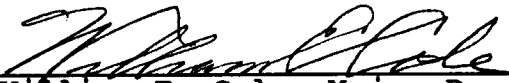
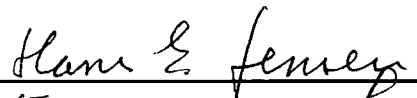
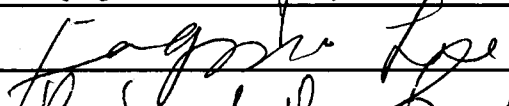
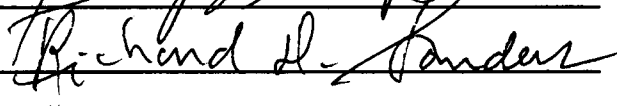


To the Graduate Council:

I am submitting herewith a dissertation written by Steven Rone Wilson entitled "Continuous Improvement and the New Competition: The Case of U.S., European, and Japanese Firms in the Mexican Maquiladora Industry." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.


William E. Cole, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:


Associate Vice Chancellor
and Dean of The Graduate School

CONTINUOUS IMPROVEMENT AND THE NEW COMPETITION:
THE CASE OF U.S., EUROPEAN, AND JAPANESE FIRMS
IN THE MEXICAN MAQUILADORA INDUSTRY

A Dissertation
Presented for the
Doctor of Philosophy
Degree

The University of Tennessee, Knoxville

Steven Rone Wilson

December, 1992

DEDICATION

This dissertation is dedicated to the memory of Amy Southworth.

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ABSTRACT

This research investigated the adoption and diffusion of continuous improvement technologies in the maquiladora industry of Mexico. The study was based on a sample of over 100 manufacturing and assembly plants located in and around the northern Mexican cities of Ciudad Juarez and Ciudad Chihuahua. The data were collected by extensive surveying, personal interviews, and plant tours.

It is concluded that maquiladora plants evidence significant success with continuous improvement technologies, these are features of the Mexican maquiladora industry that are conducive to the diffusion of continuous improvement technology, and that continuous improvement is an appropriate technology for less developed countries.

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CHAPTER 1

INTRODUCTION

The fundamental rules of competitive global manufacturing have been altered by the emergence of a new type of firm whose internal organization differs radically from those companies run on traditional Western principles of mass production. In contrast to the birth of modern mass production, as epitomized by Henry Ford's series of well publicized innovations between 1903 and 1974, this firm type has risen to a position of dominance in a more incremental and less spectacular fashion. While Ford's system effectively ended the craft-based 19th century approach to mass manufacturing, the former has launched an ever-escalating competitive standard which spells the end of traditional mass production (TMP) as a viable player in the global marketplace.

The ascension of this firm type has stimulated the interest of scholars, corporate leaders, and some policy makers. Increasingly, attention has shifted to the key role of the internal organization of the firm. This focus represents a departure for the discipline of economics which has traditionally viewed the internal operations of the firm as a "black box." Jensen and Meckling state: "[t]he firm is a 'black box' operated so as to meet the relevant marginal conditions with respect to inputs and outputs,

thereby maximizing profits, or more accurately, present value" (Jensen and Meckling, p. 216). The assumption that management will automatically choose optimal organizational systems, technologies, and strategies to maximize the present value of the business has allowed economists to leave the "box" unopened (see Rosenberg, 1982). Further, it has been assumed that improvements in organizational systems, management strategies, and process technologies that are developed by certain firms will be adopted by other firms who remain as producers in the market. In such a world, one could explain price formation and resource allocation without ever peering inside the "boxes." However, the persistence of long-term gaps in productivity growth between one set of firms that could be termed "market leaders," and others that we can call "followers," has increased the unease with the standard analytical approach to the firm (Cole, Bós, and Sanders, 1991, pp. 1-2). The new reality is forcing scholars to open the "black box" of the firm.

The new leader firms are most closely identified with successful Asian manufacturers. These firms can be described as continuous improvement firms (CIFs). Continuous improvement is a comprehensive approach to improving products and processes. This process simultaneously raises levels of product quality, labor productivity, and production capacity (see Best, 1990, and

Aoki, 1990; Cole, Mogab, and Sanders, 1992, pp. 24-27).

Continuous improvement firms employ an array of analytical tools. Among the best known are statistical process control (SPC), design of experiments, the use of fish-bone diagrams, and Pareto Charts (see Yoshida, 1989). CIFs have used such tools to great competitive advantage in tandem with "softer" technologies such as extensive planning, shared information, transfunctionalism, quality circles, just-in-time manufacturing, pokyoke (mistake-proofing), and incentives for improvements (Best, 1990; Aoki, 1990; Hattori, 1986). Such analytical tools and soft technologies can be referred to as continuous improvement technologies (CITs).

This dissertation will examine the adoption and diffusion of continuous improvement technologies in the maquiladora industry of Mexico. This discussion is based on a sample of over 100 manufacturing and assembly plants located in and around the northern Mexican cities of Ciudad Juarez and Ciudad Chihuahua. The sample includes subsidiaries of firms based in the United States, Japan, the Netherlands, Germany, France, and Taiwan. The data were collected by extensive surveying, personal interviews, and

plant tours.¹ All firm and individual names have been kept confidential.

Based on this research, we will show the following:

- 1) Maquiladora plants evidence significant success with continuous improvement technologies.

For example, 58 percent of the respondents report that the finished product quality coming out of their plants is better or much better than that found in similar, home-based operations of their company. Seventy-eight percent of the respondent firms said that they employ SPC methods in their production. Furthermore, 47 percent said that they utilize SPC to a greater extent than do their home operations. One hundred percent of the sample report that they have reduced scrap rates while 97 percent have reduced the rate of rework. Speaking to the importance of the improvement processes, 47 percent of the firms have developed process improvements in their own operations that have been transferred to home company domestic operations.

¹Surveys covered three areas in-depth: 1) Production Process, 2) Technology and Technology Transfer, and 3) Personnel and Management. Two additional surveys addressing management's view of NAFTA, and issues of culture and language, were planned. However, time constraints of plant managers prevented the exploration of these topics in terms of formal surveys. Complete results are in the Appendix.

- 2) Mexican managerial, technical, and line personnel are capable of handling continuous improvement technology.

Formal educational levels among Mexican line workers are lower than their U.S., European, or Japanese counterparts. However, the majority of managers report that this group is hardworking and learns easily. In several plants youthful Mexican workers have been trained to perform tasks involving data collection and SPC. While Mexican engineers and technicians are on average, less educated and experienced than their U.S., European, or Japanese counterparts, plant managers report that this group is very adept at creative problem-solving. Interestingly, those plants managed by Mexican appears to be generating significant improvement.

- 3) There are special features of the Mexican maquiladora industry that are conducive to the diffusion of CIT.

Many managers in the maquiladora industry have been confronted by an array of challenges that they do not face in home plants. Among these are high turnover of line employees, lower levels of experience and education among both line workers and engineering and technical personnel,

infrastructural problems, few Mexican suppliers, and geographical distances from headquarters support and domestic suppliers. Management has been forced to get "down on the floor" and become personally involved with production. Training and visual aids stressing quality and the reduction of variation helped to overcome earlier problems. However, over time this effort, coupled with "hands-on" management, enabled many maquila plants to outperform related operations in the U.S.

Moving of assembly operations to Mexico forced rethinking of whole processes. Also, many managers reported that their remote location was actually beneficial in allowing them more freedom to implement quality and continuous improvement systems. Mexican labor had no preconceived ideas about quality or continuous improvement and was very open to training and indoctrination. Many managers, particularly in U.S. firms, found Mexican workers at all levels to be extremely diligent and loyal. Research discovered a "cult" of quality and continuous improvement among Mexican plant managers, engineering, and technical personnel. Most have read extensively the literature on quality and continuous improvement (much of which has been translated into Spanish)

and enthusiastically espouse the main principles as beneficial for themselves, their companies, and for Mexico.

- 4) Continuous Improvement is, on balance, an Appropriate Technology for Less Developed Countries (LDCs).

Continuous improvement hinges on the contributions of human beings making constant improvements. As such, continuous improvement is labor intensive. While capital is important, it is labor that is the key input. Further, this approach saves on the scarce resources of capital and foreign exchange. Older capital equipment can be kept in service longer and retrofitted to serve the particular needs of the production process. This is so because the improvement process continuously upgrades existing equipment. The potential role of used equipment is very high for firms in developing countries pursuing continuous improvement.

The flexibility inherent in the process of continuous improvement fits well with the economic environment of many contemporary LDCs. This flexibility allows firms to respond to the diverse demands of small domestic markets with much less total capacity than would be required if mass

production were used. Firms in LDCs would be able to rapidly respond to dynamic global markets, and target specialty niches. This process of continuous improvement is by definition evolutionary and indigenous. While imported ideas may be necessary to provide the initial impetus, continuous improvement will gradually reflect local resource, education, and cultural patterns becoming more "homegrown" over time. In addition, given that traditional mass production evolved in industrially advanced Western society, Western managers and engineers face obstacles to understanding and internalizing the new continuous improvement technologies. Such cultural biases may not exist for managers and engineers in contemporary LDCs.

- 5) Japanese plant managers hold different views of maquila operations than their U.S. counterparts.

For example, several of the largest U.S.-based firms operating in the Mexican maquiladora industry are aggressively pursuing "Mexicanization;" or the placement of Mexican personnel at the plant manager level. One Japanese plant was managed by a non-Japanese manager. However, the others were headed by Japanese nationals who reported no plans to move

Mexicans to the plant manager level. Further, Japanese maquila operations do not show evidence of the vaunted methods that brought success to their parent companies. On average, Japanese plant managers tended to have a more negative view of their operations in Mexico than did American managers. Shared information, group work, including quality circles, empowerment at the line level, and other hallmarks of the Continuous Improvement Firm are largely lacking. The Japanese seemed as content to stick with traditional quality control (e.g., inspectors, dedicated lines, and the like) as many other U.S. and European firms.

