using standardizing container sizes.

The questionnaire results confirm these conclusions. The scale that refers directly to use of kanban had a rating of 3.000 now, with 0.643 before, and the one that refers to triggering and issuance of the schedule to final assembly had a rating of only 2.619 now, with 1.619 before. There was a higher rating for a scale which included the idea of fixed containers (2.560 before; 3.920 now), something this plant does, but, to a schedule, not via pull signals. Thus, I am discounting this higher value.

4.3.7 JIT Delivery from Suppliers (Rating: Considerable (4))

There is a fair amount of JIT delivery from suppliers. Currently, they do not use pull signals although they do use standard containers. One respondent pointed out that the major thrusts with assemble-to-order have been trying to get daily deliveries on big, bulky, common items. They have always had some daily deliveries on some items, but are doing this now on others. He said they were not like a Japanese company and could not envisage suppliers all around. But they are doing what they can to supply JIT. He added: "We have some vendors shipping in returnables, but it's not really kanban. It's driven by a daily schedule." As well, they do have trucks running regular routes to pick up supplies.

Another respondent said that the frequency of delivery is up, with the use of returnable containers up quite a bit. And a third respondent said he has had no supplier has questioned their approach to JIT supply; all said yes. They promise suppliers that, for planning purposes, they can believe their numbers over a 26-week horizon. This, in turn, allows suppliers to bring lead times down.

The questionnaire gives a fairly strong indication of JIT delivery, with values of 1.250 before and 4.143 now.

4.4 Quality

4.4.1 Supplier Quality Level (Rating: Considerable (4))

There is a fair degree of effort directed towards supplier quality. They do a number of things such as look at the historical record of the source supplier, having engineers and quality people out to visit suppliers, asking suppliers to show their plans, and having suppliers visit them. As well, they have become involved with a head office program of vendor certification, wherever there is a common supplier. This involves signing up value-added suppliers to long-term contracts. The contracts specify price, production, quality, recourse if there are problems, and competitiveness with the market. They currently have about ten such agreements and are looking at others. As well, they were trying to cut their vendor base to have long-term supply relationships. To date, they have gone from about 1400 suppliers to about 550, with still more to cut. The questionnaire results (before, 1.542; now, 3.821) support the above comments.

One informant said that now, it is now easier to deal with a minor quality problem. Five years ago, there would have been lots of paper and emotion. But, now, it is as simple as a phone call. They speak with more than the supplier's sales force; they speak with engineers, operators, the general manager, and others.

However, another respondent said that, in many cases, their suppliers were ahead of them. He offered an example of a visit to a vendor where they were all surprised when told by a shop floor employee of the benefits of SPC. He commented: "We have a problem; we can't clean up our own house, which we should do first." He said they do very little in the way of helping vendors improve their processes.

4.4.2 Zero Defects Quality Control (Rating: Partial (3))

There is little in the way of zero defects quality control efforts at Plant D. The questionnaire indicates values of 3.257 now, with 1.914 before. On tours, there was no indication of poka yoke devices except for one station where a safety-related element was 100% inspected.

In answer to the question about mistake-proof devices, one manager said they did not have a program in place to focus on this. He said they try to incorporate mistake-proof devices in specific areas but it is very marginal; they might do it now and again but usually as a sub-problem.

4.4.3 Statistical Process Control (Rating: Partial (3))

One respondent has been teaching a lengthy course in SPC, so far, to about 300 people (30% of the hourly employees). They bought it in from another outfit but put a company touch on it.

They now have about 30 workstations on SPC, whereas two years previous, they had none. However, the results differ widely. In most areas, SPC is done by operators, but in some it is still done by quality analysts. The questionnaire shows results of 3.542 currently and 1.167 before.

4.4.4 Use of Charts and Feedback (Rating: Partial (3))

There were roughly 25 new quality control boards up but not much evidence of use by employees. That is, there were very few notes, markings, messages, etc. The questionnaire results are consistent with this, showing ratings of 1.314 before and 3.086 now.

4.5 Plant Environment (Context)

4.5.1 Decentralization Of Authority (Rating: Considerable (4))

There have been very rapid moves towards decentralization. The plant, once organized functionally, has been split into two focused factories, each concentrating on a particular product line. There has been "de-layering," with a level of management removed and more planned. The questionnaire results confirm this in that they went from decentralization ratings of 2.413 a few years ago to 4.053 now.

The assignments and roles of engineers and other staff positions have changed dramatically. As one respondent said: "In the old hierarchy, we had to go on our hands and knees to the engineers and, even if you got them on your side, you would have to wait for three months for anything to happen. This is because design engineers were looking at long-term interesting design problems, so someone crying about day-to-day problems was not a priority." As well, he added that they have eliminated the quality assurance function which is now diffused through all areas.

4.5.2 Management by Wandering Around (Rating: Some (2))

There was very little discussion of this category during interviews. The plant manager was described by one respondent as being more externally oriented compared to a typical plant manager. The questionnaire (before, 1.923; now, 2.444) leads to the conclusion that the level of management visibility in terms of managers and manufacturing engineers on the shop floor is not that high.

4.5.3 Coordination of Decision Making (Rating: Partial (3))

There are differing opinions in the plant about the extent of coordination of decision making. There are numerous reports of regular meetings across functions as well as working sessions for various projects, indicating a fair degree of coordination. There is a high degree of coordination among managers, as they are being forced to operate as a team for each of the product lines; there is no one person in charge of each line.

One respondent reported that a multifunction group meets weekly to discuss product improvement. He added: "It's the best thing that's happened. Before, you could not get any cost reductions through; it was like pulling teeth. Now, the production, engineering, and quality people are there; they listen. They accept or reject your proposal. And we have a tracking sheet and follow up on commitments. This is one of the best changes that has happened."

However, there were also reports that coordination was not all that good. One interviewee pointed out that people communicate well within teams but not between teams. Another said the materials people and the manufacturing people still do not see eye-to-eye. The questionnaire results (before, 1.958; now, 3.286) reflect this mixed report.

4.5.4 Supervisors As Team Leaders (Rating: Considerable (4))

The role of the supervisor at the plant has changed drastically and quickly, with the changes having begun only a short while ago. This is reflected in the questionnaire which shows values of 1.933 before and 4.422 now. One interviewee said that, in the last 12 to 16 months, the focus was on individual supervisors to take more responsibility for quality teams and so forth. Another said that improved end-of-line acceptance was from team efforts and supervisors taking ownership, although some supervisors have not yet set up teams but simply meet among themselves.

There are still problems because of the quick rate of change. One respondent said that the supervisors' jobs were changing weekly and they still must learn to consider their whole unit instead of trying to do all the details. And another pointed out that supervisors are now under a lot of stress because their responsibilities have increased without any decrease in workload nor any certainty about expected head count reductions.

The supervisors are being pulled in two directions: by the company and by the union. Another interviewee pointed out that the people in the middle are the ones in the squeeze. And, another added that supervisors cannot push work down to coordinators because of union resistance; they say it is the supervisors' responsibility.

4.5.5 Affective Commitment (Rating: Partial (3))

There have been minor improvements in affective commitment (or loyalty). The questionnaire data reveals values of 3.175 before and 3.650 now.

One interviewee claimed that now the average employee is happier. Another said that, two years ago, employees showed up just for the paycheque but now show up for something more. And another reported about 2% absenteeism per month which he considered quite good.

4.5.6 Plant-Wide Philosophy (Rating: Partial (3))

There is very little evidence of a common philosophy in the plant. Rather, there are various views operating simultaneously. There is some evidence that some of the newer views are being slowly adopted throughout the plant.

There is a general sense that majority of workers understand the competitive need to be more productive. One respondent said that there has been a significant conversion, or cultural shift, but with some resistance. There is much scepticism as many see management's efforts as another "program of the year." He also reported that there was a philosophical difference in the plant over whether to concentrate on production or quality.

There is also a difference in philosophy reported between employees and their union. One interviewee said that employees understand the link between their work and competitiveness but the union believes the plant will close soon and so believe they should take what they can now.

The company is heading towards self-directed teams, but the union is reported to call "team" a four-letter word. Currently supervisors are able to form teams for specific purposes but the company is unable to obtain agreement with the union about setting up on-going teams. One respondent added that the union is against problem solving teams but the workers generally support teams. But, he also cited an example where one supervisor has a great team which even includes some local union executive members.

Another respondent said that the coordinators can do the job now but the union environment holds them back; it is a problem of philosophy. He added that if the plant were a non-union shop, it would be a different story.

The questionnaire confirms this lack of plant-wide philosophy with ratings of 2.467 before and 2.833 now.

4.5.7 Employee-Management Relations (Rating: Partial (3))

There is a history of very negative and confrontational employee-management relations. This was confirmed by almost everyone interviewed, with no real statements to the contrary. The treatment of employees and the quality of work life were reported by numerous interviewees as having been poor. They have had problems concerning some bitter strikes, many grievances and discharges, theft, fights, and drugs. As one respondent explained, people were poorly treated here, doing only what was ordered, with communication flowing only one way.

A few years ago, a new plant manager cleaned things up in the sense of insisting on certain rules of conduct, firing a number of hopeless cases, and so forth. The union was and still is quite militant and has resisted cooperation with management, with some exceptions. In general, they do not believe in participation.

On plant tours, the atmosphere was somewhat tense and few workers looked up to interact with my tour guide or take note of our presence. I had the distinct impression that there were a number of angry people here.

Management tends to view employees as being distinct from the union. One said there is a small contingent of activists, but very apathetic employees, and added that, one-on-one with employees, relations are excellent, but with the unions, relations are pathetic. Another said they had two forces in the plant, namely, the manpower at large and the union. And another said, the people are not militant, just the union.

In spite of the previous statements, managers stated that there were definite signs that relations have improved and are improving. But, there are still some major issues such as classification and team participation to be resolved. One said: "Now, within the last five years, it has begun to turn around. But you don't turn 40 years of whipping around quickly. The union appears to be cautiously optimistic. The manpower at large is more cooperative since the last strike in 1987. It was wild out there then; you could cut the tension in the air."

Another manager gave an example of better relations in that he had received a grievance which he was able to resolve directly with the steward. He said that, previously, this never would have happened; then, the union would have pushed it all the way.

The questionnaire results indicate that employee-management relations are improving fairly dramatically with a rating of 2.208 a few years ago having changed to 4.200 now. Nevertheless, I am discounting this higher figure in light of previous comments. I strongly suspect that it is an based on the dramatic improvements in relations which have occurred in a very short time rather than an indication of a high absolute level of good relations.

4.5.8 Influence on Employer (Rating: Partial (3))

During the interviews, there was little discussion of influence by employees. The guide here is the questionnaire, as it was also completed by a number of hourly workers who were not interviewed. It indicates that employees have gone in a very short time from having little influence over how they do their work and solve work related problems (2.000) to having a considerable amount (3.867). However, as these employees all report to the one supervisor known for JIT efforts, I am discounting the results somewhat.

As well, one manager said that there is pressure coming from workers for more participation in the work environment. This indicates that they must, therefore, perceive that they can have some influence.

4.6 Summary

In the following table, I summarize the findings by category for Plant D:

Table 5.4
Summary - Plant D

Management Initiatives		
Employment Security	None (0)	There is no provision for employment security and no sense that there will be increased sales. The only hope for security is for the plant to do a very quick turnaround and produce much more efficiently than in the past.

Employee Responsibility	Considerable (4)	There has been a strong move to push responsibility down to lower levels in the organization. The goal is the empowerment of hourly workers. However, this has not had time to filter to the hourly level; it is still being worked out at present at the level of middle management.
Training	Partial (3)	Training is reported as unfocused, unplanned, sporadic, and poorly done, especially for hourly workers, but not much better for supervisors and managers. There is training in SPC and there was JIT training for everybody. Most training of hourly workers is on-the-job training and management training is not linked to the needs of the business.
Teamwork	Partial (3)	At the management level, there is much evidence of teams and coordination between functions, which is very different than before. Currently, each of the product lines is managed by a team. At the level of hourly workers, it is up to each supervisor decides how teams are organized and structured. Only one supervisor has promoted teams in any substantial way.
Performance Measurement	Marginal (1)	There is little evidence of group measurement at the shop floor level; employees are measured on an individual basis. Most areas have a day rate and when they hit rate, they stop. Managers are now being measured more on individual non-financial yearly objectives than in the past. The only indicator of group measures is the firm measuring management on fill rate and service call rate.

Visible Commitment	Considerable (4)	The push for the current assemble-to-order, model family approach came from the top. Managers and most employees understand that the firm is moving strongly in this direction. The initiative had stalled because former plant-level managers had not been fully committed.
Employee Involvement	Considerable (4)	There is a strong move towards more involvement. There is currently little involvement of hourly workers; involvement is still at the level of group leaders and supervisors.
Flow		
Setup Reduction	Some (2)	There is not much effort directed towards setup reduction and certainly not the type of setup reduction typical under a JIT approach, namely, employee involvement in analyzing changeovers, practising, developing fixtures, reducing adjustments, and so forth. There were some isolated instances of setup reduction relying chiefly on improved machinery for faster setups.
Equipment Layout	Partial (3)	There is not much in the way of layout changes for efficient flow, except that there is a definite product flow. There are some cells set up, but not many. As one respondent said: "From the point of view of material flow, we're still in our infancy."
Small Lot Size	Extensive (6)	With the recent assemble-to-order initiative, there has been a drastic reduction in lot size. "Two years ago, we ran 15 models per week at about 200 units per run; now we run 60 models per week at about 50 units per run." They are doing small-lot production without

		corresponding setup reduction (by avoiding mixing models on a line).
Repetitive Master Schedule	Considerable (4)	They operate on an assemble-to-order, fixed, three-day schedule. So, while they do not have a repetitive schedule in the sense of building the same model mix every day, they do build roughly the same mix of model families each day.
Daily Schedule Adherence	Some (2)	There is little daily adherence to schedule. In particular, there was little evidence of scheduling in which time would be set aside for activities such as employee meetings or scheduled maintenance.
Pull System	Partial (3)	There is very little in the way of pull systems. Most operators determine what to produce next via a schedule or via a supervisor. There are some isolated instances of pull arrangements and there are some related activities such as the use of standardized containers.
JIT Delivery from Suppliers	Considerable (4)	There is a fair amount of JIT delivery from suppliers. Currently, they do not use pull signals although they do use standard containers. "We have some vendors shipping in returnables, but it's not really kanban. It's driven by a daily schedule."
Overall JIT Flow	(3.43)	
Quality		
Supplier Quality Level	Considerable (4)	There is a fair degree of effort directed towards supplier quality. They are involved with vendor certification and long-term supply arrangements. To date,

		they have gone from about 1400 suppliers to about 550, with still more to cut.
Zero Defects Quality Control	Partial (3)	They do not concentrate on mistake-proof devices, nor on 100% source inspection except in one safety-related case.
Statistical Process Control	Partial (3)	They have given training to about 30% of hourlies and have about 30 workstations with SPC. However, some of these still have quality analysts, not operators, doing the charting.
Use of Charts and Feedback	Partial (3)	There were roughly 25 new quality control boards up but not much evidence of use by employees. That is, there were few notes, markings, or messages on them.
Overall JIT Quality	(3.25)	
Plant Fnvironment (Context)		
Decentralization of Authority	Considerable (4)	There have been very rapid moves towards decentralization. The plant, once organized functionally, has been split into two focused factories, each concentrating on a particular product line. There has been "de-layering," with a level of management removed and more planned.
Management by Wandering Around	Some (2)	The level of management visibility in terms of managers and manufacturing engineers on the shop floor is not that high.
Coordination of Decision Making	Partial (3)	There are differing opinions in the plant about the extent of coordination of decision making. There is a high degree of coordination among managers but there are coordination problems at other levels.

Supervisors as Team Leaders	Considerable (4)	The role of the supervisor at the plant has changed drastically and quickly. Lately, the focus has been on individual supervisors to take more responsibility. There are still problems because of the quick rate of change, with supervisors being caught in the squeeze between management and union expectations.
Affective Commitment	Partial (3)	There have been minor improvements in affective commitment (or loyalty). There are reports that the average employee is happier and shows up for more than the paycheque, and absenteeism is running at a low value of 2%.
Plant-Wide Philosophy	Partial (3)	There is no common philosophy throughout the plant. Rather, a number of differing views operate simultaneously. Some newer views are being slowly adopted throughout the plant.
Employee-Management Relations	Partial (3)	Employee-management relations have improved and are improving but there major issues yet to be resolved. Management tends to view employees as being distinct from the union. There is a history of very confrontational relations. The treatment of employees and the quality of work life were poor.
Influence on Employer	Partial (3)	Employees have gone in a very short time from having little influence over how they do their work and solve work related problems to having a considerable amount.

5 Plant E

Plant E is a branch plant of a Canadian parent, located in central Canada. It is unionized and currently employs about 570 people. There are four main product lines, and about seven others. At the time of my visit, it had recently been organized into six focused factories.

It is mainly a supplier to original equipment manufacturers, with one major customer, among a number of others. It delivers over 90% of its product on a JIT basis and is going through the process of being certified as a JIT supplier.

Its bills of material are about four or five levels deep with a total of about 500 parts. Its operations are still about 80% job shop oriented, with a typical order size in the hundreds of units.

5.1 Management Initiatives

5.1.1 Provide Employment Security (Rating: None (0))

No efforts are made to provide employment security. In response to a question about job security, the general manager said that they were telling employees that they were not secure. He said: "We've done damn near everything to make them feel insecure." And, in response to another question: "We never really said: 'If your idea improves productivity, we won't get rid of you.'"

Another respondent said employee involvement is difficult to promote during a downturn unless there is a commitment that savings will not result in job loss. He said they were stuck as they could not promise this. And another said they do not have a policy on job security although he has raised the notion many times, in particular with respect to cost reductions.

5.1.2 Promote Employee Responsibility (Rating: Some (2))

Management efforts to increase employee responsibility have extended to the middle manager and supervisory levels due to their decentralization to focused factories. However, they still do not assign much responsibility to hourly workers.

Four different respondents commented that they do not use the human resources available, people were not allowed to have input, they were not even close to operators having press ownership or the authority to shut down, and they treat hourly employees poorly by asking them to leave their brains at home.

Two supervisors, however, pointed out that they do assign more responsibility to employees but do so on their own initiative, not at management request.

5.1.3 Provide Training (Rating: Partial (3))

A number of respondents indicated that there was not much in the way of formal training although there is some for special purposes such as MRP, SPC and safety. Otherwise, the employees choose which avenues to pursue, if any. Employees get some time off for courses and are reimbursed. Training tends to be seen as a cost rather than an investment, so the dollars tend to be unavailable when times are tough. As well, training is directed more towards salaried employees than hourly and more towards skilled than unskilled.

During the recent change to focused factories, there was no training for the new focused factory managers, in particular, for participative skills.

A few interviewees indicated that there is a fair amount of training, both in house and out of house and that the amount of such training was increasing. However, they said it was not part of a planned program.

Two respondents reported on a previous program in which employees were trained in trouble-shooting skills and groups were allowed to choose their own problems. Eventually, the program faded away because they started on trivial problems such as whether or not they needed a baseball diamond.

5.1.4 Promote Teamwork (Rating: Some (2))

There were teams in the past but they faded away. Four respondents reported that they used to have employee involvement groups (or trouble-shooting teams) a few years ago, each with a cross-section of hourly and salaried employees along with a leader, from staff or from the ranks. They met weekly for about half an hour to work on projects, some which were not important but some which were significant.

Currently, however, there are no formal programs for team promotion. As one respondent said: "In the 1992 budget, we have added in problem solving hours, but there is nothing formalized. We just take four people, say, and solve problems." A supervisor confirmed that managers do not ask them to form teams. He said some employees or foremen will interact on their own but not the managers. The general manager confirmed this lack of formal approach by discussing a current effort to invite operators to join a problem solving team as a first for them.

There are management encouraged teams, typically composed of supervisors. One respondent confirmed that workers were not typically on task forces but that occasionally the opinions of hourly workers will be asked.

5.1.5 Use Group Performance Measures (Rating: Marginal (1))

A number of respondents pointed out that direct labour is measured by incentives, that the plant is an incentive shop. One respondent said that incentive measures are first, on individual basis, and only where not possible, do they go to a group standard.

The contract requires that the plant identify the bottleneck and that standards are set from that operation. The common unit for performance measurement is standard pieces per hour. One interviewee referred to their system as a "walk away incentive system" in that learning effects are lost to the company. Any learning after standards are set accrues to the employee.

A number of respondents indicated that there were conflicts between the incentive system and various competitive priorities. One reported, with the new system, which says: "Don't make more than you have to," an operator will just begin making bonus and the machine will be down for changeover. As well, there is no incentive to produce quality parts; there is no scrap adjustment.

Another added that the incentive system promotes misuse of the "small lots" concept (i.e. there is an incentive to do long runs). As a minor example, the workers are able to convince foremen to let them run large lots. He also pointed out that they had efforts aimed at operator process control for at least five or six years but it did not work because of the incentive system.

Another respondent said: "Quality is not recognized here. We can send out shoddy material. Workers get incentive; they are paid for good or bad parts." As well, the general manager said, from a quality point of view, incentives are anachronistic and have got to go; it is just a question of time. And yet another interviewee said that the incentive system is in the way of reducing the number of classifications.

And a further respondent said workers are antagonistic about increases in the number of setups because it is physically more work and means a change to the incentive rate (i.e. more work and less money).