It is important to note that many Western firms employ methods and techniques of quality control that are associated with successful continuous improvement firms. However, without adopting a true, deeply ingrained culture of continuous improvement, these firms will not be able to match the ever-escalating standards set by the leader CIFS (Best, 1990; Hodgson, 1982).

One way to discuss this issue is by way of analogy. Let us assume a traditional symphonic orchestra. This organization embodies a mix of Taylorist-type mass production and old world craft elements. The composer is a visionary individual who presents his work to the conductor.

The composer is often seen as a brilliant producer of "great innovations," Mozart or Beethoven are examples. Industrial analogues might be Henry Ford, Bill Gates, or Akio Morita. The conductor takes this exogenously introduced music (or "product design") and directs, in top-down fashion, a group of musicians. These musicians are highly specialized, in strongly separated functional silos with little information sharing across functions. Competitive specialization determines ranking and hierarchy within the group. The orchestra is heavily reliant on private and public patrons as well as ticket and recording sales.

Now assume a "continuous improvement" (CI) orchestra. Unlike the traditional orchestra, the composer solicits suggestions and input from the conductor and the musicians. The CI orchestra plays music inspired by the collaborative efforts of composers, conductors, and musicians working across functions to produce "better" music. A strong understanding exists among players as to the nature of each other's instruments and tasks. Consumers sample new work and offer suggestions. The orchestra tests and measures musical output to eliminate variation in the process of making music. Teams comprised of composers, conductors, arrangers, musicians, and sound engineers, combine with consumers and musical company representatives to explore ways of improving the music. In the CI orchestra, composers and conductors are paid much less as a multiple of

musicians' salaries than are their traditional counterparts.

Can we speak of the traditional orchestra being able to "transfer" continuous improvement musical production from the CI orchestra? At one level, the traditional orchestra might try to learn some of the new music that is generated by the CI orchestra. In that case, the traditional orchestra would always remain a follower, looking externally for innovation. By the time the traditional orchestra has internalized the "transfers" from the CI orchestra, they are old "technology," long vacated by the ever-moving CI group. At another level, it might try to assimilate some of the tools and techniques that produce improvements without forcing drastic organizational changes. For example, analytical tools to measure and control variation might be embraced; groups could be formed to span vertical silos and individuals such as conductors and composers could be brought into the "loop." Consultants might be brought in to teach "CI music making." While there may be some improvements, the traditional orchestra is likely to remain far behind the CI orchestra in terms of the pace of improvement.

In the traditional orchestra, group work has not eliminated craft consciousness or the condescension of the aristocratic composers and conductors who seem to garner ever-higher compensation in the face of deep budget cuts (that cost jobs in the orchestra itself). Major sources of

funding for the traditional orchestra remain invested in persons who are separate from the orchestra and do not see the necessity nor immediate benefit of deviating from traditional methods.

Here we have two distinct orchestras and cultures. In the absence of institutional change in the traditional orchestra, incentive structures, prestige systems, claims of ownership, job security, and other factors, remain fundamentally unaltered. Can there be a true transfer of the process of continuous improvement from the continuous improvement orchestra to the traditional orchestra? The latter organization may adopt devices and methods from the former, but fundamental processes remain unchanged given the institutional milieu in which the traditional orchestra finds itself.

In Chapter 2, we will discuss the basic nature and role of continuous improvement in the CIF. We shall examine the elusive issue of "culture" and what impact Japanese culture may have had on the evolution of the Continuous Improvement Firm in that country.

Chapter 3 will provide an overview of the maquiladora industry of Mexico. In many ways this program, begun as the Border Industrialization Program in 1965, marks an important departure from the previous inward orientation of the Mexican economy. Its rapid growth throughout the 1980s has spawned a base of support on both sides of the border for a

comprehensive North American Free Trade Agreement, or NAFTA. In this chapter the increased presence of Japanese firms will be discussed, as well as the evolution in capital-intensity in many plants.

In Chapter 4, we shall discuss our sample of 104 assembly and manufacturing facilities and the research method employed. We shall discuss the advantages and obstacles to operating in Mexico as they relate to continuous improvement. Selected results will be discussed and analyzed. The operations of U.S.-based maquiladora plants will be compared with European plants, and Japanese plants. A discussion will be devoted to the interplay of managerial styles and culture. Further, several hypotheses will be presented to explain the impressive performance of maquiladora plants despite significant obstacles. Included in these will be the idea that plant managers have been forced to get "down to the factory floor," that operating far away from home operations can actually be an advantage, and that there exists a "cult" of quality in Mexico.

In Chapter 5 we ask the question "Is Continuous Improvement an 'Appropriate Technology' for Developing Nations?" In this chapter we shall build a case that continuous improvement does in fact constitute a technology, and that it is in many ways appropriate. We will argue that CIT uses intensively those resources that are the most abundant in contemporary less developed countries:

hardworking people, creativity, and time. We will further argue that continuous improvement is ineluctably endogenous, and as such, proceeds on the basis of domestic resources and effort.

In our Conclusion chapter, we advocate policies for LDCs that might be addressed in order for indigenous organizations to undertake continuous improvement. We reconsider the degree to which continuous improvement may be inimical to certain cultures, and thrive in others (e.g., Japan). Further, we will discuss the relevance of our findings in the maquiladora industry for Mexico under a North American Free Trade Agreement.

CHAPTER 2

CONTINUOUS IMPROVEMENT: PROCESS, TECHNOLOGY AND THE POSSIBLE ROLE OF CULTURE

I. The Continuous Improvement Process

As noted in the Introduction, the theory of the firm has not examined the managerial and organizational aspects of the firm as key competitive variables. Continuous improvement firms are closely associated with Japanese companies such as Toyota, Matsushita, and Sony, among others.¹ This has led other economic arguments to attempt explanations of "Japanese success." Arguments have focused on, inter alia, the existence of low Japanese wages (through the 1970s) as a main factor of Japanese competitiveness. A second explanation hinged on the stimulative role of government subsidization, as epitomized by the role of the Ministry of Trade and Industry (MITI). Such analyses led to charges of unfair trade and dumping (see Grilli and Sassoon, 1990). Next came an explanation that saw much of the attainment of greater quality and lower

¹This is not to deny that several successful Western firms share many characteristics in common with leading Japanese firms. Indeed, many of the most progressive and innovative of the former have excelled in areas most often associated with Japanese firms, such as team work and shared information (particularly in the process of new product development). Any subsequent attempts to characterize and contrast as between firm archetypes is not intended to gloss over the fact that there remain many overlapping practices between successful Western and Japanese firms in the area of continuous improvement.

costs as a function of superior technology. The role of robotics was rigorously investigated. That such explanations were based in part on fact lent them a great tenacity. However, these explanations were at a loss in analyzing the ongoing advance of Japanese continuous improvement firms in the face of adverse foreign exchange movements. Nor could they explain the movement of Japanese operations offshore where direct Japanese government intervention seemed less relevant. Further, such arguments did not address the reasons why Japanese continuous improvement firms derived major benefits from automation while Western traditional mass producers (TMPs) spent large sums on automation and continued to struggle with the control of quality and cost. Eventually analysis has turned to an investigation of the internal workings of the continuous improvement firm (CIF) (Cole, 1991, pp. 5-6; and Womack, Jones, and Roos, 1990).

The process of continuous improvement involves large numbers of incremental improvements made in the daily operation of the firm. These small changes are most often undocumented. In successful Japanese CIFs, creative input for improvements originate at all levels of the organization. This process of improvement is enhanced by wide access to information on the part of employees of the organization and an incentive system that greatly encourages the continuous improvement of products and processes.

The accumulation of these very small improvements can have very significant consequences. For example, the "single-step system," which reduces the changeover time for a die on a press from several hours to less than ten minutes was accomplished with "no particular epoch-making technological innovation. It [was] simply the result of the accumulation of innumerable small improvements made within the factory..." (Matsumoto, p. 43). The development of just-in-time (or "JIT") manufacturing also arises from many small improvements. What outsiders view as a "revolutionary breakthrough," such as JIT, is in reality the result of a thirty-year period of evolutionary, incremental improvement that was made possible by the optimal use of shared on-site information (see Nayak and Kettingham, 1986). The tendency of observers to misidentify the outcome of numerous improvements as great innovative leaps has led to a "breakthrough illusion" in the West (Florida and Kenney, 1990). In firms where top executives manage transfunctionally, where middle management operates across functions, and where line workers are trained to perform multiple tasks, the opportunities for conceiving new combinations and variations of previous improvements is greatly increased. This process is further enhanced by workers organized in groups and the broad encouragement of

ideas and suggestions for improvement. (Cole, Mogab, Sanders, 1992; and Bós, 1992).²

Two key aspects of personnel policy that provide incentives for the sharing of information and improvements are relative job security and promotions based on general experience (Hattori, 1986; and Aoki, 1990). In continuous improvement firms job descriptions are not as well defined as in the United States and there is a higher degree of interaction between line workers and engineers (Hattori, 1986). Dongen and Poeth have identified a system of shared values in CIFs which prompt members of the work force to promote process and product improvements (Dongen and Poeth, 1986 especially Chapter 10.)³

²For Clarence Ayres (see Ayres, 1962) technological progress is partly a function of the degree to which people combine and recombine extant tools ("tools" being broadly defined to include ideas and information). Cole, Bós, and Sanders (1991) have taken this perspective and argued that the continuous improvement firm provides an atmosphere that is critically conducive to such combinations: "If continuous improvement is something that emerges from day to day operations of a firm, then the perceptions that catalyze the change process must begin with individuals. It would then follow that the more tools, e.g. data, machines, materials, operations, etc. that a given employee has contact with, the more likely it is that an innovation will be conceived. Therefore, in firms where top executives manage transfunctionally rather than through specialized functions, where middle managers work across functions, and where operators are trained in a host of tasks and work in groups, the prospects of any given individual conceptualizing new tool combinations is greatly enhanced" (Cole, Bós, and Sanders, 1991, p. 6).

³This is all in contrast to the Western traditional mass producer (TMP) that engages in a "top-down" (sometimes called "Taylorist") form of management. Hodgson argues that this form of management has tended to shift "experiential

In general, it can be said that members of the CIF are motivated to engage in improvements that in some way increase customer value: cost (price), quality, timely delivery, and superior design attributes.⁴ It is a characteristic of the continuous improvement firm that improvements in quality often proceed hand-in-hand with reductions in the cost of production. This is largely a function of the type of learning that occurs in the CIF. The continuous improvement process is based upon experiential learning which creates new technology in an evolutionary fashion.⁵ The process of learning within the

knowledge" spawned in the process of production to the manager-planner who then returns it in the form of instructions. Such an approach precludes continuous, evolutionary improvements (Hodgson, 1988). Best asserts that nonexistent flows of production-generated knowledge in TMPs leave management without crucial data with which to ascertain root causes of poor performance: "The failure to account for, or to tap, experiential knowledge in production has left managers [of TMPs] dumbfounded as to why their firms underperform" (Best, p. 128). Florida and Kenney see the role played by employee initiative and the use of workers' knowledge as a key difference between the CIF and the TMP. Employee involvement and participation in CIFs "...lends support to the alternative conceptualization that it [the CIF] is a new and potential successor model based upon harnessing workers' intellectual and physical capabilities (Florida and Kenney, 1991, p. 388).

⁴Quality can be broadly defined to include a product's durability and performance. Focussing on the customer is seen as a top priority of the CIF (see B6s, 1992). Providing continually superior performance on the broad metric of quality combined with competitive costs and prices create what Carothers and Adams term, "net customer value" (Carothers and Adams, 1991).

⁵This is qualitatively different from the learning process represented by the "learning curve." This standard view refers to learning-by-doing and is predicated

CIF arises from, and continually feeds back into, the daily operation of the firm. Personnel who possess a general perspective and understanding of how their tasks and responsibilities relate to other work areas and functions are better prepared to creatively participate in the expansion of customer value. It is the experiential learning of the operation process itself, that provides continuous creative input back into the knowledge stream and changes the very process from which such knowledge originally sprang. Incremental improvements springing from the interactive process of experiential learning have given CIFs superior performance on the metrics of quality, cost, deliverability, and functional design that have become decision tools giving these firms strategic leverage. The continuous improvement process has allowed firms to upgrade functional design attributes while at the same time increasing their flexibility to a degree that has previously only been seen in small, craft-type producers. These simultaneous improvements in products and production

exogenously upon produced technology that is introduced through investment. Here, learning can be seen as a rote process in which "practice makes perfect (Tirole, p. 27). Learning is perfectly compatible with work force specialization. Further, the standard learning curve must be asymptotic, showing productivity gains and their associated cost reductions declining toward zero over time. Where learning-by-doing is held to improve labor productivity, hence unit cost, improvements in the CIF focus on all elements of customer value. Given the CIF's broader focus on quality, cost, deliverability, and design, we are not confronted with a simple asymptotic function (Wilson and Cole, p. 4).

flexibility have allowed large CIFs to segment the market into many niches (see Cole, Mogab, and Sanders, 1992; Womack, et.al., 1990; Best, 1990; and Piore and Sabel, 1984).

In addition to the creation of technological change, the continuous improvement process provides increased production capacity with little major capital invested (Cole and Mogab, 1992). For example, internally generated improvements which reduce product variation can result in reduced costs associated with inventories, rework, and scrap. With falling unit costs, the plant can produce a larger output per time period, with the same amount of labor, materials, and energy. In other words, the effective throughput of this plant is increased with the reduced input of materials, capital and labor, per unit of throughput. The CIF attains lower unit costs concomitant with increases in capacity that can be mobilized to meet increases in demand due to improved quality and lower costs.

For the continuous improvement firm, this increase in capacity comes from endogenously generated, incremental improvements that do not hinge on significant inflows of investment or foreign exchange. It is the manner in which the firm is organized and managed, as well as the quality of the human capital, which determine the ability to produce continuous improvement. It is a tenet of Western traditional mass production manufacturing that technological

progress rides the back of ever newer, more sophisticated capital equipment and operating technology. In the case of many great innovations this is clearly true. One need only think of sweeping change in the wake of the steam engine, cotton gin, Bessemer process, Henry Ford's assembly line and standardized auto parts, and the recent wave of computerization. However, newer (and often more expensive or complicated) is not necessarily always better in manufacturing. While many CIFs are moving in the direction of ever more sophisticated automation, untold efficiencies and improvements have been spawned in the process of ongoing reorganization and examination of production. As GM invested heavily in robotics and other "cutting-edge" technology in the 1980s, it watched its market share continue to slide vis-a-vis Japanese automakers. However, Schonberger reports that as of 1986 that Toyota's number 9 Kamigo engine plant, which has been described as "the most efficient engine plant in the world" was equipped with American made machinery that was over twenty years old (Schonberger, 1986). The machinery had been retrofitted innumerable times to fit Toyota's constantly changing needs. Maintenance was an extremely high priority with line operations playing a key role in the upkeep of the equipment. The essential point here is that Toyota achieved such success not primarily on the basis of advanced technology, but on constant attention to detail and

planning. Such an effort in the CIF appears to be spearheaded by management with full participation of all employees based on shared information, very explicit company goals, and appropriate incentive structures.

Changes in the ways of producing things that do not require capital outlays and are therefore "management and people-intensive," have had a major impact on the development of CIFs. When such practices become fully internalized to the firms, improvements in quality and cost flow readily without marginal opportunity costs. Extensive planning, shared information, transfunctionalism, quality circles (groups of employees dedicated to studying and implementing ways of improving products and processes), statistical process control, just-in-time manufacturing, pokyoke (foolproofing), and the like represent the "softer" technology of organizing people and machines, along with methods of data collection and control that have proved so formidable in the armamentariums of CIF producers. The manner of organizing machinery (for example, in "cellular" arrangements) and constant maintenance are undertaken with little if any capital investment. None of these methods require significant capital outlays, and as such, there exist no a priori reasons why such an approach might not work in a less developed country (Wilson and Cole, pp. 6-8).

II. The Technologies of Continuous Improvement

When investigating issues such as technology transfer and the role of continuous improvement, we must distinguish between (a) improvements themselves as technological forms, (b) the soft technologies that promote continuous improvement, and, (c) the tools that are used by CIFs to analyze problems. (This discussion follows Wilson and Cole, pp. 6-8). For example, just in time manufacturing is considered a major technology that emerged from the process of continuous improvement. JIT is composed of constituent technologies such as "single-minute exchange of dies," "kanban" (a facet of JIT manufacturing that assigns each part a tag in order to better plan flows of inventory through the plant), and "autonomation" (flexible and foolproof machines). These technologies are themselves the product of numerous incremental improvements, many of which are undocumented. These improvements are "homegrown" and often reflect the particular organizational characteristics and culture of the firm in which they were developed. To speak of "transferring" this technology may miss the point. Even if the receiving firm could use such technology effectively, it would not be given the ability to develop additional improvements on its own. It is likely that the firm would remain a follower firm (albeit a "new and improved" follower) trying to catch the ever moving CIF.

For a recipient firm to be able to produce its own technological change in the form of continuous improvements, the "softer" technologies of organizational structure and management systems must be adopted. As much information as possible must be made available to members of the firm. Transfunctionalism might be promoted through the practice of rotating managers across functions and cross-training line workers for many jobs. Some form of quality circles should be adopted, along with incentive systems designed to encourage the use of information for improvements. These might include lifetime employment, promotion from within, and suggestion systems. Sincere company mission statements that encourage all employees to create customer value are important.⁶

An aspect of the CIF that has been scrutinized is the analytical "tool kit" that is quite similar across firms. This kit includes statistical process control (SPC), design of experiments, the use of fish-bone diagrams, and Pareto

⁶Recipient organizations do not have to exactly mimic what CIFs have done. There are cultural issues that must be addressed in order for continuous improvement to be implemented, both in terms of "firm culture" and broader issues of national culture. For example, this author was told that the common Japanese practice of chanting slogans and group exercise was strongly resisted in Mexican plants. Perhaps such practices are not crucial to the implementation of continuous improvement systems. However, in several plants the author encountered youthful Mexican men and women employees collecting statistics and performing basic SPC and analysis. Such activity is certainly congruent with continuous improvement; and also violates certain stereotypes many in the maquiladora industry have about Mexican labor.

charts. These tools can be adopted by follower TMPs and serve to improve productions and processes. However, ongoing endogenous improvements will probably not be forthcoming for the standard firm without adopting crucial aspects of organizational structure and managerial systems from the CIF. It is no small irony that W. Edwards Deming and other Americans introduced these tools to post-World War II Japanese firms. Yoshida (1989) argues that these tools were intended to provide management with a new way of viewing the production process. Specifically, it was expected that management would see the firm as a series of cross-functional systems and accept the responsibility for managing and improving them. This is exactly what happened in the case of Japanese management. However, when TMPs use these tools they are most often used to address quality problems. Further, they are often not used (or understood) by managers. The quality department is an example of Western management's continued desire to create functional specialties (and specialists) to treat symptoms rather than entire managerial and organizational structures. A firm will have made the transition to full continuous improvement when it has fully internalized the soft technologies of continuous improvement and is using analytical tools such as SPC to produce data for management strategy as well as ad hoc problem solving.