The plant is currently considering various profit sharing schemes and group incentives to be proposed at the next contract negotiations. As one respondent said: "If we expect teams, there should be incentives based on teams." And a manager said his number one objective for this contract was to move away from the individual incentive-based pay system to one based on performance. He also said that they have put more monitors (i.e. measures) on the skilled trades area. Before, there was no way to measure skilled trades.

5.1.6 Demonstrate Visible Commitment (Rating: Partial (3))

There are some signs of visible commitment by management. As part of the move to focused factories, the offices of all salaried people on each team are now in portable buildings right on the factory floor. As well, there is a new management team; those who wanted the old ways are gone.

However, there are a number of signs that management is not as committed as some respondents would like. One interviewee commented that when managers walk around, people only receive bad comments. They are never told they did a good job. Another criticism, from a number of respondents, was that management will not challenge the union They do not take steps to remove the bad people nor will they fight grievances.

5.2 Employee Involvement

5.2.1 Employee Involvement (Rating: Some (2))

There is very little involvement of hourly workers. One respondent said that there were no employee involvement efforts except for a monthly one-hour safety meeting, at which they never discuss production. As well, the general manager said: "But no, we haven't addressed this issue of employee involvement in productivity improvement. We don't do much of that." A few other respondents confirmed that they do not ask direct workers for input nor invite them on task forces.

There used to be an employee involvement program, as outlined by five respondents. They were structured in volunteer groups of 10 to 15 salaried and hourly employees which met weekly for about half an hour. The program did not work because the company was not committed to it, according to one respondent.

The only current area of employee involvement is an individual incentive and suggestion program. Certain employees receive recognition and cash prizes for improvement suggestions. The average annual number of improvement suggestions stands at 1.72 per employee compared to 1.43 before, which is rather low compared to Japanese examples in the order of fifteen per employee per year.

Employee involvement is stalled by relations with the union. The plant had made overtures to the union officials, who eventually said no. Instead they received a letter from the union national headquarters saying it was their policy to oppose employee involvement.

One respondent commented that, in his opinion, employees in the plant would be happy to participate. Another relayed a story in which some accidental good work followed by some unexpected praise led to increased effort by employees to do even better.

The questionnaire indicates low to neutral values for employee involvement at the plant. The measures for group problem solving (1.815 before and 2.884 now) and for individual employee involvement (1.956 before and 3.000 now) are about the same. However, I am discounting even these neutral values in light of the interview data.

5.3 Flow

5.3.1 Setup Reduction (Rating: Some (2))

There are a few isolated instances of setup reduction but little is being done. One respondent said that, on average, each machine changes over each shift and they are looking at two to three setups per shift.

One example of setup reduction was a transfer press that is now down to a six-hour changeover where it previously took twice as long. This was accomplished simply by suggesting that setups should be shorter. However, this is hardly in the range of "minutes" typical under JIT operations.

One respondent reported that they had a task force for quick die change but said they do not organize properly and are not making moves to change their approach. He added that their first run capability is a problem; a typical setup takes three to four hours whereas it should be one-half hour, maximum.

Another said that there are big opportunities for setup reduction, but MRP started by assuming existing setup times. And, another said that they were doing very little, given some setups at 12 hours and the quickest at one-half hour or lower. And another respondent said that, recently, a supposed four-hour changeover took 12 hours.

During interviews, there were good indications offered that setups could be done much faster, even with current circumstances. However, most people are reported to have no idea about how long a given setup should take. There is no documentation on requirements, so they proceed according to established routines.

The questionnaire confirms the low level of effort on setup reduction (before, 1.156 and now, 2.250).

5.3.2 Equipment Layout (Rating: Partial (3))

Not much has been done with respect to layout changes, although some batch operations have been combined into lines, via conveyers, leaving little inventory between stations. The questionnaire results (before, 2.407; now, 3.444) indicate a neutral level for equipment layout.

One respondent said that they do just the odd thing here and there. There's been some changes, such as pulling machines together and adding conveyers between the presses. Another said that, for one seven-step process, there now is no stock and throughput is ten minutes. And another respondent outlined an example of a very jumbled flow for a part which followed a routing across the plant a number of times, including once outside for one operation, before being shipped. He said that, overall, not much is done with respect to layout.

5.3.3 Small Lot Size (Rating: Considerable (4))

They are moving in the direction of smaller lot sizes. Their new system of visual replenishment, used for execution of the MRP schedule, makes this move easier. The questionnaire responses (before, 2.250; now, 4.167) indicate a considerable amount of small-lot production.

One respondent said the days of batch jobs with high inventory were gone. They are now looking at a lot size of about 200. Another said they were now trying to order quantities at a fixed number of days. Yet another said that, in one year, they had cut inventory in half, achieved via a formalized schedule, small lot sizes, and more setups.

5.3.4 Repetitive Master Schedule (Rating: Partial (3))

MRP provides the schedule, indicating that the schedule is not repetitive. The system of visual replenishment is used for execution of the plan. The questionnaire results (2.286 before and 3.333 now) indicate that the schedule is not repetitive in the sense of the same daily mix. This is consistent with an MRP-based system.

5.3.5 Daily Schedule Adherence (Rating: Partial (3))

One manager posts a weekly schedule with the rule being to hit the schedule but not run over. However, he said: "We should meet schedules on a daily basis but the big problem is mindset," indicating that, they currently do not strictly adhere to daily schedules.

The questionnaire results (2.792 and 3.259) indicate little time in the schedule to allow for meetings, quality problems, and scheduled maintenance.

5.3.6 Pull System (Rating: Partial (3))

The most prevalent use of a pull system is the use of pull signals from the majority of the plant's customers who do require JIT delivery. The few customers who are not operating in such a fashion have either been dropped or are probably going to be dropped.

Internally, they use an MRP scheduling system along with a system of "visual replenishment," used for execution of the schedule. This was a conscious decision at the time MRP was put in place, not an afterthought. However, visual replenishment is not a true pull system. Rather, the operator uses a dispatch list in conjunction with the visual replenishment rules which tell which job is next. But, the authority to produce comes from the dispatch list, not a downstream pull signal. The visual signal merely tells the operator to check the supervisor's dispatch list and then produce if the list confirms.

The questionnaire results (before, 2.139; now, 3.444) support the assessment that there is definitely a pull system operating but not a complete pull system. As well, the scale I added, aiming more at the signalling aspects of a pull system indicate neutral levels (1.741 before and 3.185 now). The scale from Sakakibara et al. indicate 2.378 before and 3.600 now and the kanban scale indicates 1.906 before and 3.219 now.

5.3.7 JIT Delivery from Suppliers (Rating: Considerable (4))

There is a fair amount of JIT delivery. The questionnaire revealed values for JIT delivery of 2.500 before and 3.944 now. They now have smaller orders arriving more frequently. As an example, previously they would have ordered 150,000 lbs of steel per order; it is now about 100,000 lbs per order. One respondent said that things have improved in monitoring the inventory. Now, there is not as much scrambling and not as many special situations.

Steel is their major input, but for some other items they still order by the week because of minimum quantity orders and other cost factors, but pick up twice a week, picking up half a week's supply of each of two items on the same run. They control the freight through a lease arrangement which allows them to control the shipping because they can decide not to send the truck when supplies are not needed (e.g. when their customer is shut down). Otherwise, some suppliers would continue to ship, whereas it is better left on the supplier's dock.

A major customer is applying a JIT certification program to them, so they do the same with their suppliers. Most components are single sourced, as there are issues of lot traceability. However, this was the case before their recent changes. They are now formalizing continuous improvement procedures toward partnerships.

One respondent pointed out that there is no incoming inspection on steel but this is because it is just too difficult to unroll the steel. Instead, they just take it and, if they find rust, they charge the steel company. But, as they are considered JIT items, shipping them back does not help the schedule.

5.4 Quality

5.4.1 Supplier Quality Level (Rating: Partial (3))

There were some indicators that efforts were underway to promote and improve the quality level of suppliers. In one example, they found a way to spend up front on tooling and get long-term savings. They agreed to a contract which included an initial price increase to cover the amortized tooling cost. As well, there are indications that they do make visits to assess suppliers.

Overall, however, they were still deciding how to meet the certification requirements of a major customer concerning their approach to suppliers. They had to satisfy the customer that they were doing a good job on supplier assistance, supplier selection, and measuring the continuous improvement of suppliers. They were trying to determine how to meet and document these requirements. Specifically, they were deciding how to measure their own suppliers, given limited time and resources. Some suppliers had been told but nothing formal had yet been done.

The questionnaire (before, 2.571; now, 3.643) paint a more complete picture than outlined above. However, I am discounting it somewhat in that they are clearly still in the early stages of deciding how to ensure supplier quality.

5.4.2 Zero Defects Quality Control (Rating: Partial (3))

There are isolated instances of supervisors and employees applying principles of 100% source inspection and mistake-proof devices. One respondent said they work on "irreversible corrective action" to make things positively trouble free. And another respondent does tell his people to stop a job rather than pass on defects. He asks the engineers to make the process mistake-proof whereas the old school of thought was to put up a sign asking operators to be more careful. Instead, sensors check each and every part, usually with pretty cheap, programmable logic, fibre optics, or similar. However, these are exceptions, not rules; there is no concerted program to move in this direction.

However, another respondent said that quality was not recognized at the plant. They could send out shoddy material as workers are on incentive and are paid for good or bad parts. Also, there was much sampling at the end of the line. Neither is consistent with a zero defects approach.

The questionnaire results (before, 1.889; now, 2.956) reflect the above comments.

5.4.3 Statistical Process Control (Rating: Some (2))

There is an SPC effort, but one respondent said they were only installing an SPC program because it is required by their major customer; otherwise, they would not do it. They still have the same process problems. He said they had a similar program for five or six years but it did not work because of the incentive system.

The questionnaire supports this assessment showing values of 1.417 before and 2.500 now.

5.4.4 Use of Charts and Feedback (Rating: Partial (3))

There is some use of charts and feedback but it is not a major characteristic of operations. One respondent said there are information boards in each area. For example, there are bottleneck charts and samples of products near the workstations. He said information is now more pertinent, for example, safety indices and customer complaints. The questionnaire confirms this with a 1.511 value for before and 3.089 currently.

5.5 Plant Environment (Context)

5.5.1 Decentralization Of Authority (Rating: Considerable (4))

The plant previously had a functional organizational structure. During the previous year, there was a dramatic change to a focused factory structure, focused according to customer. There is some sharing of resources but, in general, personnel are assigned to specific focused factories. At the time of my visit, they removed one reporting level. The existing organization had been divided previously into six focused factory units (but shortly after my visit, consolidated to three focused factories). The questionnaire results show a measure of 2.971 for before and 4.000 for now, indicating considerable decentralization.

They have moved back to a more centralized operation for maintenance, after assigning maintenance personnel to focused factories. They found that assigning maintenance personnel to specific units did not work well because it became impossible to utilize scarce skills where needed.

Many interviewees reported much fighting over resources which were not specifically assigned to focused factories. In particular, presses in the primary area service more than one focused factory. There are schedules for these presses, so whenever a press is down or behind schedule, disagreements arise over which manager should then have priority. As one respondent stated: "The reporting structure was changed. Now, it is possible for a number of managers to make demands on one supervisor. There are lots of conflicts of interest."

5.5.2 Management by Wandering Around (Rating: Considerable (4))

The questionnaire reveals that managers have become more visible on the shop floor, going from a rating of 2.667 to 4.013. This indicates that managers tend to be on the shop floor using face-to-face contact, rather than using memos. As well, one respondent reported quarterly meetings of everyone in the plant, addressed by the big bosses.

Although managers are visible on the floor, the general manager is not seen as much as was his predecessor. One employee reported this as well as the general manager who said he spent less than 5% of his time on the shop floor.

5.5.3 Coordination of Decision Making (Rating: Partial (3))

There is not much evidence of coordination between departments. Rather, there are battles between focused factory managers over access to resources, as discussed above under "decentralization." One respondent pointed out that, process-wise, the plant is easy to run but the six focused factory managers could not get together and work together. Another added that, when you have to share, the focused factory with the biggest customer wins out.

There are, however, examples of coordination between the plant and its customers, such as a chance to participate in product development teams and do simultaneous engineering. One example concerns engineers going with sales personnel to help sell technical competence.

The questionnaire supports a neutral assessment for this category, with values of 2.365 before and 3.000 now.

5.5.4 Supervisors As Team Leaders (Rating: Partial (3))

The role of the supervisor has not changed much. One respondent said they did not have a program to re-orient supervisors from the old style to the new style. Another said that supervisors are still there basically to supervise the people, although they do have more access to information now. A supervisor confirmed that he has not been asked to change his role.

Another interviewee pointed out that having maintenance personnel report to the supervisors did not work well because the supervisors could not supervise skilled labour. Rather, they were used to hourly workers and the maintenance function was seen as additional work they did not want.

The questionnaire results (before, 2.846; now, 3.641) reveal a somewhat stronger result, indicating that there is some encouragement by supervisors for workers to work as teams, exchange ideas, and so forth.

5.5.5 Affective Commitment (Rating: Partial (3))

Affective commitment has not changed much. Verbal reports were all negative. One respondent said that employees in one department are antagonistic about having to do more setups as it interferes with their incentive pay. They would prefer to simply sit and watch.

Another commented that about 75% of the employees are thick and think the union signs their cheques. He said that any foreman from any other firm would say that this plant had the most lazy, useless people you could find. And, another said: "Sometimes I have to beg the employees to work. If I hardnose them, they grieve and I lose. The union knows who runs this place." Another interviewee added that their number one constraint is "mindset" in that people do not ask why; they do not understand the process and they do not want to.

However, the questionnaire revealed, at least, neutral results, showing little change from 2.896 before to 3.094 now. The rate of absenteeism has declined from 13% absent per day to 8%, much improved but still quite high.

5.5.6 Plant-Wide Philosophy (Rating: Partial (3))

There is no common plant-wide philosophy. Instead a number of philosophies exist simultaneously. Various managers are pushing change, various employees want to follow along, many employees do not really care, and the union goes along but resists going too far. The questionnaire results reveal neutral ratings of 2.683 before and 3.050 now.

5.5.7 Employee-Management Relations (Rating: Partial (3))

There are varied opinions about the state of the relationship ranging from "always good" to "not good" to "cynical attitude." The questionnaire showed that employee-management relations have barely changed, with both measures (before and current) being in the neutral range (3.019 and 3.048).

There is rule by the union contract which overrides and can interfere with other considerations. This manifests itself most in terms of (1) the incentive system, (2) job rotation, (3) the number of classifications, and (4) the relatively high number of grievances. Management either cannot or will not enforce discipline, leading to a relationship in which many feel the union runs the show. As reported by one respondent: "Management's hands are tied when it comes to disciplinary action. They would rather chastise someone for being ten minutes late than deal with real problems costing [thousands of dollars]. They deal with menial problems only." Another added: "There is not a good relationship with the union. For example, they file a grievance and we are accused of nitpicking. Nobody learns any lessons here. On the floor, if a grievance is filed, the company won't fight it."

In the past, the union opposed already existing problem solving teams and took a policy position against employee involvement. There was a recent sign that this may be subject to some rethinking.

5.5.8 Influence On Employer (Rating: Considerable (4))

There was no direct discussion of this category. Nevertheless, the results of the questionnaire (before, 2.897; now, 3.974) reveal a fairly high degree of employee influence on the employer. This tends to confirm statements from respondents about the union running things, as there is little evidence of teamwork or other avenues for employee influence.

5.6 Summary

In the following table, I summarize the findings by category for Plant E:

Table 5.5

Summary - Plant E

Management Initiatives		
Employment Security	None (0)	In response to a question about job security, the general manager said that they were telling employees that they were not secure. "We've done damn near everything to make them feel insecure."
Employee Responsibility	Some (2)	Management efforts to increase employee responsibility have extended to the middle manager and supervisory levels via decentralization to focused factories. However, they still do not assign much responsibility to hourly workers.
Training	Partial (3)	There is a variety of training but it is not part of a formal program. It is directed more towards salaried employees than hourly and more towards skilled than unskilled. It tends to be viewed as a cost rather than an investment.
Teamwork	Some (2)	There were teams in the past but they faded away. Currently, there are no formal programs for team promotion. There are management encouraged teams, typically composed of supervisors. Hourly workers were not typically included.
Performance Measurement	Marginal (1)	Direct labour is mainly measured by individual incentives. There are numerous conflicts between the incentive system and various competitive priorities. The plant is planning to propose profit

		sharing and group incentives during the next contract negotiations.
Visible Commitment	Partial (3)	There are some signs of visible commitment by management such as many staff offices now on the plant floor and the removal of "old style" managers. But, there are criticisms about them being critical of individuals but not mounting a strong challenge to the union.
Employee Involvement	Some (2)	There used to be an employee involvement program but there is little now, only an individual incentive and suggestion program. The general manager said: "But no, we have not addressed this issue of employee involvement in productivity improvement. We do not do much of that."
Flow		
Setup Reduction	Some (2)	There are a few isolated instances of setup reduction but very little is being done. A typical setup takes three to four hours, often more.
Equipment Layout	Partial (3)	Not much has been done with respect to layout changes, although some batch operations have been combined into lines, via conveyers, leaving little inventory between stations.
Small Lot Size	Considerable (4)	There is a considerable amount of small-lot production. Their new system of visual replenishment, used for execution of the MRP schedule, makes this move easier.
Repetitive Master Schedule	Partial (3)	MRP provides the schedule, indicating that the schedule is not repetitive in the sense of the same daily mix.

Daily Schedule Adherence	Partial (3)	They do not typically meet daily schedules in the sense of hitting, but not exceeding, schedule nor is there scheduled time to allow for meetings, quality problems, and maintenance.
Pull System	Partial (3)	Most of the plant's customers require JIT delivery in response to pull signals. However, internally, they use an MRP dispatch list along with a system of "visual replenishment." The authority to produce, however, comes from the dispatch list.
JIT Delivery from Suppliers	Considerable (4)	There is a fair amount of JIT delivery. They have smaller orders arriving more frequently. They control the biweekly pickup of some other items. Most components are single sourced.
Overall JIT Flow	(3.14)	
Quality		
Supplier Quality Level	Partial (3)	Overall, they were deciding how to meet the certification requirements of a major customer concerning their approach to suppliers. Some efforts were underway to promote and improve the quality level of suppliers.
Zero Defects Quality Control	Partial (3)	There are isolated instances of supervisors and employees applying principles of 100% source inspection and mistake-proof devices. However, these are exceptions, not rules; there is no concerted program to move in this direction.
Statistical Process Control	Some (2)	There is an SPC effort, but one respondent said they were only installing an SPC program because it is required by their major customer; otherwise, they would not do it. They still have

		the same process problems. They had a similar program for five or six years but it did not work because of the incentive system.
Use of Charts and Feedback	Partial (3)	There is some use of charts and feedback but it is not a major characteristic of operations. There are information boards in each area, bottleneck charts and samples of products near the workstations. Information is now said to be more pertinent.
Overall JIT Quality	(2.75)	
Plant Environment (Context)		
Decentralization of Authority	Considerable (4)	They previously had a traditional organization structure with functional groups. Now there is a new focused factory structure with a number of focused factory managers.
Management by Wandering Around	Considerable (4)	Managers have become much more visible on the shop floor although this does not include the general manager.
Coordination of Decision Making	Partial (3)	There is not much evidence of coordination between departments. Instead, there are battles between the focused factory managers over access to resources.
Supervisors as Team Leaders	Partial (3)	The role of the supervisor has not changed much nor are they being asked to change. Supervisors are still expected to mainly oversee workers although they do have more access to information now.
Affective Commitment	Partial (3)	Affective commitment has not changed much. Verbal reports were negative. However, the rate of absenteeism has declined from 13% absent per day to 8%, much improved but still quite high.

Plant-Wide Philosophy	Partial (3)	There is no common plant-wide philosophy. Instead a number of philosophies exist simultaneously. Various managers are pushing change, various employees want to follow along, many employees do not really care, and the union goes along but resists going too far.
Employee-Management Relations	Partial (3)	There are varied opinions about the state of the relationship ranging from "always good" to "not good" to "cynical attitude." There is rule by the union contract which overrides and can interfere with other considerations. This manifests itself most in terms of the incentive system, job rotation, the number of classifications, and the relatively high number of grievances.
Influence on Employer	Considerable (4)	There is a fairly high degree of employee influence on the employer. This mostly confirms statements from respondents about the union running things, as there is little in the way of teamwork or other avenues for employee influence.

6 Plant F

Plant F is a branch plant of a U.S. parent, located in central Canada. It is unionized and currently employs about 560 people. There are three main and two minor product lines. The plant is divided into four focused factories, three assembling product and one operating as a components area.

It is an original equipment manufacturer as well as having about 15% of sales through distribution of products subcontracted to other manufacturers. None of its deliveries are on a JIT basis.

Its bills of material are about three or four levels deep. Its operations are about 40% components, 40% welding, and 20% physical assembly. A typical order size is in the hundreds of units.

6.1 Management Initiatives

6.1.1 Provide Employment Security (Rating: None (0))

There are no efforts to provide employment security. One respondent said that the notion of job security is not part of the environment firms are used to in North America. He said that simply offering lifetime employment is not the answer but that workforce stability is important. He said they are not making statements and promises; to do so would be to "buck a strong trend."

And, a number of respondents mentioned a previous sizable downsizing effort and an upcoming shutdown. They offered a number of statements, each indicating that employees did not feel secure in their jobs. Employees know that the market is tough and that the company is clearly trying to cut costs.

The firm has managed to increase market share in a falling market. Nevertheless, there will be layoffs if they do not increase volume. So, there is little job security in the notion of increased sales.

6.1.2 Promote Employee Responsibility (Rating: Considerable (4))

In one of the focused factories, operators are trained to do their own setups, maintenance, and scheduling, and be responsible for quality. They decide on their own meetings, dealing with things like who is assigned to which shifts. The supervisors are there as facilitators. One respondent commented that employees decide the details of their own scheduling. He added that there had been some resistance when they tried to push responsibility down.

Another interviewee confirmed that workers were supposed to check quality themselves and, if it is not right, fix it on their own time. He reported some resistance from the older employees who he said had never been asked to think before. Recently, they have been forced to do their own scheduling and job rotation assignments. He added that, now that employees are being asked to think, they like the praise. However, he said you have to keep at it but the managers do not.

And another reported that management gave the direction by asking what it takes to be competitive, but did not give instructions to do specific things such as set up cells. They only said: "Thou shalt be competitive"; they didn't say how to proceed. He added that some employees were being told that problem solving was part of the gainsharing arrangement, so they should solve their own problems.

In another area, the workers took it upon themselves to ensure that each of them was required to do each job at least once, although they found that regular rotation was not the best way to operate.

6.1.3 Provide Training (Rating: Considerable (4))

There have been a fair number of training initiatives lately. One top manager reported operators being trained to do their own setups and their own quality, to be multiskilled in various functional operations, and to do their own maintenance and own scheduling. Furthermore, various employees were receiving training in participative management, employee involvement, group problem solving, and customer service.

A number of interviewees reported training efforts for quality. There was a push on quality including four-hour quality awareness seminars for everyone in the factory, with longer versions for a smaller group. They learned tools such as Pareto analysis and fishbone diagrams. However, the techniques were not being applied at the time. These seminars are to be followed by continuous process improvement seminars. One division manager is responsible for these quality programs for the entire plant.

However, there was not much SPC training. There was some SPC charting but employees were reported to be using it simply to get downtime, as downtime was not incorporated into the standards. As well, operators were send on some quick die change courses but there was no follow-up. One respondent said management dropped some training courses because of budget constraints. And another stated that, plant-wide, there was no real training.

In one focused factory, employees were sent to see suppliers as well as various international events to provide educational experiences. Also, they were sent to various off-site seminars and training sessions.

6.1.4 Promote Teamwork (Rating: Partial (3))

There is not much indication of management promotion of teamwork. There are instances of cooperation forced by the introduction of gainsharing in pockets within the plant. One informant reported that teamwork consisted merely in getting input from employees on matters of scheduling and job rotation assignments. There was no indication of work teams, quality circles, and so forth, although one respondent spoke of doing team building as part of more formal training.

In one focused factory, there were two groups of employees each acting somewhat as a team, given the more assembly-like nature of their operation. Nevertheless, the plant-wide incidence of teamwork is quite low.

6.1.5 Use Group Performance Measures (Rating: Some (2))

They have gone to a gainsharing system but this operates in only part of one focused factory, at present. The gainsharing formula recently changed to recognize improvements in absenteeism, quality, productivity, safety, and schedule position. Part of this is a quality index [illegible]esenting the cost of non-quality.

The three other focused factories are still on an incentive piece work system. One interviewee described the system in the components focused factory as "full-blown piece work." Within these areas, there are minor instances of group payment where there are natural groups of employees; then, bonuses are divided among the members of the small group. And the newest of the focused factories in on group incentives for each of two groups.

Many interviewees spoke of trying to and planning to move towards group incentives and away from piece work, but pointed out that this would not be easy, given past history and the plant being recently organized by the union. However, the one focused factory which now has the pockets of gainsharing will be adopting it throughout shortly.

6.1.6 Demonstrate Visible Commitment (Rating: Partial (3))

Top management is definitely committed to the thrust to focused factories; this was their idea, presented to and accepted by corporate headquarters. They are also committed to five strategic objectives, three of which relate directly to JIT, namely, to focus operations, improve quality, and promote employee involvement. One interviewee said that management used to pay lip service to various improvement approaches and kept changing philosophies but he believes that management is committed this time.

However, there were some indications that management was not making decisions and/or backing off on certain decisions rather than follow through. As well, a number of interviewees mentioned that a former top manager was clearly committed by insisting on adherence to schedule and providing support; this is reported to have slid.

6.2 Employee Involvement

6.2.1 Employee Involvement (Rating: Considerable (4))

There is a fair degree of employee involvement. However, as with some previous categories, there are mixed indicators. The questionnaire results show reasonably high values for both the category representing group approaches (before, 1.048; now, 3.815) and the one representing more individual approaches to employee involvement (before, 1.971; now, 3.644). As well, the average annual number of improvement suggestions per employee has increased from 0.5 to 2.

An employee involvement project began in the mid-80s in which cells were developed in one of the current focused factories. There were no engineers used; it was done totally through employee participation. This caused a problem, however, in that, with no engineering involvement, they lost control of tooling and documentation.

One informant offered a comparison between one line designed by engineering and a more self-governed line. He said, to this day, only the self-governed line runs well. This sold him on employee involvement.

There was a situation in which employee involvement slowly caught on because of one employee who gradually received help from others, one-by-one, until a majority of employees in the area were involved. He succeeded in making them realize they had to give something back to the company. Another respondent indicated that the infighting was phenomenal when gainsharing began. However, the employees themselves straightened it out by setting up an informal system where each had to do, at least, a given amount. They now work as a team. The attempt by the union to get rid of gainsharing was the catalyst for them to start operating this way.

As mentioned, in one focused factory, there is an "a day in the life of" program in which employees and managers engage in activities to try to understand the situation the other is faced with. As well, hourly employees will go to annual events, dealer visits, and so forth. In the same area, the layouts were employee driven, in that each had a chance to provide input. The employees here took it upon themselves so that all were required to do each job at least once but they do not regularly rotate.

Not all reports were positive, however. One respondent said that, as management became more permissive and liberal with employee involvement, some employees took advantage. In some cases, operators, who were supposed to check things at the end of their shift, simply walked off at the end. In other instances, operators are technically on teams but are still guarding knowledge of their methods, as they think employee involvement is a way for management to learn their tricks.

6.3 Flow

6.3.1 Setup Reduction (Rating: Some (2))

There were mixed messages concerning setup. In some areas, on some machines, in some focused factories, there were were good examples of reduced setup times. Nevertheless, not much was done in other areas; there is not yet overall plant-wide implementation of setup reduction.

One positive example concerns a press for which a number of dies have been permanently set so that no setups are required. And, in one of the focused factories, they have done quick changeovers with one rule being no tools, bolts, or threads. According to one informant, setups consist of changing some welding fixtures which they can do in in less than five minutes. However, there are about 20 fixtures per station. So, a whole model changeover should have taken a few hours. However, it actually takes 16 hours of elapsed working time, due to various problems such as getting lift trucks.

Another respondent reported that, in each cell of the same focused factory, they developed one multifunction fixture. He said, setups, in general, went from about 18 hours to about 20 minutes. And another reported a reduction from four hours, with two men, to 15 minutes for a particular cell in the same focused factory.

An employee in another focused factory reported, that they set up their cell for JIT, their die sets are ready to go, and they could changeover in five minutes. In a third focused factory, they only make one model, so setups are rare, namely, once per year to accommodate variations for Europe. And, many interviewees confirmed that the components focused factory was not capable of doing quick setups. They were just starting to address setup reduction in this area.

The questionnaire results show that setup reduction, although improved, is not pervasive throughout the plant, with a measure of 1.042 before and 2.219 now.

6.3.2 Equipment Layout (Rating: Considerable (4))

There are layout improvements in three of the focused factories, although only one of them is an assembly-type layout due to the bulkiness of the products produced in the other two. The questionnaire indicates a dramatic change in layout (before, 1.083; after, 3.944).

The efforts to improve layout began at assembly and are proceeding back towards the components focused factory. Due to the unfocused nature of the components focused factory, the other three focused factories still have problems getting parts on time. There are, however, some machine tools in the components area dedicated to other specific focused factories. One respondent claimed that they are still process oriented, that they still have spaghetti routings. He said they needed each process dedicated to each product line.

In one focused factory, they have set up three cells or stations, each handling about four models. As the product is bulky, each unit is started and completed at one fixed station. For one of the focused factories, there is a dedicated area which produces parts in response to pull signals. Previously, this part had been made in four different areas.

6.3.3 Small Lot Size (Rating: Partial (3))

There are signs of small-lot production, but they are isolated. Much of the plant still operates in a large batch mode. They are moving in the direction of small lots and will undoubtedly continue to reduce lot sizes in the future. The questionnaire results indicate a neutral level of small-lot production, namely, 1.333 before and 2.852 now.

Various interviewees offered indicators of operating in a batch mode. Because of the incentive system, operators were developing "cheat" inventory (pointed out on tour). They would switch the schedule to avoid setups. One respondent said they wanted to run daily batches but had too many parts, leading to too many setups. So, they would juggle the numbers to avoid setups.

In one focused factory, the batch size (for rather bulky products) was about 200 for each of three models. Components were coming from the components focused factory in batches of about 350, with extra inventory being stored in a warehouse. In a second focused factory, they alternate monthly between left hand and right hand items. They are presently designing a new system which should allow them to do these simultaneously.

There are some signs of small-lot production. One interviewee said they were and still are a batch factory. However, he offered an example where a batch of about 350 sub-assemblies had been reduced to five on pushcarts. And, one focused factory has reduced its purchase order quantities from monthly to weekly. As well, they have raised the carrying cost for their order calculations, as they want to reduce the lot size. This was reported to be working the way they set the policy.

6.3.4 Repetitive Master Schedule (Rating: Some (2))

Two of the focused factories, have a schedule which is frozen for three months and relatively firm for six, although customers may change options up to four days in advance. End items are grouped as to daily, weekly, and monthly. They used to build to averages but can now change mix more quickly and handle "peakyness," of which they get a lot.

They are trying to level load but do not have the necessary operator flexibility. They receive a 13 week schedule and a daily build rate from Marketing. But, they then juggle the numbers within the week to avoid setups. One interviewee said that they were looking at daily builds but it was too hard even though true JIT says to build daily.

The questionnaire indicates an improved but still rather low level for repetitive master schedule, with values of 0.524 before and 2.222 now.

6.3.5 Daily Schedule Adherence (Rating: Partial (3))

There was not much discussion of this category during interviews. One respondent reported that part of the new gainsharing formula includes time for maintenance and meetings and the one focused factory is always on schedule. And, he reported that another runs only a few units behind on their daily schedule and they manage to have full department meetings and safety meetings. The questionnaire shows results for daily schedule adherence of 1.476 before and 2.519 now.

6.3.6 Pull System (Rating: Some (2))

A pull system exists in only one of the focused factories and, here, was is only a partial pull system. In this area, it was a hybrid system with MRP driving earlier processes, a pull system for the last few processes, and work-in-process collecting at the transition point. If the area using the pull system were behind, for whatever reason, MRP would continue pushing and work-in-process would build up in the middle.

There were also isolated instances of the use of pull signals for selected areas. For example, there were some coloured kanban signals but these were clearly exceptions to the normal operating procedures. One interviewee reported that triggers or pull signals were sent to the components focused factory. But, the operators also received authority to produce from the master schedule which included a code to tell them which were "trigger parts." So, if an operator were low, he would just produce without a trigger because he's on incentive. And, expeditors were still used for prioritizing jobs, something which would not be necessary if a complete pull system were operating.

Another informant reported that, in terms of the overall factory, there's virtually no pull system. At most, 10% of employees would be involved in pull, with the rest of the plant operating on a push basis. As well, a respondent reported no use of pull signals with suppliers.

And, for one focused factory, most interviewees reported that, there was no pull system. Nevertheless, there was a pull system operating as a two-rack system for some very bulky parts. When a material handler would see the bottom rack empty, he would move the material from the top rack to the bottom and then refill the top. A third focused factory did not pull from the components focused factory but did pull internally, using a two-rack system as well. And, the response in the components focused factory to pull signals was to use the information as input into the MRP system rather than for immediate response.

The questionnaire ratings confirm the above comments. The ratings dealing with the triggering aspects showed values that began very low (0.667; 0.208) and then rose to levels of 2.259 (my scale) and 2.187 (kanban scale). The overall Sakakibara et al. scale deals more with worker control of production and had an early low rating (1.125), followed by a rating of 3.444.

6.3.7 JIT Delivery from Suppliers (Rating: Partial (3))

There are some indicators of JIT-like supply arrangements, but again, these do not pervade the entire plant. There is some apparent point-of-use delivery but, in fact, goods arrive at the loading dock, are unloaded, loaded and then transported to the "point of use."

In one focused factory, they are working with the 50 vendors representing the highest dollar values of purchased parts. They are working aggressively to get direct delivery and weekly delivery. About nine of these go directly to the line. This focused factory also has a good agreement with two suppliers in the U.S. who are located close to each other, leading to enough combined supply to justify a weekly milk run. As well, they are making agreements with their suppliers to use returnable containers.

There are no indications of pull signals or trigger points used with suppliers with a definite statement that these are not used for one focused factory. However, two of the focused factories use steel as their primary input. It is difficult to get a steel company to enter into a JIT-like arrangement.

Again, the results of the questionnaire (before, 0.964; now, 2.778) confirm the interview data, namely, that there are instances of JIT supply arrangements, but nothing which could be viewed as plant-wide implementation.

6.4 Quality

6.4.1 Supplier Quality Level (Rating: Considerable (4))

The questionnaire results show a marked change in supplier quality, from 2.000 before to 3.937 now.

There has been a corporate decision to reduce the vendor base. There are some longer term and sole-source supply arrangements with clauses allowing material pass through and so forth. They have begun an audit process at the request of upper management. Recently, they have asked two of their preferred suppliers to upgrade via self audits using standard audit sheets. They do audits, lasting one to two days, of roughly 8 to 12 suppliers in a given year. They determine a grade per category and finally reduce it to one number. However, they have not gone out to help suppliers with process improvements. Recently, supplier quality ratings have increased 23% and they had a 43% reduction in scrap tags.

As well, roughly 75% of incoming material no longer requires incoming inspection. If there is a problem, then it is treated as a major problem and the vendor must come in to sort and return.

6.4.2 Zero Defects Quality Control (Rating: Partial (3))

There was very little discussion or indication of zero defects quality control procedures in two of the focused factories. The third, however, does all but one of their functional tests on a pass/fail, 100% check basis. The questionnaire indicates a neutral level (before, 1.486; now, 3.044).

In one of the focused factories, an inspector would randomly check items and, if not right, the operators have to fix them on their own time, hardly 100% source inspection.

6.4.3 Statistical Process Control (Rating: Some (2))

There is little evidence of SPC. The questionnaire results showed values of 1.607 before and 2.167 now. They did some SPC charting but employees used it simply to get the downtime. One interviewee said they tried it but it was too time consuming because they are on piece work and the machinery is old and unable to hold tolerances, so there is no SPC in his focused factory. It was used in one place in one focused factory in one area were a pass/fail test was not appropriate.

6.4.4 Use of Charts and Feedback (Rating: Partial (3))

There was fair degree of evidence of charting and feedback in each of the focused factories. Each had two quality boards. The first was a monthly re-cap of scrap, re-claim, and audit results, all shown graphically on a rolling twelve-month history. The second was a "grease board" showing the daily points from their audits.

In one focused factory, they have an immediate feedback loop with nearby auditors so defective units cannot leave the plant. This loop included walking over to discuss problems. They kept one chart on the line and one in the audit station.

The questionnaire showed measures of 1.086 before and 2.978 now.

6.5 Plant Environment (Context)

6.5.1 Decentralization of Authority (Rating: Partial (3))

A number of respondents reported that the plant was reorganizing as focused factories. There are four main areas in the plant, each at different stage with respect to focused factories and decentralization. These different areas have different mixes of functions assigned to them. Typically, a focused factory manager has, or is about to have, control over manufacturing, engineering, staff support, materials control, scheduling, purchasing, planning, and supervision. As well, there is a focused factory responsible component parts and for those functions, typically initial processing of materials, which cannot be focused.

Some respondents suggested that decentralization may not have gone as far as some would assume. One said they still have too many chains of command and another said they were still process focused and that there was more to it than simply focusing the organization chart. The number of reporting levels between direct workers and the head person at the plant has decreased from five to four.

There are fewer supervisors and managers today but, as one interviewee said, they were still top heavy with management. The ratio of white collar to blue collar employees has stayed the same even though total employment has fallen from peak levels.

The questionnaire shows an increase in decentralization from 2.499 to 3.418.

6.5.2 Management by Wandering Around (Rating: Partial (3))

A few respondents reported that the current general manager w , not seen much on the shop floor; his predecessor was seen more and knew employees by name. But one of them also pointed out that the general manager now had more to do and that the manager of his focused factory had an office near the shop floor. He said that the real key was to have the responsible manager there on the floor. Thus, seeing the top managers may not be that important. The focused factory managers differ in how much each is reported to be on the factory floor, with one never seen on the floor and another seen very much.

The questionnaire indicates that management by wandering around has improved but is still not that high, confirming the above comments. The values were 1.574 before and 3.091 now.

6.5.3 Coordination of Decision Making (Rating: Considerable (4))

There were reports of the manufacturing and design functions now being in close proximity, something that would not have happened before. One interviewee from one focused factory said they moved the engineering staff right into the shop. He said that, in the past, they were "in Disneyland" and made designs which were impossible to work with, but now, having designers and manufacturing together has made a big difference; now, they can talk to engineers when there are problems.

Another respondent also reported that they had moved manufacturing people with design people. Although this was not well received initially by the designers, the working relationship has now never been better. This took two to three years. He also reported that they were having much better design coordination with another division of the company which used their subassembly in its final product. For example, rather than having to design special brackets, they were involved in initial design early enough that special brackets were not required.

However, another interviewee reported that there were still walls between departments, especially between the components focused factory and the other three. He said that the components focused factory did not care what the others did, with the feeling being mutual.

The questionnaire shows a big improvement in plant-wide coordination, with values of 2.194 before and 3.545 now.

6.5.4 Supervisors as Team Leaders (Rating: Considerable (4))

There is evidence that supervisors are being asked to act and are acting like coaches and facilitators, although this is not universal within the plant. The questionnaire shows a fairly dramatic change in the role of supervisor, going from 2.370 before to 4.061 now.

One respondent said that supervisors were there to be facilitators. As well, the number of supervisors has been reduced and the supervisors are being kept busier, having been given more responsibility.

The supervisors had a number of comments. One commented that things have changed so dramatically, he did not know what his role would be. He did say that management says all the right things, that they want supervisors to be coaches and facilitators. Another said that they knew that words like coach and facilitator are good buzzwords but they have not done much in this direction. They have, however, gone away from "whip cracking." And, a third said that he had good success with employee involvement and letting the group go ahead with what was required.

Another interviewee said there was a big difference between strong and weak supervisors, with some not visiting and getting back to people enough. And another said they do use words like "coaches" but there was a problem with management wanting to see immediate gains to report back to corporate headquarters. He also said that it was strictly supervision which recently brought the union in. He said they have good, mediocre, and piss-poor supervisors.

6.5.5 Affective Commitment (Rating: Partial (3))

There is a varied set of opinions and evidence concerning affective commitment. The absenteeism rate is around 2.2% and reported as having been cut in half in one of the more JIT-like focused factories. As well, the safety record is reported to be at a level one-third of previous accident rates.

There have been incidents of one employee beginning to demonstrate some commitment to the firm and others gradually joining in. And, one respondent reported that there has been more and more pride taken in work. He said, with the average length of employment more than ten years per employee, there is some dedication.

There are, however, some opposite messages. A number of respondents indicated that morale is now bad. One interviewee said they have a terrible problem with absenteeism and peoples' attitudes. Another said there are hard feelings as the company is seen to be treating different levels and areas unfairly. And, another said morale is bad, always dropping whenever the schedule drops. People feel threatened by downsizing efforts, changing incentive systems, and the unknown. And yet another employee said there is less company loyalty now because downsizing flies in the face of loyalty.

The questionnaire results indicate a fairly consistent level of affective commitment (before, 4.062; now 4.295). As this questionnaire was completed mostly by managers and supervisors and only a few workers, I am discounting it in favour of some of the messages above.

6.5.6 Plant-wide Philosophy (Rating: Partial (3))

There is some indication of a common plant-wide philosophy developing but, at present, it only exists in isolated pockets. They have a mixture of piece rate incentives and gainsharing in the plant. Differences of opinion about the two approaches to compensation tend to counter any common philosophy.

Gainsharing is done only in isolated parts of the plant. This effort began before the union came in. As one respondent said, gainsharing is totally against the union philosophy in that it is based on multipart skills, whereas the union is oriented towards job rules.

Another pointed out that, as a whole, they introduced the JIT philosophy in one of the focused factories, but this does not extend plant-wide. He added that there were differences of opinion at the plant, with the worst being the tie to the pay system. And he added that, up to the present, it has been all buzzwords and lip service; they kept changing philosophies.

As well, there are four distinct focused factories which are at quite different stages of JIT; this also tends to negate a common philosophy. As one interviewee said: "It is more a case of isolated pockets of evangelists. There are advocates and there are others who just want to build parts."

The questionnaire (before, 2.475; now, 3.080) confirms an assessment of pockets of certain philosophies rather than a common plant-wide vision.

6.5.7 Employee-Management Relations (Rating: Partial (3))

As with a number of previous categories, there are conflicting opinions and statements about the state of employee-management relations.

The relationship with the union was presented as going quite well. However, the plant had been non-union until recently organized. The reason for the organization was presented by a number of respondents as a combination of poor supervision and fear about job loss. One respondent said that union efforts to get rid of the gainsharing program had the opposite effect of bringing together employees who were on gainsharing to work more as a team, to avoid losing the program.