III. The Continuous Improvement Firm in Japan and the Role of Culture

As mentioned, Americans such as Deming introduced several analytical tools to Japanese firms, which learned and extended their use to great advantage. Are there aspects of the Japanese cultural experience that may uniquely predispose Japanese individuals and organizations to the practice of continuous improvement? Are the soft technologies of continuous improvement in Japanese CIFs deeply bound up with "Japanese culture"? If so, can this pose problems for transfers of such technologies? First, a brief examination of Japanese culture is in order.

The nineteenth century anthropologist Edward Tylor stated that, "culture or civilization is that complex whole which includes knowledge, belief, art, morals, law, customs, and any other capabilities and habits acquired by man as a member of society" (Tylor, 1865, p. 5). Kroeber argues that

we can approximate what culture is by saying it is that which the human species has and other social species lack. This would include speech, knowledge, beliefs, customs, arts and technologies, ideals and rules. That, in short, is what we learn from other men, from our elders or the past, plus what we may add to it. The mass or body of culture, the institutions and practices and ideas constituting it, have a persistence and can be conceived as going on their slowly changing way 'above' or outside the societies ['society' and 'culture' are closely related but not the same, ants and bees have societies, that is, aggregations of like animals, but no culture or speech] that support them...Big or little, then, culture affects human action" (Kroeber, 1987, pp. 81-82; see also Applebaum, et al., 1987).

Numerous research efforts have attempted to isolate and identify key "cultural characteristics" of the Japanese that have influenced the evolution of Japanese economic development (see for example Dale, 1986). A common view of Japan is that given a common language and the absence of large, ethnically distinct minorities, that it is a homogeneous society. Japan is therefore said to possess a "common culture."⁷

⁷Needless to say such thoughts have spawned a veritable growth industry in the academic and popular literature on Japan. What is clear is that Japan's phenomenal success simply cannot be explained as a function of an easily identified basket of separable factors. Culture and history are inseparable. As the above argument makes clear, much of the "uniqueness" of Japan is actually not so unique. For example, Italy, the Netherlands, Sweden, and Finland all share a common language and have no large, ethnically distinct minorities. By such criteria, these countries are "homogeneous." The implication that such homogeneity spawns success begs the observation that Switzerland, despite its linguistic diversity, enjoys one of the highest per capita incomes in the world. Conversely, Argentina has faltered despite a high degree of religious and linguistic homogeneity (see Ozaki, Chapter 5). However, it is true that Japan has never been colonized and was not invaded for over 1500 years prior to the Pacific War (this point has been used by those in the left to help explain Japan's vigor, e.g. Frank, 1966). Further, the American occupation after WWII certainly ranks as one of the world's least punitive by a victor over the vanquished. Indeed, contrary to the view that much of what characterizes Japanese business conduct has ancient roots in Confucian ethics and feudal social structures; it has been argued that much of what we see as uniquely Japanese (e.g., consensual decision making, lifetime employment, or "implicit agreements," close cooperation between government and business, and the like) were all invented after WWII as a direct result of the influence of MacArthur's occupation administration (Supreme Command Allied Pacific-SCAP) (see Chapman, 1991). As always the asking begs more questions. Viewing the process of continuous improvement can lead one to see some potent and mystical managerial blend based on a 2000-year-old culture. While for the purposes of critical inquiry reliance on such

Miyanaga argues that broader Japanese society is characterized by far more cultural diversity than popularly perceived. For instance, Japan's Chinese and Korean minorities have been traditional objects of discrimination. There also exists antagonism between natives of Eastern and Western regions of Japan, with Westerners seen as unsophisticated rustics by the more urbane Easterners (Miyanaga, 1991). The largest minority in Japan is not an ethnic one; but rather consists of the three million "eta" who are racially and physically Japanese. This group exists as an underclass of "polluted ones" who live largely segregated from the rest of Japanese society and who have their origins in the class of untouchables who dealt with dead animals in pre-Meiji Japan (Oppenheim, 1991, p.62). Regional, or prefectural backgrounds also appear more socially significant to the Japanese than to do such differences in the USA. Most Japanese speak the standardized version of Japanese disseminated by the centralized education system and the media. However, with close friends or with those with same regional or social background, the Japanese will often speak in their own regional dialect or accent with the assumed risk of alienating those who are unfamiliar and therefore "outside" such exclusionary regionalisms. In fact: "Common wisdom

"mysticism" is inadequate, the inability to dissect such a process into comprehensible parts demands a different set of "spectacles" with which to view the process.

holds that all Japanese speak two kinds of Japanese, standard Japanese and their own dialects, creating both uniformity and diversity in the same language" (Miyanaga, 1991, p. 12).

Several writers have seen the genesis of an alleged Japanese cultural predisposition towards cultural homogeneity in the Yamato period, when key aspects of Chinese culture, including Confucianism, were brought to Japan, and extending into the feudal Tokugawa period (Kunio, 1986). Kunio states:

In Tokugawa Japan, there was a complicated code of behaviour...In order to be accepted in society, an individual had to know which parts of the code applied to him and had to carefully observe them...In order to fulfill these obligations, personal interests were often sacrificed ...Cooperative work in a Tokugawa village was made easier by the existence of a fairly well-defined and stable social hierarchy...villagers knew from childhood where they belonged and what was expected of them" (Kunio, 1986, pp. 87-88).

Miyanaga argues that such passages confuse the vital distinction between the alleged tradition of cultural homogeneity and the sociocultural phenomenon of Japanese groups. Prior to the Meiji Restoration in 1868, Japan was comprised of over one hundred territories ruled by feudal fiefs. Ordinary people could not travel across fief boundaries without permission; social and physical mobility was low. At that time, Japan was characterized by "diffusion of power, high security, cultural diversity, low mobility, and the containment of community" (Miyanaga, 1991, p. 13). The Japanese group evolved a distinct social unit.

It was most often based on the farming household embedded in village society. This is different from broad cultural homogeneity. Ozaki observes that the very "un-Japanese" practices of job-hopping and absenteeism were rampant in late nineteenth century Japan. With feudalism still a recent memory, such behavior could be seen as anomalous if one saw in the premodern experience the origins for broad cultural homogeneity and harmony (Ozaki, 1991). Chapman (1992) argues that the immediate post-WWII years of Japan were characterized by anything but cooperative, consensual behavior. Rampant crime, particularly of the vicious kind, gangs, radicalism, youthful alienation, and labor unrest were widespread (Chapman, 1992).

The process of cultural and historical evolution in Japan has shaped a society comprised of tight groups but not characterized by a true cultural homogeneity. Many observers see the origins of Japanese groupism in the traditional farming household of Japan (see Kunio, 1986, Chapter 2). Prior to the Meiji Restoration in 1868, 85 percent of Japanese lived in peasant and farming villages and had done so for centuries. Physical and social mobility were nil. Although geography and feudalism thwarted the development of broad cultural homogeneity, long term isolation in villages helped create a strong tradition of groupism. As recently as 1955, nearly 40 percent of the labor force was engaged in family-based village agriculture.

Currently only 8 percent of the Japanese labor force works on the land; and many of these people are "part-timers." (Emmott, 1989, p. 28).

An important factor that has contributed to the perception of cultural homogeneity in Japan is the history of a strong, centralized educational system in Japan. During the post-Meiji Era the consolidation of political, economic, and military power occurred *pari passu* with the creation of a strong national educational system. In 1872, the Education Law mandated primary education for all regardless of race or sex (only seven years after the abolition of slavery in the USA and two years after the implementation of Britain's Education Act). By 1908, fully 98 percent of all Japanese children received at least six years of education. Undoubtedly the long and deep tradition of respect for learning in Japan has roots in Confucianism. After the Restoration, most schools were remodelled along overtly Western lines; however, centuries of Confucian thought remained deeply ingrained. Some observers have isolated fundamental strands of Confucianism that blended with the Shinto tradition relating to the supremacy of the imperial dynasty. This resulted in a synthesis of the Confucian view of the duties of subjects and a Shintoist-cum-Western orientation towards the nation state. Confucian ethics thus surfaced in support of national objectives and became an integral part of the primary school curriculum.

It has been argued that Confucianism in Japan, in contrast to China, was freed of much of the deep cultural conservatism of the entire tradition, and was able to become a positive force in the modernization of the country as far as the ideals of discipline, loyalty, and education promoted harmony, national solidarity and progress (Oppenheim, pp. 48-49).

Occupying forces after WWII further imposed a national system of free, standardized public education that has produced virtually 100% literacy. Miyanaga stresses that: "Shared language and knowledge, a result of centralization and standardization of acquired knowledge through education, are mistakenly assumed to be proof of a homogeneity that shapes the Japanese mind. On the contrary, every Japanese is not born with the same degree of 'Japaneseness.' Innate Japaneseness is a myth, arising from the confusing notion that the homogeneity of a group results from the common nationality of its constituents" (Miyanaga, 1991, p.14). It should be noted that the perception that Japan and the Japanese are "innately different" is widespread among the Japanese themselves. This belief is referred to as "Nihonjinron" in Japanese (Emmott, p. 25).

A highly standardized universal system of education, a shared recent history of family farming, centuries of isolation, and a high degree of perceived ethnic homogeneity, appear to have had a greater impact on the

shaping of cohesive groups in Japan. Groups in contemporary Japan stand apart from other groups and are independent and autonomous. Groups are often very harmonious; however, such harmony is reserved only for members of the group. Membership in the group is localized and closed to both foreigners and non-member Japanese. Membership in a group engenders intense loyalty and individual sacrifice in favor of the group. In current day Japan, members who leave a group are often viewed as defectors. The health and survival of the group is contingent upon the maintenance of delicate social and psychological balance among and between members, as well as the discharge of social obligations based on status and hierarchy.