Another said there's a sense of possible downsizing and employees resent that salaried people do not get laid off during shutdowns as well. A barrier still exists between hourly and salaried employees. And another respondent said there were a lot of hard feelings that the company is treating different levels differently. However, he added that five years ago, there was an "us versus them" atmosphere whereas now they were trying to get closer to "warm feelings."

A number of respondents spoke of the "day in the life" program in one of the focused factories in which hourly and salaried people work alongside each other to appreciate each others jobs.

The questionnaire results indicate a reasonable level (before, 3.667; now, 3.955). Nevertheless, I am discounting this in light of negative statements above.

6.5.8 Influence on Employer (Rating: Considerable (4))

The most compelling evidence for this category is the questionnaire results which show a value of 2.111 before jumping to 3.939, indicating that employees do have more control over their everyday work environment.

Only a few examples were discussed during interviews, one in which a focused factory team pointed out a potential problem in the middle of a major project, resulting in management agreeing to scale back on the project. Another example concerned management disagreeing with some employee suggestions but allowing the employees to go ahead anyway. A respondent reported that this made them happier and solved some problems.

6.6 Summary

In the following table, I summarize the findings by category for Plant F:

Table 5.6

Summary - Plant F

Management Initiatives		
Employment Security	None (0)	There was a recent downsizing. Employees did not feel secure in their jobs. They know that the market is tough and that the company is clearly trying to cut costs. And, no effort was being made to make them feel secure. Increased sales are not seen as a probable solution.
Employee Responsibility	Considerable (4)	In spite of some resistance, there are a number of indicators of employees being assigned and taking more responsibility. This includes setups, maintenance, scheduling, job rotation, and quality.
Training	Considerable (4)	There have been a fair number of training initiatives lately. This includes training for setups, quality, participative management, employee involvement, group problem solving, and customer service.
Teamwork	Partial (3)	There is not much indication of teamwork beyond the cooperation forced by the introduction of gainsharing in one focused factory. One respondent spoke of doing team building as part of more formal training and there were some teams in another focused factory.
Performance Measurement	Some (2)	They have gone to a gainsharing system but this is in only part of one focused factory at present. Most employees are still on a piece work incentive system. The gainsharing formula recently

		changed to recognize credit for improvements in absenteeism, quality, productivity, safety, and schedule position.
Visible Commitment	Partial (3)	Top management is definitely committed to strategic objectives, which relate directly to JIT, namely, focus operations, improve quality, and promote employee involvement. There were, however, some indicators that management was not making decisions and/or backing off on certain decisions rather than follow through.
Employee Involvement	Considerable (4)	There is a fair degree of employee involvement. However, as with previous categories, there are mixed indicators. In some instances, employees develop layouts and cells, visit dealers, provide suggestions, trade assignments with management, and pursue cross-training. In other reported instances, employees still guard their methods as private knowledge or simply leave at the end of a shift without making final equipment checks.
Flow		
Setup Reduction	Some (2)	There are mixed messages concerning setup. In some areas, on some machines, in some focused factories, there were were good examples of reduced setup times. Nevertheless, not much was done in other areas; there was not yet overall plant-wide implementation of setup reduction.
Equipment Layout	Considerable (4)	There are layout improvements three of the focused factories, although only one of them is an assembly-type layout due to the bulkiness of the products produced in the others.

Small Lot Size	Partial (3)	There are signs of small-lot production, but it is isolated. Much of the plant still operates in a large batch mode.
Repetitive Master Schedule	Some (2)	They are trying to level the load but do not have the necessary operator flexibility. They receive a 13 week schedule and a daily build rate from Marketing. But, then they juggle the numbers within the week to avoid setups. One interviewee said that they were looking at daily builds but it was too hard even though true JIT says to build daily.
Daily Schedule Adherence	Partial (3)	There was not much discussion of this category during interviews. One respondent reported that part of the new gainsharing formula includes time for maintenance and meetings and the one focused factory is always on schedule. And, he reported that another runs only a few units behind on their daily schedule and they manage to have full department meetings and safety meetings.
Pull System	Some (2)	A pull system exists only in one focused factory and, here, was only a partial pull system. It was a hybrid system with MRP driving earlier processes, a pull system for the last few processes, and work-in-process collecting at the transition point. In terms of the overall factory, there's virtually no pull system, with, at most, 10% of employees involved in pull.
JIT Delivery from Suppliers	Partial (3)	There are some indicators of JIT-like supply arrangements, but again, these do not pervade the entire plant. There are no indications of pull signals or trigger points used with suppliers.
Overall JIT Flow	(2.71)	

Quality

Supplier Quality Level	Considerable (4)	There was a corporate decision to reduce the vendor base and begin a supplier audit process. There are some longer term and sole-source supply arrangements with clauses allowing material pass through and so forth. Roughly 75% of incoming material no longer requires incoming inspection.
Zero Defects Quality Control	Partial (3)	One focused factory did all but one functional test on a pass/fail, 100% check basis. The others showed little evidence of such approaches.
Statistical Process Control	Some (2)	There is little SPC. It was used in one focused factory were a pass/fail test was not appropriate. In one focused factory, they tried it but it was too time consuming because they are on piece work and the machinery is old and unable to hold tolerances.
Use of Charts and Feedback	Partial (3)	There was fair degree of evidence of charting and feedback in each of the focused factories.
Overall JIT Quality	(2.75)	
Plant Environment (Context)		
Decentralization of Authority	Partial (3)	There are three focused factories in the plant, each at a different stage with respect to decentralization. The number of reporting levels between direct workers and the head person at the plant has decreased from five to four.
Management by Wandering Around	Partial (3)	The focused factory managers differ in how much each is seen on the factory floor, with one never seen on the floor and

		another seen very much. Top management is not seen as much as previously, but this is not viewed as important.
Coordination of Decision Making	Considerable (4)	There are still walls between departments, especially between the components focused factory and the three others, but there is much more coordination as well, especially between design and manufacturing. They also were having much better design coordination with another division of the company.
Supervisors as Team Leaders	Considerable (4)	There is evidence of supervisors being asked to act and acting like coaches and facilitators, although this is not universal within the plant. A number of supervisors and other respondents indicated that things had changed fairly dramatically.
Affective Commitment	Partial (3)	There is a varied set of opinions and evidence concerning affective commitment. There are indicators of loyalty as well as indicators of attitude and morale problems.
Plant-Wide Philosophy	Partial (3)	There is some indication of a common plant-wide philosophy developing but, at present, it only exists in isolated pockets. They have a mixture of piece rate incentives and gainsharing in the plant. Differences of opinion about the two approaches to compensation tend to counter any common philosophy.
Employee-Management Relations	Partial (3)	There are conflicting opinions and statements about the state of employee-management relations.
Influence on Employer	Considerable (4)	Only a few examples were discussed during interviews, but they indicate that employees do have more control over their everyday work environment.

Summary

In this chapter, I reported the findings from each of the site visits and provided summary descriptions and ratings for each category of the framework. In the next chapter, I develop a cross-site table of current ratings (Table 6.1) and analyze the data in an attempt to answer the two research questions posed in Chapter One. I conclude with discussions of management implications and areas for future research.

Chapter Six: Analysis and Discussion

In the previous chapter, I reduced the data collected from each plant to key categories and determined ratings for each category. As well, I provided a summary of these findings for each plant. In this chapter, I analyze the data in reference to the two research questions posed in Chapter One and conclude with discussions of management implications and areas for future research.

1 Research Question One

The first research question, posed in Chapter One, is: "What explains how well firms are able to implement elements of JIT?"

As outlined in Chapters Three and Four, I pursued this question by first proposing a set of propositions, derived from the literature, and then testing them with field data, as summarized in Chapter Five.

1.1 Data Summary

For each construct in the framework (except the choices construct which I address in a later section) the findings and ratings for the current status at each plant were summarized in Chapter Five. The ratings are repeated in Table 6.1. The ratings are those used in Chapter Five, namely, None (0), Marginal (1), Some (2), Partial (3), Considerable (4), Substantial (5), and Extensive (6).

1.2 Testing Propositions

In Chapter Four, I outlined how, with a case-based methodology, each case is considered a separate, stand-alone entity about which definite conclusions are

Table 6.1

Cross-site Summary

Plant:	**A**	**B**	**C**	**D**	**E**	**F**
Management Initiatives:						
Provide Employment Security	1	1	2	0	0	0
Promote Employee Responsibility	2	6	5	4	2	4
Provide Training	1	5	6	3	3	4
Promote Teamwork	0	6	5	3	2	3
Use Group Performance Measures	1	3	5	1	1	2
Demonstrate Visible Commitment	2	5	4	4	3	3
Employee Involvement	2	5	5	4	2	4
Flow Elements:						
Setup Reduction	2	4	4	2	2	2
Equipment Layout	4	4	4	3	3	4
Small Lot Size	3	6	3	6	4	3
Repetitive Master Schedule	1	4	3	4	3	2
Daily Schedule Adherence	0	3	3	2	3	3
Pull System	2	5	2	3	3	2
JIT Delivery from Suppliers	2	4	4	4	4	3
Overall Flow Elements	2.0	4.3	3.3	3.4	3.1	2.7
Quality Elements:						
Supplier Quality Level	3	4	5	4	3	4
Zero Defects Quality Control	4	3	4	3	3	3
Statistical Process Control	3	3	5	3	2	2
Use of Charts and Feedback	0	4	3	3	3	3
Overall Quality Elements	2.5	3.5	4.3	3.3	2.8	3.0
Plant Environment (Context):						
Decentralization of Authority	3	4	4	4	4	3
Management by Wandering Around	4	4	4	2	4	3
Coordination of Decision Making	2	4	4	3	3	4
Supervisors as Team Leaders	0	5	5	4	3	4
Affective Commitment	3	4	4	3	3	3
Plant-Wide Philosophy	2	4	4	3	3	3
Employee-Management Relations	3	4	5	3	3	3
Influence On Employer	2	5	4	4	3	4

drawn, and, in Chapter Five, I presented the data on a case-by-case basis. However, here I do the analysis proposition-by-proposition. I proceed this way for ease of presentation and to allow comparisons across cases. Nevertheless, I still follow the methods outlined in Chapter Four. That is, I accept or reject each proposition based on the data from each case before considering the proposition in light of any subsequent case.

So, in this section, I consider each of the twenty propositions outlined in Chapter Three, in light of the evidence presented in Chapter Five and summarized above. I treat a rating of 4, 5, or 6 (considerable, substantial, or extensive) as sufficient evidence for the existence of a phenomenon at the plant, a rating of 0, 1, or 2 (none, marginal, or some) as sufficient evidence to conclude that a phenomenon does not exist at a plant (in any serious form), and a rating of 3 (partial) as inconclusive evidence.

As well, I had to decide on a consistent rule for the two instances in which I use a mean value of some of the above measures to determine JIT flow and JIT quality. For these, I wanted a scheme which would allow the neutral zone to be narrower to reflect the increased confidence one should have in using more than one measure to decide whether a value is clearly high or low. There are a number of possible ways to approach this problem of determining boundaries to categories (e.g. Diederich, Messick, & Tucker, 1957). However, as the data at this point are already summary ratings of both qualitative and quantitative data, I did not want an overly statistical scheme, simply one which allowed for a clear and reasonable decision rule. Thus, although this is not a statistical exercise, I borrowed the general notion from introductory statistics (e.g. Wonnacott & Wonnacott, 1990) that, as the number of elements in a sample increases, the standard error of the sampling distribution decreases. So, I chose to reduce the width of the neutral range by a factor equal to the square root of the number of elements used to determine the mean. In other words, I make the assumption that, if it is reasonable to use a range of 2.5 to 3.5 (plus or minus 0.5) to describe the neutral zone for a single category as outlined above, then a reasonable neutral zone for a summary measure (like the mean) may be based on this notion of a lower standard error as the number of elements increases. So, I use 2.81 to 3.19 (plus or minus 0.19) to describe the neutral zone for JIT flow (average of seven categories). Similarly, for JIT quality (average of four categories), the neutral range becomes 2.75 to 3.25 (plus or minus 0.25).

As in Chapter Three, propositions are grouped into three sets: (1) management initiatives and employee involvement, (2) management initiatives and the extent of JIT, and (3) employee involvement and the extent of JIT. For each proposition, I provide two tables, one showing numerical values and the other indicating high (H), low (L), and neutral (N) values, according to the ranges just described.

1.2.1 Management Initiatives and Employee Involvement

01. Provision of workforce security is a necessary condition for employee involvement.

	A	B	C	D	E	F
Workforce Security	1	1	2	0	0	0
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Workforce Security	L	L	L	L	L	L
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both the provision of workforce security and for employee involvement. Thus, the evidence is consistent with the proposition, albeit weakly so, because of the low values. There is no reason to reject the proposition.

Plant B has a high value employee involvement without a corresponding high value for workforce security. This is strong enough to reject the proposition regardless of other evidence.

Plants C and D also have high values for employee involvement without corresponding high value for workforce security. Each of these cases provides a replication of the rejection based on Plant B evidence.

Plant E, like plant A, reveals low values for both constructs. As the proposition has already been rejected, the evidence from Plant E, which would have offered weak confirmation, has no further effect.

Plant F also offers a further replication of the rejection based on results from Plant B, C, and D.

So, Proposition 01 is rejected. Provision of workforce security is NOT a necessary condition for employee involvement.

02. Promotion of employee responsibility is a necessary condition for employee involvement.

	A	B	C	D	E	F
Employee Responsibility	2	6	5	4	2	4
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Employee Responsibility	L	H	H	H	L	H
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both promotion of employee responsibility and employee involvement. Thus, the evidence is consistent with the proposition.

Plant B shows high values for both of the constructs. These results confirm the proposition, so again, there is no reason to adjust it. Plants C and D also reveal a pattern of high values for each construct. These two replications offer strong evidence, although not proof, that the promotion of employee responsibility is a necessary condition for employee involvement.

Plant E, like Plant A, has low values for the constructs. This replication also confirms the proposition, in that the absence of employee involvement is accompanied by an absence of management promotion of employee responsibility.

And, Plant F, like Plants B, C, and D, has high values for both of the constructs. This also confirms the proposition with another replication.

So, proposition 02 is accepted. Promotion of employee responsibility is a necessary condition for employee involvement.

03. Provision of training is a necessary condition for employee involvement.

	A	B	C	D	E	F
Training Provision	1	5	6	3	3	4
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Training Provision	L	H	H	N	N	H
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both the provision of training and for employee involvement. Thus, the evidence is consistent with the proposition. There is no reason to reject it.

Plants B and C show high values for both of the constructs. These results confirm the proposition.

Plants D and E each reveal neutral values for one of the constructs so the results are inconclusive. Nevertheless, they provide no reason to reject the proposition.

Plant F, like Plants B and C, shows high values for both constructs. This replication also confirms the proposition.

So, proposition 03 is accepted. Provision of training is a necessary condition for employee involvement.

04. Promotion of teamwork is a necessary condition for employee involvement.

	A	B	C	D	E	F
Teamwork Promotion	0	6	5	3	2	3
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Teamwork Promotion	L	H	H	N	L	N
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both management promotion of teamwork and employee involvement. Thus, the evidence, although weak, is consistent with the proposition.

Plant B has high values for both constructs. These results confirm the proposition; there is no reason to reject it. Plant C also shows the above pattern of a high value for each construct and thus offers a replication of the conclusion based on Plant B.

Plant D contains a neutral value for one of the constructs so the results are inconclusive, but provide no reason to reject the proposition.

Plant E, like Plant A, has low values for the constructs. This also confirms the proposition, in that an absence of employee involvement is accompanied by an absence of management promotion of teamwork.

Plant F, like Plant D, contains a neutral value for one of the constructs so results are inconclusive, but provide no reason to reject the proposition.

So, proposition 04 is accepted. Promotion of teamwork is a necessary condition for employee involvement.

05. The use of group performance measures is a necessary condition for employee involvement.

	A	B	C	D	E	F
Group Performance Measures	1	3	5	1	1	2
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Group Performance Measures	L	N	H	L	L	L
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both both group performance measures and employee involvement. Thus, the evidence is consistent with the proposition, albeit weakly because of the low values, and offers no reason to reject it.

Plant B has a neutral value for one construct, yielding inconclusive results.

Plant C has high values for both constructs, confirming the proposition.

However, Plant D has a low value for group performance measures and a high value for employee involvement, leading to a rejection of the proposition. This is strong enough to reject the proposition regardless of other evidence.

Plant E, like Plant A, has low values for both constructs. As the proposition has already been rejected, the evidence from Plant E has no further effect.

Plant F offers a replication of the results from Plant D, namely, a low value for group performance measures and a high value for employee involvement, confirming the rejection of the proposition.

So, proposition 05 is rejected. The use of group performance measures is NOT a necessary condition for employee involvement.

06. Demonstration of visible commitment is a necessary condition for employee involvement.

	A	B	C	D	E	F
Visible Commitment	2	5	4	4	3	3
Employee Involvement	2	5	5	4	2	4

	A	B	C	D	E	F
Visible Commitment	L	H	H	H	N	N
Employee Involvement	L	H	H	H	L	H

Plant A has low values for both the demonstration of visible commitment and for employee involvement. Thus, the evidence is consistent with the proposition.

Plant B has high values for both of the constructs. These results confirm the proposition.

Plants C and D also reveal the above pattern of high values for both constructs. These two replications offer further strong evidence, although not proof, that management demonstration of visible commitment is a necessary condition for employee involvement.

Plants E and F each show a neutral value for one construct so their results are not conclusive.

So, proposition 06 is accepted. Demonstration of visible commitment is a necessary condition for employee involvement.

1.2.2 Management Initiatives and the Extent of JIT

07. Provision of workforce security is a necessary condition for JIT flow.

	A	B	C	D	E	F
Workforce Security	1	1	2	0	0	0
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Workforce Security	L	L	L	L	L	L
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both provision of workforce security and JIT flow. Thus, the evidence is consistent with the proposition, albeit weakly because of the low values, and offers no reason to reject the proposition.

Plant B has a high value for JIT flow without a corresponding high value for workforce security. This evidence is strong enough to reject the proposition regardless of other evidence. Plants C and D offer replications of the results from Plant B, namely, a low value for provision of workforce security and a high value for JIT flow, confirming a strong rejection of the original proposition.

Plant E reveals a neutral value for one construct so the results are inconclusive.

Plant F, like Plant A, has low values for both provision of workforce security and JIT flow. As the proposition has already been rejected, the evidence from Plant F has no further effect.

So, proposition 07 is rejected. Provision of workforce security is NOT a necessary condition for JIT flow.

08. Promotion of employee responsibility is a necessary condition for JIT flow.

	A	B	C	D	E	F
Employee Responsibility	2	6	5	4	2	4
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Employee Responsibility	L	H	H	H	L	H
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both employee responsibility and JIT flow. Thus, the evidence is weakly consistent with the proposition. There is no reason to reject it.

Plant B has high values for both of the constructs, confirming the proposition. Plants C and D also have high values for each construct. These two replications offer further strong evidence, although not proof, that management promotion of employee responsibility is a necessary condition for JIT flow.

Plant E shows a neutral value for one construct so results are inconclusive.

Plant F has high values for employee responsibility but does not show corresponding high values for JIT flow. Nevertheless, this is consistent with the proposition and offers no reason to reject it.

So, proposition 08 is accepted. Promotion of employee responsibility is necessary for JIT flow.

09. Provision of training is a necessary condition for JIT flow.

	A	B	C	D	E	F
Training Provision	1	5	6	3	3	4
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Training Provision	L	H	H	N	N	H
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both provision of training and JIT flow. Thus, the evidence is consistent with the proposition, albeit weakly, and offers no reason to reject it.

Plant B has high values for both constructs. These results confirm the proposition. Plant C also has high values for each construct. This replication offers further evidence, although not proof, that provision of training is a necessary condition for JIT flow.

Plants D and E each contain a neutral value for at least one construct so results are inconclusive, but there is no reason to reject the proposition.

Plant F has a high value for provision of training but does not show a corresponding high value for JIT flow. Nevertheless, this is consistent with the proposition and offers no reason to reject it.

So, proposition 09 is accepted. Provision of training is necessary for JIT flow.

10. Promotion of teamwork is a necessary condition for JIT flow.

	A	B	C	D	E	F
Teamwork Promotion	0	6	5	3	2	3
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Teamwork Promotion	L	H	H	N	L	N
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both promotion of teamwork and JIT flow. Thus, the evidence is consistent with the proposition, albeit weakly because of the low values.

Plant B shows high values for both constructs, confirming the proposition, so again, there is no reason to adjust it. Plant C also shows a pattern of high values for each construct. This replication offers further evidence, although not proof, that promotion of teamwork is a necessary condition for JIT flow.

Plants D, E, and F each contain a neutral value for one construct, yielding inconclusive results, but providing no reason to reject the proposition.

So, proposition 10 is accepted, mainly on the strength of evidence from Plants B and C. Promotion of teamwork is a necessary condition for JIT flow.

11. The use of group performance measures is a necessary condition for JIT flow.

	A	B	C	D	E	F
Group Performance Measures	1	3	5	1	1	2
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Group Performance Measures	L	N	H	L	L	L
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both use of group performance measures and JIT flow, consistent with the proposition.

Plant B reveals a neutral value for one construct so the results are inconclusive, but provide no reason to reject the proposition.

Plant C has high values for both constructs. These confirm the proposition.

However, Plant D has a high value for JIT flow without a corresponding high value for the use of group performance measures. This is strong enough to reject the proposition regardless of other evidence.

Plant E, like plant B, contains a neutral value for one construct so the results are inconclusive.

Plant F, like Plant A, has low values for both group performance measures and JIT flow. As the original proposition has already been rejected regardless of further evidence, the evidence from Plant F has no further effect.

So, proposition 11 is rejected. The use of group performance measures is NOT a necessary condition for JIT flow.

12. Demonstration of visible commitment is a necessary condition for JIT flow.

	A	B	C	D	E	F
Visible Commitment	2	5	4	4	3	3
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Visible Commitment	L	H	H	H	N	N
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both demonstration of visible commitment and JIT flow. Thus, the evidence is consistent with the proposition.

Plant B has high values for both constructs. This confirms the proposition, so again, there is no reason to adjust it. Plants C and D also have high values for each construct. These two replications provide further strong evidence, although not proof, that management demonstration of visible commitment is a necessary condition for JIT flow.

Plants E and F each contain a neutral value for at least one construct so results are inconclusive. However, there is no reason to reject the proposition.

So, proposition 12 is accepted. Demonstration of visible commitment is a necessary condition for JIT flow.

13. Provision of workforce security is a necessary condition for JIT quality.

	A	B	C	D	E	F
Workforce Security	1	1	2	0	0	0
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Workforce Security	L	L	L	L	L	L
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both provision of workforce security and for JIT quality. Thus, the evidence is consistent with the proposition.

Plant B has a high value for JIT quality without a corresponding high value for provision of workforce security. This evidence is strong enough to reject the proposition regardless of other evidence. Plants C and D yield two replications of the results found for Plant B, namely, a low value for provision of workforce security and a high value for JIT quality, confirming a rejection of the proposition.

Plants E and F each contain a neutral value for one construct so the results are inconclusive.

So, proposition 13 is rejected. Provision of workforce security is NOT a necessary condition for JIT quality.

14. Promotion of employee responsibility is a necessary condition for JIT quality.

	A	B	C	D	E	F
Employee Responsibility	2	6	5	4	2	4
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Employee Responsibility	L	H	H	H	L	H
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both employee responsibility and JIT quality. Thus, the evidence is consistent with the proposition, albeit weakly because of the low values.

Plant B shows high values for both constructs, confirming the proposition. Plants C and D also reveal high values for each construct. These two replications provide strong evidence, although not proof, that promotion of employee responsibility is a necessary condition for JIT quality.

Plants E and F each contain a neutral value for one construct so the results are inconclusive, but provide no reason to reject the proposition.

So, proposition 14 is accepted. Promotion of employee responsibility is a necessary condition for JIT quality.

15. Provision of training is a necessary condition for JIT quality.

	A	B	C	D	E	F
Training Provision	1	5	6	3	3	4
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Training Provision	L	H	H	N	N	H
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both provision of training and JIT quality. Thus, the evidence is consistent with the proposition.

Plant B has high values for both constructs. This confirms the proposition. Plant C also has high values for each construct. This replication offers further evidence, although not proof, that provision of training is a necessary condition for JIT quality.

Plants D, E, and F each contain a neutral value for at least one of the constructs so the results are not conclusive. There is no reason to reject the proposition, however.

So, proposition 15 is accepted, mainly on the evidence from Plants B and C. Provision of training is a necessary condition for JIT quality.

16. Promotion of teamwork is a necessary condition for JIT quality.

	A	B	C	D	E	F
Teamwork Promotion	0	6	5	3	2	3
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Teamwork Promotion	L	H	H	N	L	N
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both promotion of teamwork and JIT quality, consistent with the proposition.

Plant B has a high value for each construct. This confirms the proposition. Plant C also reveals high values for each construct. This replication offers further evidence, although not proof, that promotion of teamwork is a necessary condition for JIT quality.

Plants D, E, and F each contain a neutral value for at least one of the constructs so results are inconclusive, but do not provide any reason to reject the proposition.

So, proposition 16 is accepted, mainly on the evidence from Plants B and C. Promotion of teamwork is a necessary condition for JIT quality.

17. The use of group performance measures is a necessary condition for JIT quality.

	A	B	C	D	E	F
Group Performance Measures	1	3	5	1	1	2
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Group Performance Measures	L	N	H	L	L	L
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both the use of group performance measures and JIT quality. Thus, the evidence is consistent with th position.

Plant B has a neutral value for one construct so results are inconclusive.

Plant C has high values for both of the constructs. This offers confirmation of the proposition.

However, Plant D has a high value for JIT quality without a corresponding high value for the use of group performance measures. This is strong enough to reject the proposition regardless of other evidence.

Plants E and F each contain a neutral value for one construct so results are inconclusive.

So, proposition 17 is rejected. The use of group performance measures is NOT a necessary condition for JIT quality.

18. Demonstration of visible commitment is a necessary condition for JIT quality.

	A	B	C	D	E	F
Visible Commitment	2	5	4	4	3	3
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Visible Commitment	L	H	H	H	N	N
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both the demonstration of visible commitment and JIT quality. Thus, the evidence is consistent with the proposition.

Plant B has a high value for each construct, confirming the proposition. Plants C and D also have high values for each construct. These two replications offer further strong evidence, although not proof, that demonstration of visible management commitment is a necessary condition for JIT quality.

Plants E and F each contain neutral values for both constructs so the results are inconclusive.

So, proposition 18 is accepted. Demonstration of visible commitment is a necessary condition for JIT quality.

1.2.3 Employee involvement and the Extent of JIT

19. Employee involvement is a necessary condition for JIT flow.

	A	B	C	D	E	F
Employee Involvement	2	5	5	4	2	4
Flow Elements of JIT	2.0	4.3	3.3	3.4	3.1	2.7

	A	B	C	D	E	F
Employee Involvement	L	H	H	H	L	H
Flow Elements of JIT	L	H	H	H	N	L

Plant A has low values for both employee involvement and JIT flow. Thus, the evidence is consistent with the proposition, offering no reason to reject it.

Plant B shows high values for each construct, confirming the proposition. Plants C and D also provide high values for each construct. These replications are further strong evidence, although not proof, that employee involvement is a necessary condition for JIT flow.

Plant E reveals a neutral value for one construct so results are inconclusive, but provide no reason to reject the proposition.

Plant F has high values for employee involvement but does not show corresponding high values for JIT flow. Nevertheless, this is consistent with the proposition and offers no reason to reject it.

So, proposition 19 is accepted. Employee involvement is necessary for JIT flow.

20. Employee involvement is a necessary condition for JIT quality.

	A	B	C	D	E	F
Employee Involvement	2	5	5	4	2	4
Quality Elements of JIT	2.5	3.5	4.3	3.3	2.8	3.0

	A	B	C	D	E	F
Employee Involvement	L	H	H	H	L	H
Quality Elements of JIT	L	H	H	H	N	N

Plant A has low values for both employee involvement and JIT quality. Thus, the evidence is consistent with the proposition.

Plant B has high values for both constructs. These results confirm the proposition. Plants C and D also have high values for each construct. These two replications offer further strong evidence, although not proof, that employee involvement is a necessary condition for JIT quality.

Plants E and F each contain a neutral value for one construct so results are inconclusive. There is no reason to reject the proposition, however.

So, proposition 20 is accepted. Employee involvement is a necessary condition for JIT quality.

1.3 Discussion and Summary

The tests of the twenty propositions reveal two patterns of conclusions. In the first pattern, results are consistent with the proposition. That is, high values of the dependent construct are always associated with high values of the independent construct. This is consistent with the assertion that one construct is a necessary condition for another. This pattern, although confirming the proposition, does not prove it; it merely adds weight to the validity of the proposition, given the available evidence. However, if another case were included in the analysis, it could confirm the proposition or reject it outright by providing one good counterexample.

The second pattern of results leads to a clear rejection of the proposition. If any one case clearly shows a high level for a dependent construct along with a low level for a proposed necessary condition, evidence is sufficient to reject the proposition, regardless of evidence in other cases.

Overall, of the twenty propositions, fourteen were accepted (pattern 1) and six were rejected (pattern 2). The twenty propositions are summarized below along with brief explanations for the six rejected propositions.

Proposition Summaries:

01. Provision of workforce security is NOT a necessary condition for employee involvement.

    This rejection is based on consistently low values for workforce security at each of the six plants, along with high values for employee involvement for all but plants A and E. The reason for this strong rejection is very likely connected to the nature of the construct which addresses the provision of workforce security by management rather than, say, a feeling of security on the part of employees. See the discussion below.

02. Promotion of employee responsibility is a necessary condition for employee involvement.

03. Provision of training is a necessary condition for employee involvement.

04. Promotion of teamwork is a necessary condition for employee involvement.

05. The use of group performance measures is NOT a necessary condition for employee involvement.

This rejection is based on Plants D and F at which high values of employee involvement were found in the absence of group performance measures. See the discussion below.

06. Demonstration of visible commitment is a necessary condition for employee involvement.

07. Provision of workforce security is NOT a necessary condition for JIT flow.

This rejection is based on low values for workforce security at Plants B, C, and D along with high values for JIT flow. As mentioned, this may be based on the way in which workforce security was operationalized. See the discussion below.

08. Promotion of employee responsibility is a necessary condition for JIT flow.

09. Provision of training is a necessary condition for JIT flow.

10. Promotion of teamwork is a necessary condition for JIT flow.

11. The use of group performance measures is NOT a necessary condition for JIT flow.

This rejection is based solely on the results for Plant D in which there was a high value for flow elements without a corresponding high value for group performance measures. See the discussion below.

12. Demonstration of visible commitment is a necessary condition for JIT flow.

13. Provision of workforce security is NOT a necessary condition for JIT quality.

    This rejection is based on consistently low values for workforce security for all six plants along with high values for quality at Plants B, C, and D. See the discussion below.

14. Promotion of employee responsibility is a necessary condition for JIT quality.

15. Provision of training is a necessary condition for JIT quality.

16. Promotion of teamwork is a necessary condition for JIT quality.

17. The use of group performance measures is NOT a necessary condition for JIT quality.

    This rejection is based solely on the results for Plant D in which there was a high value for quality elements without a corresponding high value for group performance measures. See the discussion below.

18. Demonstration of visible commitment is a necessary condition for JIT quality.

19. Employee involvement is a necessary condition for JIT flow.

20. Employee involvement is a necessary condition for JIT quality.

Two constructs representing two of the management initiatives in the framework are connected with all six rejections of propositions. These two are "provision of workforce security" and "use of group performance measures." In subsequent paragraphs, I discuss these two and suggest reasons why they led to rejections. If the propositions concerning these two constructs are temporarily removed from the framework, the remaining seven constructs yield a clean pattern of fourteen confirmed propositions. The reduced framework would consist of four management initiatives (promotion of employee responsibility, provision of training, promotion of teamwork, and demonstration of visible commitment) being necessary conditions for each of employee involvement. JIT flow, and JIT quality. Furthermore, employee involvement is shown to be associated with JIT flow and JIT quality.

In the case of workforce security, no firm in the study provided any substantial degree of workforce security. Nevertheless, Plants B, C, and D had high values for each of employee involvement, JIT flow, and JIT quality, the dependent constructs for which workforce security was proposed as necessary. As well, Plant F had a high value for employee involvement in spite of a low value of workforce security. Thus, in spite of many claims in the literature about the necessity of job security, the evidence here clearly rejects the notion that provision of job security is a necessary condition for obtaining results along JIT lines. The reason for this rejection probably lies with the notion of job security as something provided by management. No firm in the study was even considering the idea of a contractual type of obligation. During interviews, questions about job security were typically rejected quickly; there was no hint of any "weighing of pros and cons" on the part of those interviewed. Nevertheless, the notion of job security may still be relevant to JIT.

For example, comparing the first two plants, management at Plant B would love to be able to provide such security but cannot take the risk because of economic uncertainty. Management at Plant A, on the other hand, have no intention of doing so. Nevertheless, in each plant, there is still some sense of job security. Job security at Plant B seems to be connected more with being part of a winning team than with having a contractual obligation. And, at Plant A, there was some sense of job security in that management was being fairly successful at landing new contracts and bringing in work. Employees had the impression that management could find and deliver the volume of new contracts needed to keep everyone busy.

The backlog of work due to the transfer of the one product line from a U.S. plant helped this perception. Thus, at both plants, job security was seen more as something flowing from the ability to be competitive and obtain orders rather than flowing directly from management decree.

The other three rejections of propositions centre around the construct representing the "use of group performance measures." Only Plant C revealed a high value for this construct. But Plants B, C, and D, had high values for the dependent constructs, namely, employee involvement, JIT flow, and JIT quality. As well, Plant F had a high value for employee involvement in spite of a low value for use of group measures. So, contrary to some of the literature, the use of group performance measures does not appear to be a necessary condition for obtaining JIT-like results.

The reason for these rejections is not as clear as for the provision of job security. The rejections were based on the situation at Plant D where there is little evidence of group performance measures but high values for employee involvement, JIT flow, and JIT quality. Another review of the data revealed little. It appears that the absence of piece rate incentive systems may be good enough to allow a plant to move forward even though systems of group measurement would undoubtedly be preferable. The two plants (E and F) which currently have some form of long-standing individual piece rate system did not show high values for JIT flow and JIT quality, with only one of them (Plant F) showing a high value for employee involvement. They are both actively moving away from piece rate incentive schemes in spite of some employee resistance.

The twenty propositions are causal statements as they identify either a sufficient, necessary, probable, or contributing cause for a phenomenon (Brewer & Hunter, 1989:149). However, in order to stipulate causal links, one must empirically demonstrate three things, namely, covariation, temporal sequence, and non-spuriousness (Brewer & Hunter, 1989:150; Cook & Campbell, 1979:18).

The first of these, correlation, has already been demonstrated above for the propositions accepted. And temporal sequence may be demonstrated by the manner in which data were collected. Questionnaire data, aimed at establishing the extent of JIT flow, JIT quality, and employee involvement asked for "now" and "before" responses for each item. "Before" was identified by the key informant at each plant as the date when "major efforts to implement Japanese-like approaches to manufacturing" began. On the other hand, interview data, which focused on the actions of management, covered the period of time since the date just mentioned to the present. Thus, there is a clear temporal sequence consisting of manufacturing practices before JIT efforts began, management initiatives since then, and current manufacturing practices.

Although the temporal sequences between management initiatives and JIT-like outcomes are fairly easy to demonstrate, those between employee involvement and JIT flow and JIT quality are difficult to establish. Although I didn't consider employee involvement to be an element of JIT for this study, I did collect sequence data on it along with the data for the JIT elements. Of the four plants where employee involvement was being actively pursued, two of them (B and C) reported employee involvement as the first process change pursued and two of them (D and F) reported it as the last. Thus, the causal nature of the last two propositions (19 and 20) is not demonstrated.

Finally, apparent non-spuriousness may be demonstrated by comparing the management initiatives here, which emphasize participatory approaches, to those discussed in Chapter Two as alternate viewpoints of JIT. That is, I will briefly argue that neither an industrial engineering view, a supplier-oriented view, nor a kanban-oriented view fits the data.

One alternate explanation for the observations of this study is that the outcomes are not due to the management initiatives identified here but rather to an industrial engineering approach. Such an approach would concentrate on the physical systems, processes, and standards while giving little emphasis to the "softer" issues of employee participation and so forth. This possible explanation may be quickly rejected by noting that Plant B doesn't emphasize industrial engineering. For example, the manager of one product line pointed out that the last two line balances were done by employees, not industrial engineers. And, at Plant C, one of the earlier actions taken by the plant manager was to go around objections of the engineering manager to set up teams for reducing setup times. As it only takes one good counter-example to reject a proposition, an explanation based on good industrial engineering doesn't fit the data.

Another rival explanation is that a concentration on JIT supply arrangements is central and would explain the outcomes noted. This may also be rejected quickly by noting that neither Plant B nor Plant C placed any unusual emphasis on supply arrangements. Plant B placed JIT supply as ninth of eleven JIT elements pursued and Plant C placed it as sixth of eleven. In spite of some problems in interpreting the sequence data, this clearly shows that neither case is consistent with the proposition that JIT supply is the major orientation. Thus, this rival explanation may be eliminated as well.

A third rival explanation is that the outcomes could be due to a kanban type of pull system being the major thrust of a firm's JIT approach. Again, this explanation may be quickly dismissed with one good counter-example by noting that Plant C currently does very little in the way of kanban approaches while still having high values for JIT flow, JIT quality, and employee involvement.

Although the plant environment constructs were intended for possible use in analyzing the second research question and were not included in the propositions, I decided to briefly examine the relationships between the plant environment and other parts of the framework. I use average ratings to capture the extent of a clan-like plant environment (as outlined in Chapters Three and Four), the degree of management initiative (using the four initiatives identified as necessary for JIT), the degree of employee involvement, and the extent of overall JIT implementation. These values are derived from Table 6.1 and summarized in Table 6.2.

Table 6.2
Current Plant Environment vs. Other Constructs

	A	B	C	D	E	F
Low Power Distance [1]	3.5	4.0	4.0	3.0	4.0	3.0
Collectivism [2]	1.0	4.5	4.5	3.5	3.0	4.0
Cultural Congruence [3]	2.5	4.0	4.0	3.0	3.0	3.0
Clan-Like Environment [4]	2.33	4.17	4.17	3.17	3.33	3.33
Management Initiatives [5]	1.3	5.5	5.0	3.5	2.5	3.5
Employee Involvement	2	5	5	4	2	4
JIT Flow Elements	2.0	4.3	3.3	3.4	3.1	2.7
JIT Quality Elements	2.5	3.5	4.3	3.3	2.8	3.0
Overall JIT [6]	2.25	3.90	3.80	3.35	2.95	2.85

(1) Average of decentralization of authority and management by wandering around
(2) Average of coordination of decision making and supervisors as team leaders
(3) Average of affective commitment and plant-wide philosophy
(4) Average of the three previous measures
(5) Average of the four management initiatives identified as necessary for JIT
(6) Average of the two previous measures

At this point, it was tempting to follow much the same procedure as before, namely, develop propositions stating that aspects of the plant environment were necessary for certain other constructs in the framework. However, it is just as likely the reverse could be true, namely, various management initiatives affect the plant environment. Next, it was tempting to simply consider the correlations between the plant environment and each of the other measures. However, as each firm represents a separate case and not just a data point, it is inappropriate to simply calculate a correlation coefficient. So, I decided to check the above relationships by examining the ranks of the plants on each of the summary measures considered above. These are shown in Table 6.3:

Table 6.3
Ranks: Current Plant Environment vs. Other Constructs

	A	B	C	D	E	F
Clan-like environment	6	1.5	1.5	5	3.5	3.5
Management Initiatives	6	1	2	3.5	5	3.5
Employee Involvement	5.5	1.5	1.5	3.5	5.5	3.5
Overall JIT	6	1	2	3	4	5

The above table clearly shows that there is a strong relationship between a clan-like environment and each of the other three categories considered, namely, the four previously identified necessary management initiatives, employee involvement, and the overall level of JIT implementation. In particular, Plant A ranks low on all measures and Plants B and C rank higher on all.

2 Research Question Two

The second of the two research questions posed in Chapter One was: "What explains the choices by firms to pursue particular elements and implementation sequences of JIT?"

As mentioned in Chapter Four, I approached this research question differently than the first. For the first question, I initially proposed propositions derived from the literature and then tested them with the data. For this second question, I posed no direct propositions. Rather, I assumed that possible explanations for choices and sequences of JIT elements would be evident in the plants' early environments and other factors made evident during the course of the study. Thus, my starting point for answering the second research question was a search for propositions suggested directly by the data. These propositions would be the final explanations for this research question, as the same data cannot be used to both derive and test propositions.

Tables 6.4 and 6.5 summarize the magnitude and sequence of JIT elements pursued by each plant, using the data reported in the "process change" portion of the manufacturing practices questionnaire (Appendix III, p.7). As explained in the discussion of operational definitions in Chapter Four, I considered an element to have been actively pursued at a plant if, by subtracting 0.6 standard deviations from the mean, the value was still larger than 3.00 (the neutral point on the "0" to "6" scale).

I show in Table 6.4, the magnitude of those JIT elements being pursued in a major way at each plant. The figures indicate the extent to which the firm pursued a particular element, not the degree to which the element had been successfully implemented.

Table 6.4

JIT Elements Pursued

Plant:	A	B	C	D	E	F
Setup Reduction	4.0	3.8	4.4			
Equipment Layout	5.0	4.5	4.8			4.3
Small Lot Size		5.2	4.7	4.8	4.6	
Repetitive Master Schedule		5.0	5.3	5.2		
Daily Schedule Adherence		4.3			3.9	
Pull System		4.8	4.2			
JIT Delivery from Suppliers		4.9	4.6	4.4	4.2	
Supplier Quality Level	4.0	4.0	4.7	4.2		3.5
Zero Defects Quality Control			4.5			
Statistical Process Control	3.5	4.2	5.4	4.2		
Use of Charts and Feedback		4.4	4.5			
Total Elements Pursued:	4	10	10	5	3	2

As can be seen, management at Plants B and C chose to pursue the most complete sets of JIT elements. In Table 6.5, I show the sequence of those JIT elements actively pursued, according to when the initial effort was made.