An example of maintaining balance and reducing friction within a group is the case of policy concerning managerial promotions in a Japanese electronics firm. In this firm, a newly promoted manager does not receive a salary increase until his new position is approved of by his subordinates, who are also his former peers. This approval takes years. He must work harder with heavier responsibilities at no extra pay until his subordinates approve of his new position. When such respect is earned, he will earn his raise from those beneath him. Such behavior may indicate that group cohesion is the result of a cultural legacy of controlled social processes rather than a spontaneous

manifestation of "innate Japaneseness" (Miyanaga, pp. 15-16). Larger groups also may contain smaller, homogeneous subgroups. One can be a member in more than one group at the same time; a member of a Matsushita division is also a member of the larger Matsushita family. The group member and his group are competitive with other Matsushita divisions, but all are expected to harmonize with the company as a whole.

The tight and exclusionary homogeneity of groups in Japan, both create a greater degree of cultural pluralism and competition than commonly believed (see Miyanaga, 1991). They are admirably suited to corporate capitalism. Aggression and competition, carefully controlled within the group, are efficiently focussed on competition with other groups and their members. In contrast to Americans who often stress individual differences within groups, the Japanese tend to overlook their own cultural diversity and stress harmony within the group. The group's constituent members share in a unity of purpose and are bound by psychological and social ties that are quasi-familial. Statements such as the following by Akio Morita of Sony are quite typical among Japanese managers: "There is no secret ingredient or hidden formula responsible for the success of the best Japanese companies. No theory or plan or government policy will make a business a success; that can only be done by people. The most important mission for a

Japanese manager is to develop a healthy relationship with his employees, to create a family-like feeling within the corporation, a feeling that employees and managers share the same fate. Those companies that are most successful in Japan are those that have managed to create a shared sense of fate among all employees, what Americans call labor and management, and the shareholder" (Morita, p. 130).

IV. Summary

It appears that the Japanese workforce is culturally predisposed to the formation of highly motivated, service-oriented groups. This workforce is among the best educated in the world and is very receptive to learning and knowledge.⁸ These groups function as surrogate families which widely share ideas and information. Groups such as these would seem well suited to engaging in the process of customer-focussed, incremental improvements. The anthropologist Edward Hall has advanced the thesis that some cultures share information more easily than others. "High-context cultures" are those in which people are deeply involved with each other and in which information is widely

⁸It is estimated that the Japanese high school system produces graduates who are at the same academic level of the average 22-year-old U.S. college graduate (see Rohlen, 1983). Comparative studies of international education data rank Japanese primary and high school students as first in the world in science and mathematics. Further, the Japanese graduate a far greater proportion of applied science graduates, such as engineers, than do other advanced countries (Institute of Economic Affairs Education Unit, 1987; also, International Association for the Evaluation of Educational Achievement, 1989).

shared. In such cultures, "simple messages with deep meaning flow freely." According to Hall, Japan qualifies as a high-context culture; in contrast to more individualized, somewhat fragmented, "low-context" cultures such as those of Switzerland and Germany (and to a lesser extent the U.S.) where tacit understanding based on shared information is less in evidence (Hall, 1981, p. 39). It is possible that groupism in Japan both reflects and is made stronger by "high context" communication. As noted, many improvements are not documented. This may be due in part to a form of communicating that relies more on unspoken, tacit understanding than on "spelling out" meaning.⁹

It is plausible that "high-context" communications might facilitate the process of making incremental improvements. Communications may flow more easily both "up" from the floor and "down" from the highest echelons of the organization. Workers and managers participating in groups, such as quality circles, may encounter fewer misunderstandings if all members are of the same "high-context" culture. In a "high-context" culture such as Japan's, with a highly educated workforce, training may be more effective with workers able to quickly attain high

⁹It is also possible that in organizations with fewer job classifications (given a more generalist, cross-functional orientation), that formal documentation is deemed less necessary. Further, larger numbers of job classifications based on functional specialization might require greater use of documentation for control and training purposes.

levels of proficiency in the use of computers, statistical methods, and troubleshooting on a variety of abstract levels. High-context communication might also make cross-functionalism and a generalist approach easier given deeper comprehension of communication among the group's members.

The quasi-familial loyalty engendered within the Japanese group may be nourished by lifetime employment and promotion from within the continuous improvement firm. Both lifetime employment and promotion within the firm are seen as powerful incentive systems which encourage personnel to obtain firm specific information and use it for improvements. It may be the case that Japanese groupism, embedded in a "high-context" culture (which also places a premium on effort and learning) has allowed the Japanese CIF to evolve using techniques and philosophies introduced from the outside by Deming and others. Yoshida (1989) makes the point that the Japanese emphasize the holistic aspects of production and were able to adopt tools and perspectives from outside that allowed them a broader view of the production process.

If the Japanese CIF has successfully borrowed technologies and analytical tools from the outside, can other organizations do the same? We have noted that standard firms can and have adopted many of the analytical tools so successfully used by Japanese CIFs. However, without fundamentally changing the soft technologies in the

form of organizational structure and managerial systems, these TMPs will remain follower firms. It is these softer technological forms that most readily reflect cultural influences. While we doubt the existence of broad Japanese cultural homogeneity, it is probable that strong cohesion of the Japanese group offers fertile ground for the implantation and evolution of the soft technologies of continuous improvement. While there is solid evidence of a long history of groupism in Japan, it is important to recall that this cultural trait did not create the "Japanese miracle," but provided the rich humus from which the growth could spring. As noted, Chapman (1991) reports that much of what later came to be seen as synonymous with "Japan, Inc." (e.g., consensual decision making, lifetime employment, promotion from within, enterprise groups and the like), was given initial impetus during MacArthur's occupation administration. Certainly, the existence of Japanese groupism was amenable to the new rule changes. However, there are no general reasons to assume that an organization committed to attaining continuous improvement cannot do so by focussing on group cohesion through the adoption of some form of transfunctionalism, shared information, lifetime employment, and promotion from within. It is possible that unique cultural traits of the Japanese have made them particularly well suited to such an approach, however, other

cultures that display their own forms of groupism may find ways to apply them to continuous improvement.

While the particular cultural characteristics of Japanese groups may have been an advantage in the development of the CIF in Japan, these same characteristics may prove problematic in attempting to set up production in countries other than Japan, or in entering into joint ventures with other firms. First, to the extent that Japanese groups are exclusionary, there are immediate problems in admitting "outsiders." Further, if in fact the Japanese group proceeds on the basis of high-context communication, there may be problems communicating with others from lower-context cultures. This may be particularly critical in attempting to transplant the holistic process of continuous improvement.

In Japanese CIFs, as with standard Western firms, strategic planning and policy is exclusively within the purview of top management. Group ethos and consensus decision-making may be central to such firms' success, but should not be misinterpreted:

The concept of consensus is natural to the Japanese, but it does not necessarily mean that every decision comes out of a spontaneous group impulse. Gaining consensus in a Japanese company often means spending time preparing the groundwork for it, and very often the consensus is formed from the top down" (Morita in Oppenheim, p. 40).

Yamashita concurs:

Consensus management is frequently misunderstood abroad. Daily business is conducted from the bottom

up, but long-term planning is top-down. Basic policy does not originate at lower levels" (Yamashita, p. 43).

Morita reports that "gaining consensus" often means "preparing the groundwork for it." It is very possible that such activities depend very heavily on smooth flows of information that are communicated in ways that all constituent members of the group or organization understand. However, the exclusivity of the Japanese group and the existence of high-context communication may make this difficult or impossible to effect across cultures. Instead, the Japanese CIF may opt not to attempt implementing a system of endogenously generated continuous improvements. Rather, systems and processes will be made repetitious and routine and decisions will be made strictly from the "top-down." This appears to have happened in the maquiladora industry of Mexico. In Chapter 6 we shall return to the issue of transferability and the appropriateness of continuous improvement technologies for less developed countries.

CHAPTER 3

AN OVERVIEW OF THE MAQUILADORA INDUSTRY

I. A Brief History of the Maquiladora Industry

The maquila industry of Mexico exists under special provisions of both Mexican and American law. Mexico allows duty-free imports of capital equipment for use in manufacturing, as well as components to be used in assembly, so long as a minimum of 80 percent of the plants' output is exported. Importantly, Mexico allows 100 percent foreign ownership of all maquila operations (Echeverri-Carroll, 1988, p. 2). The maquiladora industry grew very rapidly during the 1980s. In 1982, the industry was comprised of 585 plants employing just over 127,000 workers (INEGI, 1988, compiled in Sklair, p. 68). In early 1992, over 2,100 plants were in operation employing over 467,000 persons (Twin Plant News, December 1991, p. 68).

In 1962, Items 806.30 and 807 of the Tariff Schedule of the United States went into effect. Such items are currently subsumed under the Harmonized Tariff Schedule (HTS) 9802. Article HTS 9802.00.60 (formerly 806.30) allows that metal articles (excluding precious metals) manufactured in the United States, exported for processing, and then returned to the United States for further processing, are subject to duty on the value added in the foreign processing. Under Article HTS 9802.00.80 (formerly 807.00)

imported articles assembled in foreign countries from components fabricated in the United States are subject to duty only on the value added in the foreign country (United States Tariff Commission, 1970, pp. 84-85). Of these two provisions, imports have been much greater under the original 807.00 than under 806.30. Item 807.00 accounts for approximately 98 percent of all imports entering the U.S. under the offshore assembly provision of the U.S. Tariff Code (Clark, Sawyer, and Sprinkle, 1990, p. 2).