Table 6.5

Sequence of JIT Elements Pursued

Plant:	A	B	C	D	E	F
Setup Reduction	3	7	2			
Equipment Layout	1	4	5			1
Small Lot Size		8	1	4	3	
Repetitive Master Schedule		6	4	3		
Daily Schedule Adherence		10			1	
Pull System		5	3			
JIT Delivery from Suppliers		9	6	5	2	
Supplier Quality Level	4	3	10	1		
Zero Defects Quality Control			7			
Statistical Process Control	2	1	9	1		2
Use of Charts and Feedback		2	8			

Unfortunately, the above sequence data are not usable. This is because they represent average responses which have variances high enough to override most of the sequence differences shown above. So, I simply cannot state sequences with any confidence. In other words, questionnaire respondents were quite consistent in outlining "what" the plant did, but were very poor at being able to say "when" efforts to do these things began. This was probably not due to respondents' fading memories but rather difficulty in specifying exactly what is meant by the beginning of an effort. As well, different respondents would have been aware of JIT initiatives at different times and would have had differing perceptions and inside knowledge about when initiatives began, even with perfect memories.

This inability to make statements about sequence also means that I cannot make any confident statements about general types of JIT approaches, such as firms concentrating on JIT supply first, contemplated in Chapter Three. Such determinations will have to wait for future research. Thus, I drop further consideration of the sequence of JIT elements and concentrate in subsequent analyses on explaining the number of JIT elements pursued.

2.1 The Early Environment

As mentioned in Chapter Four, I assumed that the early plant environment would help explain the choices of JIT elements. In this section, I try to explain the total number of elements pursued in relation to the early plant environment (Tables 6.6 and 6.7). I am interested in whether any aspects of the early plant environment can help explain more complete JIT efforts.

Table 6.6 indicates the ratings from the questionnaire for the early plant environment. Here, I use only the questionnaire data as interview data on the early environment are quite sparse. That is, given limited time, interviews tended to concentrate on the current state of each plant, not on the early environment.

Table 6.6
Early Plant Environment
Questionnaire Results

Plant:	A	B	C	D	E	F
Decentralization of Authority	2.93	2.91	2.30	2.41	2.92	2.40
Management by Wandering Around	2.94	2.93	3.01	1.92	2.67	1.57
Coordination of Decision Making	3.04	2.81	3.12	1.96	2.37	2.19
Supervisors as Team Leaders	3.44	2.74	2.63	1.93	2.84	2.37
Affective Commitment	4.06	4.02	3.29	3.18	2.90	4.06
Plant-Wide Philosophy	3.56	3.58	3.40	2.47	2.68	2.48
Employee-Management Relations	3.81	3.04	4.10	2.21	3.02	3.67
Influence On Employer	2.89	2.92	2.81	2.00	2.90	2.11

Table 6.7 repeats the above data using high (H) and low (L) values only, where a neutral value is defined to be between 2.5 and 3.5. Neutral values are not shown as they clutter the table as well as lead to inconclusive results.

Table 6.7
Early Plant Environments
Questionnaire Results

Plant:	A	B	C	D	E	F
Decentralization of Authority			L	L		L
Management by Wandering Around				L		L
Coordination of Decision Making				L	L	L
Supervisors as Team Leaders				L		L
Affective Commitment	H	H				H
Plant-Wide Philosophy	H	H		L		L
Employee-Management Relations	H		H	L		H
Influence On Employer				L		L

From Tables 6.4 and 6.5, only Plants B and C pursued a high number of JIT elements (ten of the eleven considered). And, as may be seen on Table 6.7, there are only three constructs in the early environment which received high ratings for either Plants B or C, namely, affective commitment, plant-wide philosophy, and employee-management relations. However, Plant A also had a high value for each of these three and none was common to both Plants B and C. Therefore, I may immediately draw the conclusion that, contrary to initial expectations, none of the constructs in the early plant environment had a clear effect on the choices of JIT elements to pursue. This conclusion is significant as I had assumed that the early environment, such as the state of employee-management relations, would have had a major bearing on the elements of JIT pursued. It appears, however, that management chooses JIT elements for other reasons without being much affected by the existing state of the plant environment.

2.2 Other Explanatory Factors

Given that the early plant environment offered little help in answering the second research question, I attempted to offer explanations from other available data. One tactic suggested by Eisenhardt (1989:540) for searching for cross-case patterns is to look for within-group similarities coupled with intergroup differences. The groups, in this case, are those plants which have pursued a high versus low number of JIT elements. So, I reviewed the source documents once more for similarities between Plants B and C which might help explain their pursuit of a high number of JIT elements. Following this, I checked these potential explanations against the data for each of the other plants.

Although there were many similarities between Plants B and C, most already documented in Chapter Five and previous tables, I considered only those which might reasonably be expected to explain the number of elements pursued. The similarities discovered were (1) the organizational level of the initiator of JIT efforts, (2) the extent of active support by the plant manager, and (3) the elapsed time since initial JIT efforts.

In the following sections, I examine each of these in more detail and develop associated propositions. The procedures for examining propositions are similar to those for the first research question; only the source of the propositions differs. Here, this means that each proposition, based on plants B and C, must be consistent with the data from the other four plants as well. As before, each proposition is considered, in turn, in light of data from each plant as a stand-alone entity.

2.2.1 Organizational Level of Initiator

The first similarity between Plants B and C is the position or level in the organization of the manager who initially promoted JIT-like approaches.

Plant B had a directive from the president of the Canadian operations to pursue JIT-like approaches and this directive was in line with well known approaches of the U.S. parent. Like Plant B, the JIT initiative at Plant C began with an early top-down directive from the CEO of the entire organization. This was a clear mandate to pursue such approaches in a major way.

This similarity suggests the following proposition:

01. For management to choose to pursue a "full" set of JIT elements, it is necessary for the initial promotion of JIT-like approaches to come from a high level in the organization.

I further consider the proposition by examining the other four plants which did not pursue a high number of JIT elements.

At Plant A, the initial effort for JIT-like approaches came from the former production manager (reporting to the plant manager). As well, the corporate headquarters staff, described by the production manager as "not HR rounded," definitely did not support efforts of this type. Rather, they were issuing precisely opposite directives, namely, to return to measuring individual efficiencies, to ignore the union, and so forth. Plant A pursued only four of the eleven JIT elements considered for this study, so the above proposition is confirmed.

Plant D, being a sister plant of Plant B, had the same directive to pursue such approaches from the president of the Canadian operations. However, Plant D had pursued only five of the eleven elements considered for this study. So, in spite of being a sister plant, the outcome was not as extensive. So the proposition is also confirmed.

At Plant E, the initial major effort began with the operations manager, reporting to the plant manager. Plant E pursued only three of the eleven JIT elements considered. So, Plant E provides a replication of the results from Plant A, giving no reason to change the above proposition.

Plant F is a Canadian subsidiary of a U.S. firm, well known for early JIT approaches. The current president had been on a training mission in Japan in 1980. This led to three pilot plants within the corporation being chosen for JIT. And Plant F approached JIT in earnest in 1982. Nevertheless, Plant F has pursued only two of the eleven elements considered. So, Plant F, like Plant D, also supports the proposition that top-level directives are necessary.

2.2.2 Active Support by Plant Manager

The second similarity between Plants B and C is that the plant manager was on board and actively supported JIT initiatives.

At Plant B, the plant manager had recently replaced another who had been instrumental in promoting JIT-like approaches. The new manager also had experience in such approaches from other operations within the firm. Thus, all recent plant managers had been actively on board with the JIT efforts. At Plant C, the plant manager had been a major player in the early efforts at JIT. He was and is still the main proponent of JIT efforts. This suggests the proposition:

> 02. For management to choose to pursue a "full" set of JIT elements, it is necessary for the plant manager to actively support and promote JIT initiatives.

This proposition is further examined by considering the situation in the other four plants which did not pursue a high number of JIT elements.

At Plant A, the plant manager had his own non-JIT approach to manufacturing improvement, concentrating on other systems of management. He was not concerned with such JIT-related activities as team building for hourly workers, for example. As Plant A pursued only four of the eleven JIT elements considered for this study, the above proposition requires no change.

At Plant D, the current plant manager actively supported the JIT efforts but this was not the case for former plant managers. One of a number of reasons suggested for Plant D lagging behind its sister plant, Plant B, is that former top plant-level managers were not on board with respect to the JIT efforts promoted by headquarters. Plant D has pursued only five of the eleven elements considered for this study. This value reflects recent efforts as well as the lack of previous efforts. This also confirms the proposition.

At Plant E, the plant manager allowed the operations manager to pursue JIT-like, and similar, initiatives but he did not actively support and promote JIT initiatives. As already outlined, Plant E pursued only three of the eleven JIT elements considered for this study. This is similar to Plant A and provides further confirmation of the proposition.

At Plant F, the plant manager is on board and is actively pursuing JIT-like approaches. He has been at the plant for roughly seven years, with a brief period away. However, Plant F has only pursued two of the eleven elements considered. Nevertheless, this is consistent with the above proposition that active support by the plant manager is necessary.

2.2.3 Time Since Initial JIT Efforts

The third similarity between Plants B and C is that, for each, a number of years have passed since initial efforts to pursue JIT-like approaches.

In the early 1980s, Plant B began initial efforts at quality circles and Plant C began initial efforts at flow improvements, each with some emphasis on employee involvement. However, Brewer and Hunter (1989:149) define causes as events which produce or aid in the production of other events. The passage of time is not an event so cannot be considered a necessary cause, only a necessary modifier of other proposed causes. This suggests the following modifying proposition:

> For the previous proposed relationships to hold, it is necessary for a number of years to pass since initial JIT efforts.

I examine this proposition further by considering the situation at the other four plants which did not pursue a high number of JIT elements.

The JIT efforts at Plant A began around August 1989. As Plant A did not rank highly on number of elements chosen, the proposition is confirmed but may be modified to read:

> For the previous proposed relationships to hold, it is necessary for more than two years to pass since initial JIT efforts.

Although Plant D is a sister plant of Plant B, there were no early attempts at employee involvement, quality circles, or other JIT-like approaches. Rather, formal efforts at JIT began in August 1988. As Plant D has pursued only five of the eleven elements, all very recently, the above proposition gains more confirmation and may be adjusted to read:

03. For the previous proposed relationships to hold, it is necessary for more than three years to pass since initial JIT efforts.

Plant E began efforts just recently, in January 1990. It has pursued only three of the eleven JIT elements. So, this is consistent with the proposition that more than three years must pass.

Plant F, however, began JIT efforts in 1982 but has only pursued two of eleven JIT elements. Nevertheless, this is consistent with the proposition, as modified.

2.2.4 Extent of Workforce Reduction

Plant F meets all three factors discussed in previous sections but does not match Plants B and C in terms of the number of JIT elements pursued. Thus, the first three factors do not differentiate Plants B and C from the others, in particular, Plant F. So, I continued by reviewing the source data for Plant F for factors which would distinguish it from Plants B and C. A major distinction centred around the issue of cutbacks. Plant F had undergone some fairly drastic cutbacks in staff levels (e.g. a 37% reduction in salaried positions) during the time of JIT implementation, leading to a lull in JIT activity. Although there were also some recent layoffs at Plant B, they were not as drastic and were ameliorated by serious and visible efforts by management to minimize the damage. Employees at Plant B believed that management was doing all it could to avoid layoffs. The fact that 25 employees were held on special assignments rather than laid off was well known and appreciated by employees. Plant C experienced an increase in employment level during this time.

However, as with the previous factor, a lack of workforce reduction cannot be considered an event and therefore can't be a cause. Rather, it should also be considered a modifier.

These observations suggest the following modifying proposition:

04. For the previous proposed relationships to hold, it is necessary to have any workforce reductions clearly seen as actions of last resort.

I then check this proposition against the three other plants (A, D, and E).

Plant A has experienced no cutbacks and, in fact, has increased employment lately. This provides no reason to adjust the proposition.

Plant D replicated the situation at Plant F. There were recent cutbacks with no indicators that management made special efforts to minimize the effects. So, the above proposition is further confirmed.

Plant E experienced some cutbacks as well, but all values for this discussion connected with Plant E are low. So, not much may be said except that the data offer no reason to reject the proposition.

2.2.5 The Use of Piece Rate Incentive Systems

A second distinction between Plant F and Plants B and C concerns the use of a piece rate incentive system. At Plant F, such a system is well entrenched. Lately, there have been moves towards gainsharing but, to date, gainsharing exists only in a few areas in one of the focused factories. On the other hand, Plant B has only a pocket of a former incentive system and Plant C has no such system.

Similar to the last two factors, the absence of a piece rate incentive system should be considered a modifier, not a cause. This suggests the following modifying proposition:

05. For the previous proposed relationships to hold, it is necessary to be without a piece rate incentive system.

I then check this proposition against the three other plants (A, D, and E).

Plants A and D meet the condition of no piece rate incentives but also have low values for the number of JIT elements pursued. Nevertheless, they confirm the proposition.

Plant E has a strong piece rate incentive system along with low value for JIT elements. This further confirms the proposition.

2.3 Discussion and Summary

The previous discussion suggested five factors, derived from the data, which, at least partially, explain the number of JIT elements pursued by various plants. These five are: (1) the organizational level of the initiator of JIT efforts, (2) the extent of active support by the plant manager, (3) the elapsed time since initial JIT efforts, (4) any workforce reductions clearly seen as actions of last resort, and (5) the absence of a piece rate incentive system. The first two of these factors were suggested as causal and the last three as modifiers.

Combining the five factors, a more complete statement is:

> For management to choose to pursue a "full" set of JIT elements, it is necessary for the initial promotion of JIT-like approaches to come from a high level in the organization and for the plant manager to actively support and promote JIT initiatives, provided more than three years have passed since initial JIT efforts, any workforce reductions were clearly seen as actions of last resort, and there is no piece rate incentive system.

As outlined for the first research question, I must also address the issues of temporal sequence and non-spuriousness in order to argue for causal relations. It is fairly easy to demonstrate temporal sequence for the two causal propositions. These will be discussed, in turn, followed by a discussion of spuriousness.

Considering the first proposition (organizational level of the initiator of JIT efforts), Plants B and C offer clear evidence (aside from common sense) that the initiation occurred before the high number of JIT elements were pursued. At Plant B, although there had been early efforts at process improvement for more than a decade, the big push for JIT came at a company conference in August, 1988. The questionnaire data shows marked changes for the eleven JIT elements before and after August, 1988 (average of 2.222 to average of 3.824). Thus, it is reasonable to argue that the sequence of events was high-level directives at the conference followed by changes in JIT elements pursued. And, at Plant C, the date dividing "before" and "now" was 1982, about the time of top-down directives. Marked changes were also revealed (average of 1.622 to average of 3.595), also confirming the temporal sequence.

And, considering temporal sequence for the second proposition (the active support of the plant manager), both Plants B and C had plant managers who were actively on board in the early days and, in the case of Plant B, actively involved with JIT-like improvements such as quality circles long before the term JIT was used. Using arguments similar to those above, temporal sequence may also be demonstrated.

The third requirement to make a case for causal propositions is to attempt to demonstrate that the relations are non-spurious by considering rival explanations for the observed results. Very few plausible rival explanations suggested themselves, but I will briefly consider two of the more plausible.

One such explanation is competitive pressure. It could be argued that the two relationships identified were not causal at all but were simply reflections of competitive market pressures. That is, competitive pressure leads to upper management initiating JIT approaches, plant managers becoming active JIT supporters, and a high number of JIT elements pursued. This rival explanation may be eliminated, however, with reference to Plant C where there was very little competitive pressure when the corporate CEO directed that JIT efforts be pursued and when the plant manager became actively involved For sure, they were pursuing these efforts in order to remain competitive but there were no serious competitive threats at the time. Furthermore, it makes little sense to argue that competitive pressure would lead directly to the pursuit of JIT elements without some intervening management action.

A second plausible explanation might be that supervisors and other people closer to the plant floor lead to higher levels of JIT elements pursued and that initiatives by higher level managers are simply coincidental. However, at both Plants B and C there is a strong common theme of management setting goals and parameters and then supervisors and direct workers finding ways to meet the goals. At Plant B, there were indications that the process began with management but only later became bottom-driven. At Plant C, there were indications of definite training sessions to help supervisors become coaches, along with indications that it is difficult for supervisors to change. There were no indications of initial bottom up approaches. So, this rival explanation is also inconsistent with the data.

Thus, overall, there is reasonable evidence to suggest that the first two propositions are causal and not simply correlations.

Unfortunately, there is another problem. The two causal factors cannot be easily differentiated from one of the "management initiative" constructs, namely, "demonstrate visible commitment." So, adding these two factors to the research framework to explain the number of JIT elements pursued would lead to very low discriminant validity between a number of constructs. For example, it would be extremely difficult to argue that top-level management initiation of JIT led to a choice to pursue a high number of JIT elements which, in turn, led to demonstrated visible commitment by management. It is far easier to note that top management initiation is, in itself, demonstrated commitment.

So, the JIT choices construct in the framework is not modelled correctly. In the above discussions, I've shown that the temporal sequence flows from management initiatives to JIT choices, opposite that suggested in the framework. So, it is more valid to propose that demonstrating visible commitment (and other management initiatives) leads to choices of JIT elements. That is, "choices of JIT elements" does not constrain or influence management action, as originally suggested.

Another problem with using the choices construct as originally proposed concerns the implication that management makes a "one-shot" decision to pursue a particular set of JIT elements. This is not the case. The managers in this study did not simply choose all at once. Rather, their choices were reflections of their actions over a number of years.

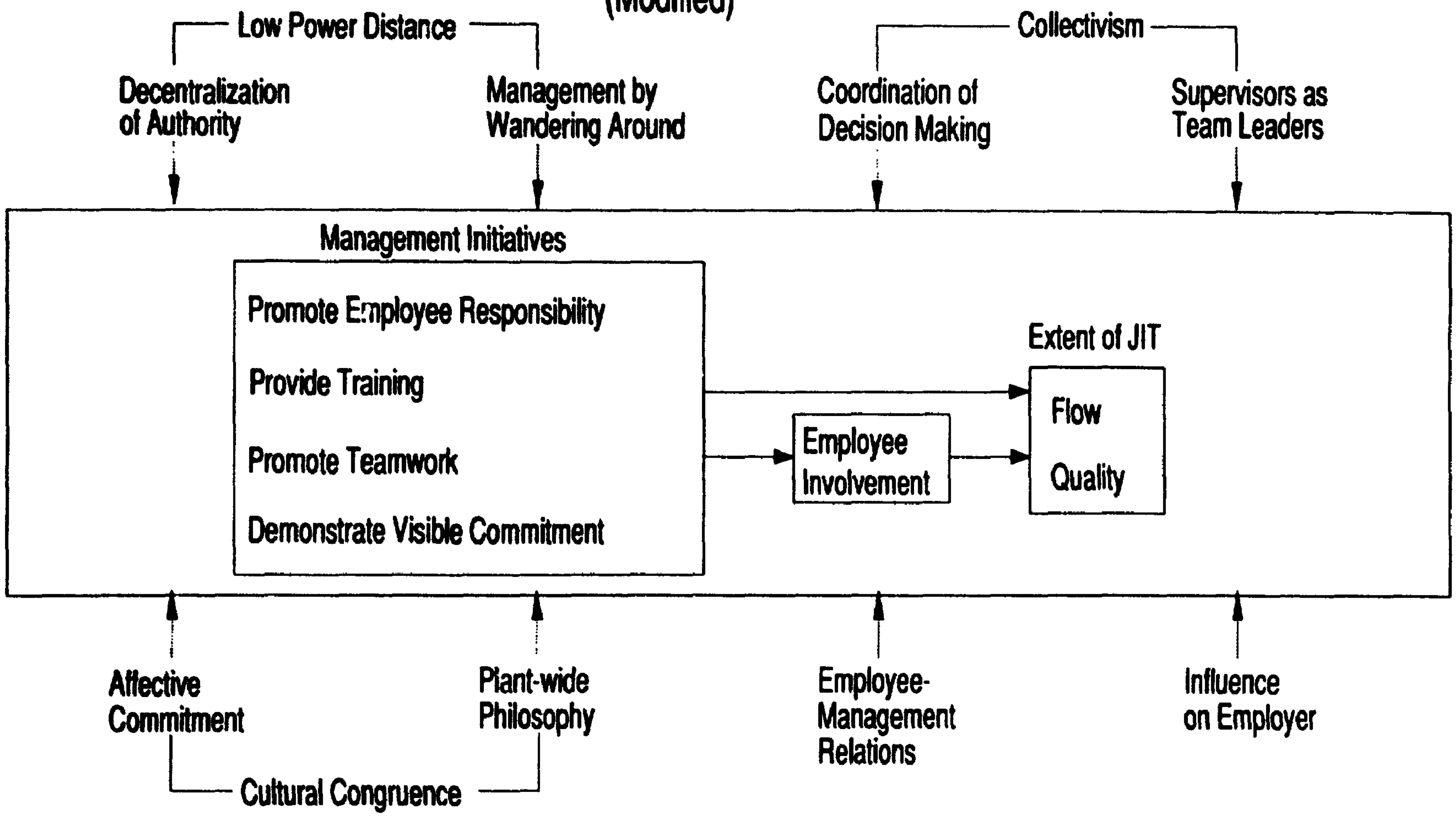
In summary, I partially explained the number of JIT elements pursued, by offering the propositions just outlined. However, the analysis also made it clear that the placement of the construct in the framework was incorrect as it would lead to problems of discriminant validity. The correct placement would be after, rather than before, the management initiatives constructs. However, it is better to simply drop the choices construct from the framework for two reasons. First, as mentioned, management doesn't actually choose elements all at once. Second, the data show that there is a very close match between the JIT elements pursued and the JIT flow and quality results, so there would also be discriminant validity problems here. The idea of choices of JIT elements to pursue is best left described by the actual results. And, management initiatives, rather than being partially explained and constrained by initial choices about JIT, should be treated as exogenous constructs, albeit ones which might still be influenced by the plant environment.

3 Implications for Management

This study has a number of implications for management with respect to JIT implementation. These concern the role of management, the role of employee involvement, the issue of providing workforce security, the issue of group performance measures, and the role of plant culture. These are discussed in turn in the following sections.

For reference, the framework, modified to reflect previous discussions, is shown in Figure 6.1.

Figure 6.1
RESEARCH FRAMEWORK
(Modified)



3.1 Implications for Management at Sites Visited

In the following discussion, I briefly outline some implications for management at each plant visited.

3.1.1 Plant A

Plant A, although originally represented by one of the managers as engaging in JIT, was definitely not doing so. The interesting consideration here is that they ranked lowest on all the major areas of the framework, namely, plant culture, management initiatives, employee involvement and measures of JIT flow and quality. Nevertheless, they were doing well in their market, indicating that a just-in-time approach is, of course, not the only way to succeed. In particular, they are using industrial engineering techniques to clean up their flow lines, allowing them to use throughput time reduction as a vehicle for obtaining new orders.

This strategy works for them at present but they could easily stall whenever it becomes necessary to make substantial further improvements. They are not establishing a system which allows for continuous improvement of the production process. Currently, improvements rest too heavily on the capabilities of a few staff people. To make matters worse, they are being forced by headquarters to return to traditional measures of labour and machine efficiency. They are currently doing well but any competitor following a JIT approach could easily match them on the technical aspects of production, such as layout, as well as beat them on other improvements requiring active employee involvement and learning. In short, Plant A has a competitive advantage at present but it does not appear to be sustainable, given that their approach can be easily copied. They would find it very difficult to change their current strategy.

Although there is no formal provision for employee job security, the employees at Plant A gave the impression of being reasonably secure in their jobs. This seemed to be based on the belief that the current managers were competent in obtaining new work. The recent addition of the new line transferred from a U.S. sister plant helped in this perception. This suggests a couple of things: (1) job security is not necessarily dependent on formal management initiatives to promise or guarantee jobs; it may be dependent on knowing you are part of a firm which is doing well in the marketplace, and (2) as indicated in the study, there is no particular connection between the formal provision of job security and JIT results.

3.1.2 Plant B

Plant B ranked highly on most of the areas considered for this study. This provides an excellent example of how the various parts of the framework fit together. Although it is often difficult to determine cause and effect, it is quite clear from the experience of Plant B that a clan-like environment, promotion of employee responsibility, provision of training, promotion of teamwork, demonstration of visible commitment, employee involvement, and JIT flow and quality all fit together in a very consistent pattern.

With respect to the issue of job security, employees probably felt more secure in their jobs than indicated by the lack of any formal assurance by management. This appears to be so in spite of a downturn in sales which led to recent layoffs.

Employees felt apprehensive about future production levels; however, they also thought managers were trying their best to provide as much employment as possible. Management retained, on special assignment, 25 employees who would otherwise have been included in the layoffs and they listened to the group of employees who suggested ways to avoid shipping jobs to Mexico. Both of these instances were clearly very symbolic to many people in the plant; the two stories were recounted on a number of occasions.

Managers were concerned about the long-run impact of being forced to reduce positions but employees seemed to understand and were mainly concerned about future production levels. Past efforts which led to a clan-like plant culture appeared to be paying off. Although managers were concerned, there was little doubt that they would be able to continue improving once the downturn had passed.

Plant B is an excellent example of a plant in which the parts of the framework fit together very nicely and in which continuous improvement of the production process becomes a way of life.

3.1.3 Plant C

Like Plant B, Plant C demonstrates the viability of a concerted effort to continuously improve along a number of dimensions. It also has a clear clan-like plant culture with corresponding high levels of management initiatives and JIT-like results - once again, a very consistent pattern. This clan-like culture was reflected in the very active involvement of employees in formal group problem solving within local areas. The plant could not have reached this level of involvement without many other aspects of the framework being in place, in particular, the emphasis on the four management initiatives. Management at Plant C was committed to continuous improvement, employees were expected to take responsibility, teamwork was actively encouraged, and training was given prominence. This matched the consistently high values found for aspects of clan-like culture at Plant C.

As with other plants, job security, although not formally guaranteed to employees, was not a major concern. In general, employees assumed that the plant was run well enough that there would be continued business. They also seemed to understand that the situation was this way due to their own efforts.

Plant C was the only one in the study exhibiting a high value for group performance measures. This is consistent with the notion that group performance measures make sense, are helpful when in place, but are not necessary conditions for JIT results.

LIke Plant B, Plant C is also an excellent example of a plant in which the overall framework shows consistency. The plant culture, management intitiatives, and JIT results all fit together.

3.1.4 Plant D

Plant D was a very interesting case in large part due to the speed with which improvements were being made. It began a few years ago at a very low level in terms of most of the items addressed in this study, including some fairly severe labour-management problems, but was quickly turning things around. There was an open question as to whether or not the corporate offices would keep the plant open without such major improvements and this was undoubtedly driving the process. At the time of the study, Plant D still had a long way to go before achieving the types of results enjoyed by Plant B, its sister plant.

The main reason for the differences between these two sister plants seemed to be the degree to which the plant managers followed through with head office directives. At Plant B, the plant managers had all been actively involved in putting improvements in place. At Plant D, however, earlier plant managers apparently paid little attention to corporate desires and did not actively promote them at the plant level. Recently, however, one plant manager was brought in deal with some severe employee-management problems and managed to fix the worst of them. He was followed by the current plant manager who has actively worked hard to decentralize and push responsibility down as far as possible. At the time of the study, he had managed to do this to the level of supervisors but the supervisors were still having trouble moving it down further. The current plant manager is a major reason things are now moving so quickly after being so slow for many years.

Plant D is a good example of the results possible when a commitment is made turn around a bad situation. There have been some dramatic improvements in a very short period of time. However, there has still been insufficient time to obtain full results and their measures for the majority of the constructs in the framework are still in the middle ranges.

At Plant D, there was no provision of job security nor any particular feeling of security. The overriding consideration was the perception that things had better change quickly or the plant might be shut down.

As mentioned, Plant D was the reason for the rejection of the proposition that group performance measures were necessary for various JIT results. In particular, there were no group measures, aside from throughput measures which treated the overall plant as a group. Nevertheless, Plant D had managed to achieve relatively high flow and quality levels, which were likely heading higher. Again, it makes sense that the use of group performance measures could be a contributing factor to JIT results but the experience of Plant D indicates that they are not necessary.

The managers at Plant D still has many improvements to make but are now on the right track. They have a particular advantage in being able to learn from the experience of their sister plant.

3.1.5 Plant E

The managers at Plant E were having trouble deciding on their overall improvement strategy. They were attempting to implement a fair number of similar approaches to production improvement. These ranged from an improved MRP system, to a system of visible control, to a "theory of constraints" approach, to a system of focused factories. However, this all led to pockets of improvement in various areas, with none working exceptionally well.

This all reflects their lack of a clear mission or commitment to a particular approach. The plant manager, at the time, seemed to allow and somewhat support the efforts of other managers but he was definitely not actively involved in setting overall direction or instilling a particular philosophy throughout the plant.

They had a major problem with the existing piece rate incentive system. Piece rates simply don't mix with the types of improvements they were attempting. Most managers and many of the employees understood this; nevertheless, there was a problem in removing piece rates from the collective agreement. They had plans to do so in upcoming negotiations but it was unclear what the implications of a strong bargaining position might be.

As well, they have a problem with the plant culture. Most of the schemes described above will not deliver major benefits without having the plant culture in place to support such efforts. Plant E received neutral ratings on most of the constructs measuring the extent of a clan-like culture.

Thus, Plant E has a number of problems to fix. They won't be able to implement JIT (or similar approaches) without first solving the problem of the piece rate system. As well, clarity on their overall mission would yield a more consistent approach to plant improvement.

3.1.6 Plant F

Plant F is much like Plant E in the sense of having focused factories which were not that well focused. They had problems with pockets of improvement amid many areas of old-style manufacturing, different managers pushing in different directions and with quite different levels of intensity, and a piece rate incentive system. In their case, however, the plant manager had supported the JIT efforts for some time. Nevertheless, there was little evidence that he had been successful at pushing through some of the necessary changes. A good example concerns the piece rate system; it should have been eliminated long ago, yet there seemed to be tolerance for some quite unworkable situations. For example, one of the focused factories had some of its people on a gainsharing program and others on piece rates.

At Plant F, there are a number of good signs that things are changing but, at present, some very good practices still exist alongside some very bad old-style practices.

3.2 Role of Management

One major conclusion from this study is confirmation that management is the key to successful JIT implementation. There is strong support, although not absolute proof, for the propositions that four management initiatives (promotion of employee responsibility, provision of training, promotion of teamwork, and demonstration of visible commitment) are each necessary conditions for each of employee involvement, JIT flow, and JIT quality.

The early environment, however, did not explain the choices of JIT elements to pursue. This is contrary to initial assumptions that conducive early environments, such as one with good employee-management relations, would make it easier to pursue a wider set of JIT elements. Rather, five other factors, mostly related to the role of management, offer explanations. These are the level or position within the firm of the initiator of JIT efforts, the extent to which the plant manager actively supports these initiatives, the time since initial JIT efforts, any layoffs clearly seen as actions of last resort, and an absence of piece rate incentives. In other words, the early environment is not important in explaining subsequent choices; rather, management is the key. A very similar conclusion was drawn by Montagno et al. (1990:13):

> Thus, one of the important conclusions drawn from this study is that JIT implementation is a result of conscious management choices to structure behavior patterns in the firm rather than the limitations and biases of the physical environment which have been presumed to limit positive change.

Thus, management can simply decide to proceed with JIT initiatives without much concern about the existing plant environment. The commitment to solve certain implementation problems is more important than the nature of the problems themselves.

3.3 Role of Employee Involvement

Employee involvement plays a very central role. It was shown to be highly associated with JIT quality and JIT flow. The four management initiatives, mentioned above as necessary conditions for JIT flow and quality, all appear to operate through employee involvement. Table 6.8 considers various strong relationships between independent and dependent constructs. A strong relationship is one in which the independent and dependent constructs each have high values; relationships with low values for each construct, although consistent, are not strong evidence. The plant labels for which a particular strong relationship was shown to hold are listed in the appropriate cell of the table.

Table 6.8
Plants Showing Strong Confirmation of Propositions

	Dependent Construct:		
Independent Construct:	**JIT Flow**	**JIT Quality**	**Employee Involvement**
Promote Responsibility	B C D	B C D	B C D F
Provide Training	B C	B C	B C F
Promote Teamwork	B C	B C	B C
Demonstrate Visible Commitment	B C D	B C D	B C D
Employee Involvement	B C D	B C D	-----

The evidence is quite strong here. As may be seen looking across the rows of the table, there was no instance in the results, for any plant, where any management initiative led to a high level of JIT flow or JIT quality without also leading to a high level of employee involvement. However, as mentioned, while there is evidence for the temporal sequence from management initiatives to the other constructs, it is difficult to establish the temporal order between employee involvement and JIT flow or JIT quality. The most likely explanation is that employee involvement and JIT flow and quality influence and reinforce each other.

3.4 Workforce Security

Another major conclusion from this study concerns workforce security. Although undoubtedly important, it is not necessary for management to provide a negotiated contract guarantee for workforce security nor make any form of decree. So, lifetime employment, or other types of promises is not a necessary condition to successfully implementing JIT. Part of the explanation for this may have been the fact that there was a recession during the time of this study.

However, this does not mean that issues of job security may be ignored. While not demonstrated strongly in this study, there were indications that job security is still very important. It is very important to note that security, as discussed in this study, concerns the official undertakings of management; it does not address other considerations such as employees' sense of security or concern about job loss.

Thus, it is possible that other measures of security might lead to different conclusions. For example, if I had addressed the extent to which employees felt secure on the job, I would likely have received quite different responses about the importance of workforce security for JIT efforts.

Nevertheless, management should recognize that a formal promise of job security is not necessary for successful JIT implementation. There is no reason to assume that it is necessary, for example, to emulate certain Japanese approaches by promising lifetime employment in return for involvement and participation.

The difference is that employment security comes, not from management fiat, but from the plant being able to compete successfully in world markets. Employees who know they work for, and are a valued part of, such an organization will have a far better sense of job security than available from any negotiated agreement or pronouncement from management. The notion of job security is connected more with being part of a winning team and/or management bringing in new business than with promises or contractual obligations.

3.5 Group Performance Measures

This study also found that the use of group performance measures did not prove to be necessary. This conclusion is not as strongly supported as the one on workforce security as only one plant led to the rejection. Nevertheless, this is sufficient evidence to reject the proposition.

Although the use of group performance measures makes perfect sense in a JIT context, management should not view its introduction as a necessary condition. It is appears that a firm can move ahead without first establishing group measures. This could be due to any number of factors including those not explored in this study. One possibility is that managers and employees both recognize the need to work together to improve, given the uncertainty of the competitive situation. This is certainly so in the case of Plant D which led to the rejection of the proposition that group performance measures were a necessary condition.

A minimum condition for moving forward, however, is the absence of piece rates. These should be removed quickly even if group measures are not adopted. Piece rates and JIT do not mix.

As well, Bates et al. (1990:29) speculate that group rewards may take longer to change than shop floor practices. This certainly seems consistent with two of the plants in this study in which shop floor practices were being changed in spite of difficulties in replacing individual piece rate incentives with group approaches.

3.6 Clan-like Culture

Although, environmental factors were not required for explanation as much as originally assumed, there is good evidence that a clan-like culture (i.e. one which has low power distance, is collectivist, and has high cultural congruence) is consistent with the rest of the framework, namely, the four management initiatives found necessary for JIT, employee involvement, and higher levels of JIT flow and quality. This is in keeping with the conclusions drawn by Bates et al. (1990:24) that there was a strong relationship between a clan-style organizational culture and a world class manufacturing strategy.

In general, management should attempt to (1) reduce power distance at the plant by decentralizing decision making and increasing management visibility, (2) increase collectivism by promoting the coordination of decision making and developing supervisors as team leaders, and (3) promote cultural congruence by encouraging affective commitment (mainly by providing meaningful work, making it clear that employees are valued members of the firm) and by promoting a consistent plant-wide set of beliefs or philosophy.

Causal directions were not clear, nor directly addressed in this study, but it makes sense to assume that effects flow in both directions. That is, a clan-like environment allows managers to take certain actions and managers can take action to promote a clan-like plant environment. However, as Bates et al. (1990:27) warn, changing plant cultures is a viable, but very difficult, long-term strategy.

4 Implications for Further Research

4.1 Content Areas

There are a number of content areas in which further research would be fruitful. These are suggested by both the research framework and the results of this study. One major area concerns the apparent central role of employee involvement in JIT. In particular, this study suggested that the management initiatives which lead to good JIT results operate through employee involvement. However, a question remains about just how central a role employee involvement plays. Is it really a central theme? Is it always necessary, or simply helpful? Can there be instances where the four management initiatives identified in this study lead to JIT flow and quality without much evidence of employee involvement? As well, the temporal sequence between employee involvement and JIT flow and JIT quality could not be established; further research is needed.

A promising research project would be to try to sort out the different "path effects" using statistical data collected from a broad-based survey along with a second-generation analysis technique (Fornell, 1984; Fornell & Bookstein, 1982; Pedhazur, 1982) such as Partial Least Squares (PLS) or Linear Structural Relations (LISREL). Presumably, this could differentiate the direct and indirect effects concerning management initiatives, JIT flow, JIT quality, and employee involvement. Although this current study suggests that management initiatives operate through employee involvement, it would be helpful to be able to separate these from any direct effects. This separation could not be done with the present approach and data. I expect such a study would confirm the central role of employee involvement.

The research framework and results of this study also suggest that more research is needed into the relationships between a clan-like plant environment and management initiatives aimed at promoting JIT-like activities in the plant. The framework of this current study was not aimed at establishing causal links between the plant environment and other constructs in the framework. The direction of causal effects is not clear. It is quite likely that there is a two-way effect, with the initial thrust coming from management, but with the plant environment subsequently influencing future management action. This could all bear a more detailed look.

There is also a need for further work on the concept of job security and how it relates to JIT-like results, and, in particular the link between job security and employee involvement. Is the provision of job security simply not necessary or are there other more important forms of security aside from management decree? There were hints in this study that job security is still very important but flows from employees knowing they are part of a winning organization and/or that management is good at finding new business. In this study, I considered only job security as provided directly by management; I did not try to assess other constructs such as employees' sense of security. There is a good research project to be pursued here.

The other management initiative which did not bear out as necessary for JIT flow and quality is the use of group performance measures. I could not offer much explanation for this result except to suggest that the implementation of group measures takes time and that there are likely sufficient competitive incentives to improve so firms proceed without first implementing group measures, provided piece rate incentives are eliminated. The issue of the importance of group performance measures leaves much room for future research. In spite of the results, it still makes good sense that the use of group measures should be a positive action to be pursued by management as part of JIT efforts. Further research is needed to determine why this did not appear to be necessary in this study.

Another promising area of future research would be to test the five propositions derived from the data while addressing the second research question. These could not be tested with the same data used for their derivation. So, further research could test the propositions that necessary conditions for pursuing a full set of JIT elements include (1) the initiator of JIT efforts being at a high level in the organization, (2) active support by the plant manager, provided (3) sufficient elapsed time since initial JIT efforts, (4) any workforce reductions clearly seen as actions of last resort, and (5) no piece rate incentive systems.

In general, the timing and sequence of JIT implementation could stand a much closer look. The relationships between sequence, type of JIT approach, and JIT results are not clear. This was one of the initial aims of this study but it became impossible to sort out a reasonable time line as to when and to what degree certain JIT elements were introduced. To do a decent job on this would require a detailed, preferably longitudinal, study in which the major research questions centred around these timing and sequencing considerations. Precise criteria would have to be used to better define what is meant by an initial effort and detailed company records would have to be examined to better determine timing.

Also, this inability to derive a reliable sequence made it impossible to sort plants into types. I had hoped to be able to compare plants by considering their early JIT approaches according to types suggested in Chapter Two. For example, what are the differences based on different viewpoints about JIT such as JIT as mainly supply, mainly a collection of industrial engineering techniques, mainly a kanban "pull" system, or a complete philosophy and system? This will have to wait for subsequent research.

4.2 Methodology

A major lesson from this study was confirmation that case-based methods, while difficult to do well, are fruitful in yielding results. Face-to-face interviews, or field work of some sort, are generally necessary for understanding in the operations management field. I would not have learned as much from simply doing a broad survey followed by statistical analysis.

However, this does not mean that statistical analysis would not be useful. In fact, the next logical step in this research would be to attempt confirmation of some of the results using a more broad-based mail survey. This survey would be designed to test the statistical generalizability of the results, whereas this study was concerned with analytic generalizability. (The distinction between the two was discussed in Chapter Four.) However, any such broad survey would have to be carefully designed. In particular, questionnaires would have to be aimed at a selected set of people within any given plant; they should not be simply mailed out at random.

Simply mailing questionnaires addressed to plant managers would lead to very suspect results, for this field of study. There are undoubtedly many problems with surveys concerning what really happens to questionnaires from the time they are mailed until the time they are returned and transformed into so-called hard data.

As well, there is also research needed in measuring various constructs in the framework. In particular, before a broad survey can be done, it is necessary to be able to measure the extent to which certain management initiatives are undertaken at each plant. I did this via extensive interviews for this study but would require valid and reliable constructs for a mail survey.

And finally, there is still work to be done on measuring JIT itself or related approaches such as "lean production" or "world class manufacturing." Although good work has been done, in particular by researchers at the University of Minnesota and Iowa State (e.g. Sakakibara et al., 1990), the concepts are very slippery and interdependent.

4.3 Generalization

As outlined in Chapter Four, case research concerns analytical, not statistical generalization. The domain to which results may be generalized is defined by the extreme cases within a study. For this study, I may fairly safely generalize the conclusions across repetitive assemblers and fabricators, both union and non-union, ranging in size from a few hundred to a few thousand employees, and at various stages of JIT implementation. As well, although the plants visited are in central Canada, it is fairly safe to generalize to plants in other parts of North America, as there were no indications nor any real reason to assume that geographical location per se would make a difference. Further study can help more sharply define the domain to which these results may be generalized.

Appendix I - Interview Protocol

General:

- Introduction

- Purpose of Study: to try to explain key factors that help or hinder firms in implementing Japanese approaches to management

- Confidentiality: Interview will be confidential; I will only be reporting data at the site level. I am interested in your opinion. There are no trick questions.

- Procedure: 1) open-ended interview questions, 2) will leave a questionnaire with you - will pick up later

- JIT Definition problem: many terms for Japanese approaches; for this interview will use term JIT (*or corresponding term used at plant*) to mean 1) material flow, 2) quality, and 3) employee involvement aspects.

- Questions will be aimed at a number of broad areas. For each area, I would like to review:

  - the situation before efforts to adopt Japanese approaches;
  - any problems and desired changes;
  - what was done to try to change the situation;
  - the situation today; and
  - anything else you think is important.

- The term "Before" should be interpreted as (*date*).

Questions:

- First, a general question:

  Which major factors help or hinder efforts to implement JIT (*or corresponding term used at plant*)?

- Then, for various factors X (next page):

  - Before, what was the situation concerning Factor X?
  - Were there any problems? Was any change change in the situation desired?
  - What was done?
  - What is the situation today?
  - What factors help or hinder Factor X?