A brief review of the historical antecedents to the development of the maquila industry is insightful (Sklair, pp. 24-42, provides a concise discussion of this topic). The period between 1848 and 1914, while largely one of world peace, was a tumultuous one in terms of U.S.-Mexican relations. This era has been characterized as one of "cultural, racial, economic, political, and military conflict along the U.S.-Mexican border" (Fernandez, p. 76). On the U.S. side a rapidly expanding market system contrasted greatly with an inward looking and protectionist Mexico to the south. Such different systems colliding along a porous border made smuggling attractive and easy. Beginning in the 1860s the Mexican government enacted a series of policies designed to both control smuggling along the border and to integrate its northern frontier more closely with the national economy. Federally authorized "Free Zones" of one form or another were to span the entire

border region. Such policies had the perverse effect of exacerbating smuggling between the frontier region and the Mexican interior and may have retarded industrial development of the region (see Fernandez, Chapter 4; and Sklair, p. 28).

In 1933 the Mexican Federal government established a Free Perimeter in the towns of Tijuana and Ensenada. By 1939 all of Baja California Norte and Baja California Sur, as well as part of Sonora were declared a Free Zone (Mendoza Berrueto, pp. 47-50). The Zone was designed to increase the supply of products not produced locally by allowing duty free imports of raw materials and other industrial necessities from the U.S. for local processing. Sklair argues that these Free Zones had the unintended effect of opening up the northern Mexican frontier to an even greater influx of U.S. products (Sklair, p. 28). In 1942, the Bracero Program was established by the United States and Mexico to give legal sanction to the traditional northward flows of Mexican migrant laborers. The Bracero Program helped to meet the exigencies of a wartime labor shortage and would ultimately involve over four million workers until its unilateral cancellation by the U.S. in 1964 (Briggs, pp. 4-6; and Fouts, p. 4). The eventual demise of the Bracero Program was anticipated by the Lopez Mateos administration of Mexico which, in an attempt to provide employment for displaced Bracero workers, preemptively established the

Programa Nacional Fronterizo in 1962 (known most widely by its acronym, PRONAF). This National Border Program was designed to promote far reaching social and economic development along the border through the establishment of cultural facilities, social services, and the creation of an industrial base. However, adequate funding never materialized for such an ambitious scheme. Most available monies were highly concentrated in a small number of border towns such as Ciudad Juarez and Nogales. The PRONAF program was finally shelved in 1971 (Mungaray and Moctezuma, p. 23, 1984).

With the exception of some highly visible new shopping malls and bridges, the PRONAF has been largely viewed as a failure. However, this initial attempt at border development brought together powerful forces who were open to change. For example, the PRONAF Advisory Committee, comprised of influential entrepreneurs and bureaucrats who had devised the original PRONAF program, launched into an exploration of various other possibilities for border industrial development. The group commissioned Arthur Little de Mexico S.A. to undertake an extensive investigation of border area opportunities. The study concluded that the development of manufacturing along the border had the best hope of success if its output was targeted for the U.S. market (Bermudez, quoted in Sklair, p. 43).

Campos Salas of the Ministry of Industry and Commerce (SIC), announced a new scheme in 1965 to allow the temporary duty-free importation of materials and components into Mexico for assembly and subsequent reexport. The main condition was that they remain "in-bond" while in Mexico, hence the origin of the term "inbond industries" (Sklair, p. 44). This was to lead to the introduction by the Mexican government of the more formal and permanent Border Industrialization Program (BIP) in 1965. The operating rules of the BIP evolved through a series of government decrees over several years. In 1971, the basic rules governing the maquiladora program were in place. By that year there were more than 200 maquilas in operation employing approximately 30,000 workers (Sklair, p. 45).

The Ministry of Industry and Commerce (SIC) was picked to administer the maquila program. Regulations clearly state that the maquila industry is a promotional program which will "grant assistance to investors to establish industrial units within a 20 kilometer strip parallel to the international border line or to the coast line" (Mexico, SIC, quoted in Sklair, p. 1). The program authorizes tax free imports of "raw materials, parts, components, machinery, tooling equipment, and everything else needed for the transformation or processing, assembly and finishing of products to be entirely exported (Mexico, SIC, quoted in Sklair, pp. 1-2). The 1971 regulations list the term of the

program as "indefinite" and list the following northern border cities of Mexico as permissible site locations for maquila industries: Tijuana, Tecate, Mexicali, San Luis Rio Colorado, Nogales, Naco, Agua Prieta, Las Palomas, Ciudad Juarez, Ojinaga, Ciudad Acuna, Piedras Negras, Nuevo Laredo, Ciudad Aleman, Reynosa and Matamoros (Mexico, SIC, quoted in Sklair, pp. 1-2). The legislation further states that any item may be processed except those that "may be dangerous to health (Mexico, SIC, quoted in Sklair, p. 2).

The BIP in effect converted the entire border region of northern Mexico into a de facto free zone regarding assembly operations and the importation of inputs. The regulations of 1971 also permitted for the first time the establishment of maquilas outside the border and free zones (Sklair, p. 47; and Echeverri-Carroll, 1988, pp. 7-12). Overall, the growth of the maquila industry was impressive, albeit sporadic, throughout the 1970s. It would not be until the significant and ongoing peso devaluations beginning in 1982 that the growth of the maquila industry became rapid and sustained (Echeverri-Carroll, 1990, p. 2). The number of maquila plants grew rapidly from 248 in the fourth quarter of 1973 to 464 for the first quarter of 1974; with the number of employees rising from 60,356 to 78,025, respectively (Van Waas, p. 172). Growth throughout the 1970s fluctuated with about 540 plants in operation employing 111,000 employees by the end of the decade.

II. Recent Trends

The peso devaluations beginning in 1982 marked the beginning of a long slide for Mexican wages. Hourly labor compensation for starting laborers declined from \$2.96 per hour in 1980 to barely fifty cents per hour in 1990 (U.S. Department of Labor, 1988, p. 6; Tolan and Kammer, p. 44). Importantly, the peso devaluations have made Mexico the lowest wage country vis-a-vis those countries where in-bond plants have traditionally located, i.e., Hong Kong, Singapore, and South Korea (Echeverri-Carroll, 1990, p. 2). The rate of growth in the number of maquila plants averaged 7.2 percent per year after 1983 as compared with 3.5 percent in prior years (Fernandez Kelly, p. 157). Low wages and proximity to the U.S. market are obviously major factors in determining the direction and magnitude of maquila expansion in Mexico. Legislation has also encouraged this process. In 1983, the "Decree for the Promotion and Operation of the In-Bond Industry for Export," allowed maquilas to sell a maximum of 20 percent of their production in Mexico provided that there are no competing Mexican goods on the market and that a local content requirement has been met (Echeverri-Carroll, 1988, p.4). This decree also stipulates that maquilas must provide technical assistance to current or potential suppliers. Despite such landmark trade liberalization, it does not appear that a significant amount of maquila output has been sold on the domestic market. The

reasons for this are unclear, although the possible existence of obstacles in the Mexican marketplace (such as undeveloped market channels) combined with a collapse of domestic consumption are likely causes (Sklair, p. 69).¹ In 1985 Mexican banks created certain financial incentives for maquila start-ups in the form of dollar loans for construction and machinery and peso loans for manufacturing and leasing contracts (BANCOMER, 1985, pp. 16-17).

Electronics and textiles/apparel were the two most important sectors in the maquila industry throughout the 1960s and 1970s. Television sets and components comprised the largest single category of 806.30 and 807 imports into the United States from Mexico. Television production remains very important; for example, over nine million TV sets were assembled in 1990 in Ciudad Juarez alone. The growth of maquilas assembling electronic parts, particularly television components, can be traced to the U.S. reaction in the 1960s to mounting Japanese competition. At that time, U.S. participation in Mexican maquila operations intensified as firms sought sources in addition to those in Taiwan and

¹Further, maquiladoras purchase very few product inputs from Mexican suppliers (Brannon, James, and Lucker, p. 5). This author was told by plant managers that their main obstacle was that such supply simply did not exist. When there were Mexican sources, they not did meet standards of timely delivery, quality, or price. However, maquiladora plants purchase large amounts of building materials, office supplies (not including office equipment, such as computers, calculators, and the like) and food stuffs from Mexican suppliers.

Singapore. During the 1960s and 1970s, the apparel industry was the second largest user of U.S. components for reexport to the United States as assembled products (Echeverri-Carroll, 1990, p. 1).

While electronic assembly remains the largest group within the maquila industry, the assembly of automobile inputs increased most sharply during the 1980s. Responding to intense Japanese competition, U.S. automakers relocated the production of labor-intensive inputs to the low-wage maquila industry. The appreciation of the yen vis-a-vis the dollar in the late 1980s, coupled with the mounting threat of U.S. import restrictions against Japanese autos, have stimulated the growth of Japanese maquila plants. These plants produce and assemble inputs for Japanese as well as U.S. automobile companies located in the United States. Employment in all the auto-related maquilas grew very rapidly between 1980 and 1988, increasing their participation in total employment in the industry from 6.2 percent to 20.1 percent during this period; while electronic-related maquilas decreased their participation from 63.8 percent to 41.2 percent, respectively (Echeverri-Carroll, 1990, pp. 1-5).

The average plant size of maquila operations has been increasing. Maquilas averaged 193 workers per plant in 1980 and grew to an average of 271 in 1987 (Echeverri-Carroll, 1988, p. 4). This trend may reflect greater scale economies

accruing as a result of increased capital-intensity in the production process. This is highly probable in those firms employing complex production processes (Schwartz, pp. 2-4). The term "second generation maquilas" has been coined to refer to those plants that are employing more technically sophisticated techniques (Wilson, quoted in Echeverri-Carroll, 1988, p. 7). Of particular importance to the Mexican maquila industry is the advent of surface mount technology (SMT), a process innovation which allows the direct attachment of components to printed circuit boards without the manual insertion through the holes in the board. SMT is a rapidly evolving automated process with profound implications for employment in the maquila industry. About 45 percent of maquila exports are component and board assemblies, both of which are projected to be automated using SMT and other new techniques by the mid-1990s (Sanderson, p. 137). Technologies such as SMT offer the producer greater reduction of for products variation with much higher engineering tolerances. Increasingly, products such as circuit boards require very high levels of precision. Technology such as SMT offer the best levels of quality and is an example of a clear advantage over manual assembly.

The impact of new manufacturing technologies such as SMT upon employment and production in the maquila sector depends on several factors. The Japanese are believed to

possess about a two year lead in the development and implementation of such technologies. The high costs of implementation, coupled with the ability of Japanese firms to spread the costs and risks of new investment, has given them a further competitive advantage over U.S. firms. If U.S. firms redouble their efforts to close the automation gap (which larger companies appear to be doing), then employment in U.S. operated maquilas is likely to suffer. Given the very low cost of labor in Mexico, manual assembly remains the least-cost alternative. However, an increasing number of processes demand automated production to rapidly reduce variation. Regardless of the wage level, machines are the only alternative for maintaining requisite levels of quality in increasingly intricate products (Sanderson, pp. 140-141).

About 83 percent of maquila plants are located along the 2,000 mile U.S.-Mexican border. However, the movement of maquila plants into the interior of Mexico has increased since the early 1970s. Sklair isolates three main factors that have encouraged the interior migration maquilas. First, wages in the interior of Mexico were significantly lower relative to the northern wage levels in the mid-1970s. We cannot speak of one minimum wage as Mexican Federal law has set various minimum rates accordingly to region. Further, nonwage benefits that are mandated also vary. Therefore, only rough estimates of border and interior wage

differentials can be made. However, reasonable estimates suggest that wages in the interior are about 25 percent lower than along the border. However, such a wage differential alone cannot explain movement to the interior. For plants already operating on the border, the logistical costs of relocation may well offset any wage differentials, particularly given already low wages on the border. A second factor influencing southward movement has been the increasingly stressed infrastructure of the border areas. The two largest maquila cities of Ciudad Juarez and Tijuana are prime examples of overworked bridges, roads, and sewerage systems. Cities located farther from the border such as Ciudad Chihuahua, Monterrey, and Guadalajara, offer an already established infrastructure that could handle additional development. Thirdly, during the rapid growth of border maquilas since 1982, border locations have experienced labor shortages and high levels of turnover and absenteeism (Sklair, pp. 141-142). Turnover is lower in interior locations given the proximity of familial and social networks. "Locals" who work at interior plants are far less mobile than the labor force in border areas.

The 1983 Mexican decree allowing firms to sell 20 percent of their production on the Mexican market has provided an additional stimulus for firms to move to the interior. Echeverri-Carroll forecasts that the possibility of buying components from established Mexican manufacturing

industries in the interior will allow maquilas to gain greater access to the domestic market. Further, as maquila production processes become more sophisticated the demand for more highly skilled labor will make large urban cities of the interior more attractive (Echeverri-Carroll, p. 7).

III. The Growth of Japanese Maquiladoras

The growth of Japanese owned maquilas has accelerated since 1985. While over 90 percent of all maquila operations are U.S. owned, the rate of growth of Japanese plants is impressive, increasing from 39 to 52 in one year between 1988 and 1989. Early Japanese participation in the assembly industries of the Pacific Rim was initially undertaken by small and medium sized firms. In contrast, the first Japanese firms to open Mexican maquilas have been industry giants such as Sony, Hitachi, Sanyo and others (Echeverri-Carroll, forthcoming, p. 12). To date, the largest concentration of Japanese maquilas is in the Tijuana region. Tijuana and Southern California have long-established business ties with Japanese firms. Many Japanese firms have administrative and production facilities in the San Diego and Los Angeles area which have facilitated Japanese expansion in the maquila sector of Tijuana. However, since 1986 there are a greater number of new Japanese maquilas being opened along the Texas-Mexico border than in any other region (Echeverri-Carroll, 1988, p. 29).

Locational decisions for Japanese owned maquilas are strongly influenced by plant specialization. Most electronics-oriented Japanese maquilas have been and continue to be located on the California-Mexico border. Japanese electronics maquilas produce output for three basic consumers: parent companies in the United States, other Japanese or U.S. customers in the United States, and other maquilas (most Japanese operated maquilas are actually considered "U.S. owned" insofar as they are subsidiaries of Japanese affiliates operating in the U.S). An example of the first case is Sanmex, S.A., a Sanyo-owned operation which provides fans produced in Tijuana to Sanyo in San Diego which are then sold or distributed throughout the U.S. market. Sanmex is also exemplar of the second case, it makes refrigerators for Sears in the U.S.; while Taisho Electromex, S.A., makes television components that sold to several Japanese TV manufacturers. The third option of selling to other maquilas seems to be more developed in Tijuana. For example, Tocabi, Tabuchi, and Onamaba-Sumitomo supply Sony and Matsushita in Tijuana (Echeverri-Carroll, 1988, pp. 32-33).

Japanese maquilas producing automobile components continue to concentrate along the Texas-Mexican border. This locational choice reflects the fact that many of the newly arrived Japanese maquilas along the Texas border are automobile parts suppliers to Japanese firms that are

manufacturing in places such as Tennessee, Kentucky, Ohio, and Michigan. For example, Yazaki-owned maquilas in and around Ciudad Juarez produce auto wire harnesses for Ford and Mazda in Michigan, for Honda in Ohio, and for Toyota in Kentucky and Nissan in Tennessee. Japanese automobile maquilas along the Texas border are projected to continue to grow rapidly. Honda and Toyota have announced aggressive plans to expand U.S. based car production through the mid-1990s (Echeverri-Carroll, 1988, pp. 32-33; and forthcoming, p. 5).

As with U.S. maquiladoras (with the exception of packaging and office supplies), Japanese maquilas do not currently source from Mexican suppliers. Newly established firms source exclusively from Japan and then after becoming better established seek out U.S. suppliers. However, this view may be changing among Japanese firms. There is evidence that Japanese plants are actively seeking out Mexican suppliers for long term relationships (Brannon, James, and Luckner, p. 5). This may represent a shift of Japanese perceptions about Mexican, and perhaps other North American suppliers. In general, it has been reported that Mexican and U.S. suppliers have been seen as producing an inferior product by most Japanese plants (Echeverri-Carroll, 1988, p.35; and Sanderson, p. 143).

Japanese maquila spokespersons cite cheap labor as the prime reason for setting up shop in the maquila industry of

Mexico. The "endaka," or appreciation of the yen against the U.S. dollar in the latter half of the 1980s, made assembly in Mexico even more attractive. A second major reason cited is the proximity of the U.S. market and parent companies producing in the United States. A third reason, never explicitly mentioned, is the circumvention of any impending protectionism or trade legislation limiting the imports of Japanese products into the United States (Echeverri-Carroll, 1988, p. 35).

Japanese maquilas producing for parent companies operating in the United States have not been as affected by such protectionist sentiment. For example, in April of 1987 the United States announced retaliatory tariffs placed on Japanese semiconductors. Japanese firms operating in the maquila industry and exporting into the U.S. under 806.30 and 807 were not subject to those penalties (LaFalce, p. 169). Markides and Berg argue that some Japanese firms have moved manufacturing and assembly operations to Mexico specifically to avoid American protectionism (Markides and Berg, pp. 115-117). In a similar vein, Encarnation makes the case that U.S. trade restrictions are the most important determinants of Japanese direct investment in U.S. assembly and manufacturing (Encarnation, pp. 117-151).

Insofar as items 806 and 807 of the U.S. tariff code are available to non-U.S. firms, Scott and Worley have wondered if the maquila program has created an uproar by

"...unwittingly allowing astute Japanese multinational corporations to discover an economical and unique back door into the U.S. economy" (Scott and Worley, p. 163). In responses to interviews, Echeverri-Carroll found that labor costs and the proximity of U.S. based operations (with the implicit goal of circumventing trade barriers) are most prominent in Japanese strategic planning. Items 806 and 807 did not appear to figure in such planning in any appreciable way (Echeverri-Carroll, 1988, pp. 34-35).

At the present time the United States and Mexico have entered into historical discussions toward the creation of a free trade agreement. This course of events marks a radical departure from over eighty years of U.S.-Mexican trade relations. President Salinas de Gortari of Mexico, in a surprise reversal of his previous stance on a U.S.-Mexico free trade agreement, sent an emissary to Washington in early 1990 to lay the foundations for formal talks. The prospect of a North American Free Trade Area, including Canada (who has an eighteen-month-old agreement with the U.S.), the U.S., and Mexico, with a combined population greater than the European Community of 1992, has become a very real possibility.

Such a possibility places the booming maquila industry in a new light. Clearly, firms well-established in the maquila industry prior to the enactment of such an agreement will be well positioned to take advantage of trade

liberalization based on intra-area comparative advantage. Experience in Mexican operations (working through cultural and bureaucratic "learning curves") will give "pre-agreement" firms an advantage over later arrivals. Further, firms already operating in the maquila sector may be better poised to take advantage of the greater access to the Mexican market that a free trade agreement may bring. Non-U.S. firms, and particularly the Japanese, will watch this process carefully. The ramifications of a fully-integrated North American market are not lost on Japanese observers. After travelling to Toronto to study the details of the U.S.-Canada free trade pact, Kimihide Takimura, chief of a Mitsui group unit and an experienced businessman in Mexico, stated in July of 1990: "We have to learn the mechanics of these agreements and look at Mexico more seriously now" (quoted in Moffet, p. 4). While many Japanese have retained a wait-and-see attitude based on past negative experiences, other companies such as Nissan remain optimistic, pouring one billion dollars into a new plant in Mexico. While not a maquila plant, such rapidly developing events portend greater interest and participation in Mexico and the maquila program by Japanese firms (Baker and Miller, pp. 50-51).