Factors X:

Management Actions:

- provide workforce security
- promote employee responsibility
- enhance capabilities
- promote teamwork
- use group performance measures
- demonstrate visible commitment

Dimensions of JIT:

- set-up reduction
- equipment layout
- small lot size
- transfer lot size
- repetitive master schedule
- daily schedule adherence
- kanban
- pull system
- JIT delivery from suppliers
- autonomation
- supplier quality level
- zero defects quality control
- statistical process control
- use of charts and feedback
- product design simplicity
- preventive maintenance
- in-house equipment
- small group problem solving
- employee involvement

Plant Environment:

- decentralization of authority
- management by wandering around
- communication and coordination of decisions
- role of supervisors
- loyalty of employees to the firm
- shared values and beliefs at the plant
- employee - management relations
- influence of employees on working conditions

Operations Performance:

- throughput
- quality
- dependability

Others:

- workforce participation
- inventory (levels, turns)
- productivity

Appendix II - Interview Protocol - Improvement Projects

General:

- Introduction
- Purpose of Study: to try to explain key factors that help or hinder firms in implementing Japanese approaches to management
- Why you?
  I asked to speak to those involved in a recent process improvement project.
- Confidentiality: Interview will be confidential; I will only be reporting data at the site level. I am interested in your opinion. There are no trick questions.
- Procedure: 1) open-ended interview questions, 2) will leave a questionnaire with you - will pick up later
- JIT Definition problem: many terms for Japanese approaches; for this interview will use term JIT (*or corresponding term used at plant*) to mean 1) material flow, 2) quality, and 3) employee involvement aspects.
- What do I want?
  I'm interested in your account of the "project" and your involvement with it.

Your Account:

- How did you first become involved with this project?
- What were the main events? How did it proceed?
- What was your role in the project?
- Who else was involved and what were their roles?
- How well did all of you work together?
- Were there any problems? Why?
- What worked well? Why?
- Anything else?

Appendix III - Manufacturing Practices Questionnaire

This appendix contains a copy of the manufacturing practices questionnaire, as presented to respondents, with questionnaire items in random order.

Below, I match each construct of interest with the questionnaire items used in its measure. Reverse scored items are shown in parentheses.

Construct	Item numbers
Setup time reduction	75,76,79,81
Equipment layout	9,22,70
Small lot production	(26),(37),58
Transfer lot size (new items)	5,(20),29,38,55
Repetitive master schedule	30,51,71
Daily schedule adherence	(18),28,65
Kanban	3,23,32,59
Pull system	19,33,39,48,70
Pull system (new items)	4,13,82
JIT delivery from suppliers	8,16,36,41
Autonomation (new items)	2,14,56,64,73
Supplier quality level	1,31,44,66
Zero defect quality control	17,34,53,57,61
Statistical process control	24,63,72,80
Use of charts and feedback	6,7,47,54,78
Product design simplicity	(10),21,60
Preventive maintenance	12,27,(62),67,69
Preventive maintenance (new items)	15,46,50
In-house equipment (new items)	35,40,43,74,83
Small group problem solving	25,49,52
Employee involvement (new items)	11,42,45,68,77

Name: ______________________

University of Western Ontario - Questionnaire

MANUFACTURING PRACTICES

Please Note:

I will collect the completed questionnaire from you before my site visit is finished. I will not show it to other members of your company.

In my study, I will be reporting only averages and other aggregate measures, not data from individual questionnaires.

INSTRUCTIONS

This questionnaire contains statements that may be correct, incorrect, or partially correct at your plant. Each question asks for:

- your response "Now" and
- your response as it **would have been** if you were answering it before, where "Before" means ____________.

Please use the values from 0 to 6, to indicate how much you believe each statement applies to the situation at your plant. A response of "na" means the statement is meaningless or not applicable.

0	1	2	3	4	5	6	na
Strongly Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Strongly Agree	Not Applicable

Example:

We work overtime, if required, to meet the daily schedule.	Now	0 1 2 3 4 5 6	na
	Before	0 1 2 3 4 5 6	na

If, **in your opinion**, overtime is usually, but not always, used to meet a daily schedule, you might circle a number like "5" (in the "Now" row).

If, in your opinion, overtime was never used before to meet a daily schedule, you might circle a number like "0" (in the "Before" row). (If you were not employed at the plant then, please leave the "Before" rows blank).

Manufacturing Practices Questionnaire

0	1	2	3	4	5	6	na
Strongly Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Strongly Agree	Not Applicable

No.	Statement		Rating	
01.	Our suppliers are actively involved in our new product development process.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
02.	One operator typically handles a variety of machine types.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
03.	We use kanban squares, containers or signals for production control.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
04.	Production rates are issued only to final assembly.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
05.	We transfer components in lot sizes less than the batch size.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
06.	Charts showing schedule compliance are posted on the shop floor.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
07.	Charts plotting the frequency of machine breakdowns are posted on the shop floor.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
08.	We have long-term arrangements with our suppliers.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
09.	We have organized our plant floor by means of manufacturing cells.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
10.	We are not concerned about the number of parts in an end item.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
11.	We attempt to improve our processes even when there are no pressing problems.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
12.	We have a separate shift, or part of a shift, reserved each day for maintenance activities.	Now	0 1 2 3 4 [illegible] 6	na
		Before	0 1 2 3 4 5 6	na
13.	Production at a workstation is triggered by a signal from a following workstation.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
14.	Our equipment is set to signal an operator whenever there are problems.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
15.	Operators are responsible for minor maintenance on the equipment they operate.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
16.	Our suppliers are certified or qualified for quality.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
17.	We try to minimize the time between the occurrence and detection of a defect.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na

Manufacturing Practices Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

18. There is no time in the schedule for machine breakdown or production stoppages.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
19. We use a pull system to control our production.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
20. Typically, machines performing similar operations are located in a common area.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
21. The emphasis in part design is to minimize the part count.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
22. We have eliminated many long material conveyors.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
23. Our suppliers deliver to us in kanban containers, without the use of separate packaging.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
24. Processes in our plant are designed to be "fool proof."	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
25. Our plant forms teams to solve problems.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
26. We have large lot sizes in our plant.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
27. We dedicate a portion of each day solely to preventive maintenance.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
28. We usually meet the production schedule each day.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
29. We synchronize successive operations so that all operate at the same speed.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
30. The master schedule is level-loaded in our plant from day to day.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
31. Quality is our number one criterion for selecting suppliers.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
32. We use a kanban pull system for production control.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
33. We use a backflushing system, where components are subtracted from inventory records after each product is made.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

Manufacturing Practices Questionnaire

0	1	2	3	4	5	6	na
Strongly Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Strongly Agree	Not Applicable

34.	We typically inspect all processed items at the workstation doing the work.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
35.	As a rule, we prefer a number of small dedicated machines to one large general purpose machine.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
36.	We receive daily shipments from most suppliers.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
37.	We tend to have large lot sizes in our master schedule.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
38.	Items flow from one operation to the next without inventory buildup.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
39.	Direct labour is authorized to stop production for quality problems.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
40.	We have modified almost all of the equipment in this plant.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
41.	Our vendors supply us on a just-in-time basis.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
42.	Employees are constantly eliminating activities that don't add value.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
43.	Equipment vendors often come to us for new ideas on equipment modification.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
44.	We rely on a small number of high quality suppliers.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
45.	Employees frequently make small process improvements at their workstations.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
46.	Operators are responsible for all maintenance; they call specialists when needed.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
47.	Information on quality performance is readily available to employees.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
48.	The control of production is in the hands of the workers.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

Manufacturing Practices Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

49.	During problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
50.	Maintenance staff are available to train and help operators with maintenance activities.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
51.	Our master schedule repeats the same mix of products from hour to hour and day to day.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
52.	Many problems are being solved through small group sessions.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
53.	Human error in processing is usually caught by 100% checking devices.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
54.	Charts showing defect rates are posted on the shop floor.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
55.	Successive operations are typically located close together.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
56.	Our equipment is set to stop automatically whenever there are problems.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
57.	The only acceptable level of defects at this plant is zero.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
58.	We are aggressively working to lower lot sizes in our plant.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
59.	Vendors fill our kanban containers, rather than filling purchase orders.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
60.	We make an effort, in the design process, to list only the specifications which are really needed.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
61.	We make ongoing efforts to eliminate the causes of defects, rather than simply "firefight."	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
62.	We have a relatively high rate of downtime for repair, compared with our industry.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
63.	A large percentage of the equipment or processes on the shop floor is currently under statistical quality control.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

Manufacturing Practices Questionnaire

0	1	2	3	4	5	6	na
Strongly Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Strongly Agree	Not Applicable

64.	Workers have the authority and responsibility to stop production when there are problems.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
65.	Our schedule is designed to allow time to make up for production and quality problems.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 _ 6	na na
66.	We strive to establish long-term relationships with suppliers.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
67.	Our equipment is in a high state of readiness for production at all times.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
68.	Employees provide a high rate of formal process improvement suggestions.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
69.	We emphasize good maintenance as a strategy for achieving quality and schedule compliance.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
70.	Our machines and processes are laid out in close proximity to each other.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
71.	We make every model every day.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
72.	We make extensive use of statistical techniques to reduce variance in processes.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
73.	Operators typically are responsible for more than one machine at the same time.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
74.	We often make or modify equipment in-house to fit particular needs.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
75.	Our crews practice set-ups to reduce the time required.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
76.	We have converted most of our set-up time to external time while the machine is running.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
77.	Employees frequently develop new and better standard operating methods.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
78.	Information on productivity is readily available to employees.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

Manufacturing Practices Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

79.	We have low equipment set-up times in our plant.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
80.	We have standardized process instructions which are given to personnel.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
81.	We are aggressively working to lower set-up times in our plant.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
82.	We have a strict maximum inventory level for each component.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na
83.	We insist on special modifications from equipment vendors.	Now	0 1 2 3 4 5 6	na
		Before	0 1 2 3 4 5 6	na

TIMING OF PROCESS CHANGES:

There are a number of possible process changes listed on the next page. I am interested in finding out when your plant first tried to make major changes in each area.

1) Please use the values "0" to "6" to indicate the degree to which your plant has attempted each change.
   - A response of "6" means your plant has made a major attempt to implement a particular change.
   - A response of "0" means no attempt has been made to date.

2) Please indicate your best recollection of the date (month and year) of the initial effort to implement each change.
   - If your plant is planning to implement the change in the future, please estimate the date you expect to begin.

NOTE: I am looking for the timing of the INITIAL decision or effort to improve, not the date you obtained results.

Thank you for your cooperation.

Manufacturing Practices Questionnaire

Process Change:	Major Attempt? None <=> Major	Date of initial effort: Month	 Year
• making most models each day	0 1 2 3 4 5 6	______	______
• levelling production to a constant daily rate	0 1 2 3 4 5 6	______	______
• reducing transfer lot sizes	0 1 2 3 4 5 6	______	______
• reducing production lot sizes	0 1 2 3 4 5 6	______	______
• reducing purchased lot sizes	0 1 2 3 4 5 6	______	______
• arranging just-in-time supply	0 1 2 3 4 5 6	______	______
• making or modifying process equipment in-house	0 1 2 3 4 5 6	______	______
• making one worker responsible for multiple machines simultaneously	0 1 2 3 4 5 6	______	______
• doing scheduled preventive maintenance	0 1 2 3 4 5 6	______	______
• "pulling" material from the preceding workstation	0 1 2 3 4 5 6	______	______
• reducing setup times	0 1 2 3 4 5 6	______	______
• using mistake-proof devices for source inspection	0 1 2 3 4 5 6	______	______
• using machines that automatically stop when there is a problem	0 1 2 3 4 5 6	______	______
• encouraging small-group process improvement	0 1 2 3 4 5 6	______	______
• meeting a daily schedule	0 1 2 3 4 5 6	______	______
• organizing equipment so that successive operations are close together	0 1 2 3 4 5 6	______	______
• simplifying product/part design	0 1 2 3 4 5 6	______	______
• using "kanban" signals to obtain material	0 1 2 3 4 5 6	______	______
• using visual charts and feedback	0 1 2 3 4 5 6	______	______
• using statistical process control (SPC)	0 1 2 3 4 5 6	______	______
• encouraging employee involvement in continuous process improvement	0 1 2 3 4 5 6	______	______
• scheduling at less than capacity to meet daily plan exactly	0 1 2 3 4 5 6	______	______
• insisting on improved supplier quality	0 1 2 3 4 5 6	______	______

Appendix IV - General Situation Questionnaire

This appendix contains a copy of the general situation questionnaire, as presented to respondents, with questionnaire items in random order.

Below, I match each construct of interest with the questionnaire items used in its measure. Reverse scored items are shown in parentheses.

Construct	Item numbers
Decentralization of authority	(1),(15),(29),34,38
Management by wandering around	2,3,(18),23,(28),41
Coordination of decision making	14,26,(36),39
Supervisors as team leaders	5,17,37
Affective commitment	10,(16),19,22,27,31,32,35
Continuance commitment	6,7,12,13,21,22,25,30,33
Plant-wide philosophy	4,8,9,20,24
Employee-management relations	on final page
Influence on employer	11,40,42

University of Western Ontario - Questionnaire

GENERAL SITUATION

Please Note:

I will collect the completed questionnaire from you before my site visit is finished. I will not show it to other members of your company.

In my study, I will be reporting only averages and other aggregate measures, not data from individual questionnaires.

I have no way of identifying you and there are no trick questions.

Would you please check the most appropriate category:

____ Worker ____ Supervisor ____ Manager

INSTRUCTIONS

This questionnaire contains statements that may be correct, incorrect, or partially correct at your plant. Each question asks for:

- your response "Now" and
- your response as it would have been if you were answering it before, where "Before" means ____________.

Please use the values from 0 to 6, to indicate how much you believe each statement applies to the situation at your plant. A response of "na" means the statement is meaningless or not applicable.

0	1	2	3	4	5	6	na
Strongly Disagree	Mostly Disagree	Slightly Disagree	Neutral	Slightly Agree	Mostly Agree	Strongly Agree	Not Applicable

Example:

There is real danger of losing business to our competition.	Now	0 1 2 3 4 5 6	na
	Before	0 1 2 3 4 5 6	na

If, in your opinion, competitors are now "a bit" of a threat, but not a serious danger, you might circle a number like "4" (in the "Now" row).

If, in your opinion, competitors were very little threat before, you might circle a number like "1" (in the "Before" row). (If you were not employed at the plant then, please leave the "Before" rows blank).

General Situation Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

01.	Even small matters have to be referred to someone higher up for a final answer.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
02.	Our engineers are located near the shop floor to provide quick assistance when production stops.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
03.	Managers in this plant believe in using a lot of face-to-face contact.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
04.	Stories are often told within the plant about accomplishments of past employees.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
05.	Supervisors encourage people who work for them to work as a team.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
06.	Too much in my life would be disrupted if I decided I wanted to leave this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
07.	It would be very hard for me to leave this company right now, even if I wanted to.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
08.	This plant has a clear view about how to achieve goals.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
09.	This plant has a very definite idea about how things should be done.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
10.	I feel "emotionally attached" to this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
11.	Employees here have a lot of influence in changing how they do their work.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
12.	One of the major reasons I continue to work for this company is that another company may not match the overall benefits I have here.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
13.	It would be too costly for me to leave this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
14.	Departments in the plant communicate frequently with each other.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
15.	There can be little action taken here until a supervisor approves a decision.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

General Situation Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

16.	I think that I could easily become as attached to another company as I am to this one.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
17.	Supervisors frequently hold group meetings where the people who work for them can really discuss things together.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
18.	Managers here are more likely to send a memo than to tell employees something face-to-face.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
19.	I enjoy discussing this company with people outside it.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
20.	This plant develops a very special kind of employee.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
21.	One of the few serious consequences of leaving this company would be the lack of available alternatives.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
22.	I feel a strong sense of belonging to this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
23.	The plant manager is seen on the shop floor almost every day.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
24.	Stories which contain organizational wisdom are often told within the plant.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
25.	I feel that I have too few options to consider leaving this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
26.	Management seems to work together well on all important decisions.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
27.	I feel like "part of the family" at this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
28.	Managers are hardly ever seen on the shop floor.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
29.	Any decision I make has to have my boss's approval.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
30.	Right now, my staying with this company is a matter of necessity as much as desire.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

General Situation Questionnaire

0 Strongly Disagree	1 Mostly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Mostly Agree	6 Strongly Agree	na Not Applicable

31.	This company has a great deal of personal meaning for me.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
32.	I would be very happy to spend the rest of my working life with this company.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
33.	I am afraid of what might happen if I quit my job without having another one lined up.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
34.	I can do almost anything I want without consulting my boss.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
35.	I really feel as if this company's problems are my own.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
36.	Departments within the plant seem to be in constant conflict.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
37.	Supervisors encourage people who work for them to exchange opinions and ideas.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
38.	This plant is a good place for a person who likes to make his or her own decisions.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
39.	Generally speaking, everyone in the plant works well together.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
40.	Employees here have a lot of influence in how work-related problems are solved.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
41.	Most of our manufacturing engineers have their offices located directly on the shop floor.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na
42.	Employees here have a lot of influence in what they do.	Now Before	0 1 2 3 4 5 6 0 1 2 3 4 5 6	na na

Next page please ....

General Situation Questionnaire

For the following, circle the number that represents your opinion of the balance between the two end-states indicated for each scale:

For example, if you believe that employee-management relations are now generally friendly with just a few instances of hostility, you might circle "5" on the first line below.

Now, the employee-management relationship at this plant is:

Now	hostile	0 1 2 3 4 5 6	friendly
Now	dishonest	0 1 2 3 4 5 6	honest
Now	bad	0 1 2 3 4 5 6	good
Now	destructive	0 1 2 3 4 5 6	constructive
Now	distrusting	0 1 2 3 4 5 6	trusting
Now	conflict-ridden	0 1 2 3 4 5 6	cooperative
Now	inappropriate	0 1 2 3 4 5 6	appropriate
Now	unbusinesslike	0 1 2 3 4 5 6	businesslike

Before, the employee-management relationship at this plant was:

Before	hostile	0 1 2 3 4 5 6	friendly
Before	dishonest	0 1 2 3 4 5 6	honest
Before	bad	0 1 2 3 4 5 6	good
Before	destructive	0 1 2 3 4 5 6	constructive
Before	distrusting	0 1 2 3 4 5 6	trusting
Before	conflict-ridden	0 1 2 3 4 5 6	cooperative
Before	inappropriate	0 1 2 3 4 5 6	appropriate
Before	unbusinesslike	0 1 2 3 4 5 6	businesslike

Thank you for your cooperation.

Appendix V

University of Western Ontario - Questionnaire

OPERATIONAL MEASURES AND GENERAL INFORMATION

INSTRUCTIONS

This questionnaire concerns operational and general information at this plant. Please answer all questions as they apply to this plant only, not to the company as a whole.

You are the only person being asked to provide this information. Feel free to consult with others but do not feel obliged to spend excessive time deriving answers.

When did major efforts to implement Japanese-like approaches to manufacturing begin at this plant? Approximate Date: ____________

For the following questions, the term "Before" means "before the above date."

For each question, please indicate your units of measure, if different than suggested.

OPERATIONAL MEASURES

- Average inventory turns (per year) Before _____ Now _____
- Average raw material inventory (days) Before _____ Now _____
- Average work-in-process inventory (days) Before _____ Now _____
- Average finished goods inventory (days) Before _____ Now _____
- Average equipment downtime (% of time unavailable) Before _____ Now _____
- Average units produced to schedule (%) Before _____ Now _____
- Average customer service level (% of requests met on time) Before _____ Now _____
- Approximate turnover rate of employees (% replaced per year) Before _____ Now _____
- Average absenteeism rate (% absent per day) Before _____ Now _____
- Market share for main product (% of total market) Before _____ Now _____
- Annual sales revenue ($ per year) Before _____ Now _____
- Average reject rate at a typical workstation (%) Before _____ Now _____
- Average throughput time (weeks from order release to shipment) Before _____ Now _____
- Average improvement suggestions per employee (number per year) Before _____ Now _____
- Maximum time main customers are willing to wait for an order (days) Before _____ Now _____
- Average time for major suppliers to deliver (days). Before _____ Now _____

GENERAL INFORMATION

- The main industry in which the firm competes ______________________
- Main product lines produced at this plant (list main one first) ______________________ ______________________ ______________________ ______________________ ______________________
- Plant status (please check one)

  Stand-alone plant ____
  One of a number in firm ____
  Branch plant ____

- If a branch plant, the nationality of the parent company ______________________
- Percentage of processes which are like:

  a job shop operation ____ (%)
  a batch operation ____ (%)
  an assembly operatio.ı ____ (%)

- Approximate number of levels in the bill of materials ____
- Percentage of processes in which the plant is:

  an original equipment manufacturer ____ (%)
  (OEM) ____ (%)
  a supplier to other OEMs ____ (%)
  a supplier to other suppliers

- Percentage of deliveries to your customers v hich are JIT deliveries ____ (%)
- Material requirements planning system (please check all functions that apply):

  no system ____
  material requirements ____
  capacity planning ____
  inventory management ____
  shop floor control ____

- Name of the main labour union (or none) ______________________

GENERAL INFORMATION (continued)

• Number of direct employees at this plant	Before ______ Now ______
• Number of salaried employees at this plant	Before ______ Now ______
• Number of reporting levels between direct workers and the head person at the plant	Before ______ Now ______
• Number of product lines produced here	Before ______ Now ______
• Approximate number of different, active part numbers	Before ______ Now ______
• Number of job classifications for direct workers	Before ______ Now ______
• Approximate labour cost as a percentage of sales	Before ______ Now ______
• Approximate material cost as a percentage of sales	Before ______ Now ______
• Approximate overhead cost as a percentage of sales	Before ______ Now ______

Thank you for your cooperation.

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