CHAPTER 4

CONTINUOUS IMPROVEMENT AND MAQUILADORA INDUSTRY: SELECTED FINDINGS IN U.S. AND EUROPEAN PLANTS

I. Study Sample and Research Method

As noted, the maquiladora industry of Mexico has grown rapidly in the decade of the 1980s and into the 1990s. Some of the world's largest transnational corporations conduct assembly operations in this region. The maquiladora industry offers an opportunity to study and compare the implementation and development of continuous improvement technologies among plants of U.S., European, and Japanese origins. Further, since the majority of plants in the sample are incorporated outside of Mexico, it is possible to observe attempts at transplanting the continuous improvement approach from the parent company to the maquiladora. Mexico is a less developed country (LDC) and evidence collected and analyzed may inform policy for other LDCs.

This study is based on a sample of 104 manufacturing and assembly facilities located in and around the cities of Ciudad Juarez and Ciudad Chihuahua, both of which are located in the northern Mexican state of Chihuahua.¹ While

¹Of these plants, 83 were subsidiaries of U.S. firms. Fifteen were non-U.S. subsidiaries, including seven Japanese plants, four Dutch plants, one French subsidiary, one German plant, one from the U.K., and one from Taiwan. Four plants were joint ventures between U.S. and Japanese firms, and two were American companies recently acquired by a Japanese industrial group. Only one of the managers of the European

there is a greater number of maquila plants concentrated in the city of Tijuana in the state of Baja California Norte, the average number of employees, level of value added, and area under roof is far greater in Ciudad Juarez.² Each firm completed a questionnaire, covering three general areas:

(1) Production Process, (2) Technology and Technology Transfer, and (3) Personnel Management. (See Appendix for the complete survey instruments. Complete results may be obtained from the author.)

Each questionnaire was followed by extensive interviews with plant managers, division managers, engineers, quality control and assurance managers. In several plants, line and other direct workers were also interviewed. Overall, over 250 persons were interviewed between April and November 1991.³ Across the sample of 104 manufacturing facilities,

firms was a native European (from the Netherlands). The other plant managers were from the U.S. The manager of the Taiwanese firm was an American citizen who was born in the U.S. In the results that follow, there were no significant differences between the European plants and the Taiwanese plant and mass of U.S. plants. This undoubtedly reflects the fact that the managers were mostly American.

²For example, as of December 1991 Tijuana had 656 plants employing 70,262 persons. Ciudad Juarez had only half as many plants at 321 but employed almost twice as many people at 134,838, implying significantly larger plant size (Twin Plant News, December 1991). As of late 1990, Ciudad Juarez produced over twice the value added of Tijuana, at \$777.6 million versus 378.0 million, respectively (Border Trax, September, 1991).

³Survey questions were usually answered by the plant manager or the head of quality assurance or quality control. In several cases, the plant manager included other managers concerned with issues of continuous improvement and quality

interviews (including plant tours) averaged two hours. In several instances the author was invited to stay for a half a day or longer to speak with several managers, engineers, and line workers. The author was not permitted full access to three plants because of secrecy surrounding new products.

In order to increase the chances of gaining an interview, respondents were assured of absolute anonymity. Specific questions concerning sensitive data were avoided. Questions concerning new production information and any proprietary data were not addressed. Wage and benefits policy (except as the generally related to such metrics as quality) were not discussed. Environmental policy and practices were not addressed on the survey instrument. Importantly, financial data were not examined.

While such issues are clearly important and might provide evidence of a continuous improvement approach, they represent extremely sensitive issues which could serve to heighten the suspicions of an already publicity-shy group of managers. Such a non-invasive approach proved profitable as many managers relaxed and spoke at great length about many such sensitive topics, including personnel and financial information. Further, by stressing anonymity and focussing on continuous improvement and quality, the author was able

in the interview and the questions were addressed collectively and answers were agreed on by consensus.

to gain entrance to far more plants than was first predicted.

The author was warned by several academics and consultants prior to conducting this research that plant managers were suffering "research fatigue" resulting from a steady stream of academic and journalistic investigators, as well as many surveys. Management complained of having been pilloried and misrepresented after good faith efforts to open their plants to journalists and academics.⁴ At a time when the maquiladora industry was being portrayed as exploitive and environmentally reckless, companies responded by requiring clearance from corporate headquarters in order

⁴This author was told by several managers that they had been badly misrepresented by the press and hostile academic researchers. Initial attempts at taping interviews were scrapped after the general negative reaction to the practice. Some managers forbade taping, while others seemed uncomfortable and reticent with the recorder running. One manager indicated that he had been taped by a journalist on the condition that specified parts be "off the record." While driving in his car weeks later he was shocked to hear his own recorded voice on the radio answering canned questions that greatly twisted his earlier "off the record" remarks. Another president of a multiplant subcontracting maquiladora company told me that he opened his plants to the reporters from a major East Coast newspaper's Sunday magazine on the condition that they not misrepresent what they saw. When the article was published, one of his plants was pictured on the top of a page with a caption identifying it by name and location. Directly below the picture was a second picture of a plant portraying a large waste pipe spilling ominous looking contents into a drainage ditch. There was no caption under the picture, which led the reader to infer that it was one of the subcontractors's plants. "We have no waste pipes at any of our plants-the picture is of someone else's plant." While the author does not intend to defend the maquiladora industry against valid criticism, such stories were all too common.

to gain access to plants. It was difficult, but not impossible, to access Japanese plants. A prominent industry consultant told this researcher, "I can get you in several world class plants, but I can't get you in any Japanese plants." The author was told by this consultant and another academic researcher that Japanese plants in Mexico assiduously avoided publicity.⁵ The stress placed on anonymity and the interest in quality and continuous improvement (or, in many cases, interest in what the plants were "doing right") may have proved the factors that allowed the author to gain entrance to over 100 plants.

This is an early investigation of continuous improvement in the maquiladora industry of Mexico. At later stages it would be useful to establish experiments that may generate testable data. However, in the current investigation of the maquiladora industry of Mexico, such a data set does not exist. By necessity, this inquiry into

⁵When discussing the issue of keeping a "low profile" in Mexico with Japanese managers and engineering personnel, none seemed to think that such a thing existed. For whatever reasons, however, the Japanese do not participate to any extent in the industrial park associations or in the various maquiladora promotion groups. The predominant perception among managers of U.S. and European companies is that the Japanese are very closed and secretive. One manager of a large U.S. electronics firm who heads a group told this researcher with obvious chagrin of how hard he had worked to include Japanese managers in local functions. It seems that a dinner meeting at a local hotel was followed by a variety show which included a comic. None of the organizers knew his routine would include several assaultive "Japanese-bashing" type jokes which obviously were offensive to the Japanese contingent.

the realm of quality and continuous improvement involved talking to people and looking at processes and machines. Such a study presents certain challenges. When interviewing managers and other personnel, the researcher must assume that the individual answering actually knows the answer (or believe he or she knows it), is not lying or exaggerating, or is simply not responding in a way intended to satisfy the interviewer. After many interviews, it is hoped that one can grope closer to the "truth." Further, with each successive interview more knowledge is gained about contemporary concerns over continuous improvement and quality.

II. Quality and Continuous Improvement in the Maquiladora Industry: Some Selected Findings and Positive Trends

Table 4.1 shows the most noteworthy responses in terms of product and quality, and those which explore phenomena we most closely associate with continuous improvement. The following discussion refers to the subsidiaries of U.S. and European based firms.⁶ The Japanese portion of the sample will be discussed separately in Chapter 5.

⁶Of the European-based firms, only one manager interviewed was from Europe. While division managers were often European, individual plant managers were almost all from the U.S.

Table 4.1. Product and Quality			
Question	Possible Response	% of plants	# of plants
In terms of finished product quality, how does your plant compare with domestic operations of the parent company?	Much better Better About the same Worse	12 46 35 7	12 48 37 7
Does your plant use Statistical Process Control methods in production?	Yes No	78 21	82 22
Do you use statistical design of experiments (including Taguchi methods)?	Yes No	36 63	38 66
If you do use SPC, do you use it <u>more</u> , the same, or less than home plants?	More Same Less	47 38 15	39 31 12
In terms of conformity to specifications how does your plant compare with domestic operations of the parent company?	Better Same Worse	37 53 7.4	35 55 14

In Table 4.1 we refer to the following findings. First, where meaningful comparisons could be made between the output of maquiladora plants and sister plants in the firm's home country, 58% of the respondents answered that their finished product quality was higher than home country plants.⁷ All of the firms that admitted to having poorer

⁷It is important to stress that in the course of an interview the difference between responses such as "better" and "much better" was often a shrug of the shoulder or a nod of the head. Of course, it is impossible to quantify the difference between "better" and "much better." Often a plant manager would confidently assert that, for example, his plant utilized "JIT manufacturing." On the floor, the

quality were in the "start-up" phase (usually in production less than 18 months). Many managers were emphatic about their superior finished product quality relative to domestic operations. Several plant managers produced data measuring quality by various metrics (e.g. field failures, defects in parts per million, or "PPMs," reports from customers, etc.). Numerous maquila managers reported that customers showed a clear preference for their output over sister plants in the U.S. or Europe.⁸

One of the most renowned problem solving tools in the armamentarium of continuous improvement production is statistical process control, or SPC. Seventy-eight percent of the respondent firms said that they employ some form of SPC in their production. Many of the respondents were just beginning to implement SPC, while others were using it only in very specific applications. In such cases, most managers indicated an ongoing interest in spreading the application of SPC throughout the processes of their plant. Several

quality control or assurance manager would exclaim to the researcher that they were not using JIT. The responses herein reported are not testable data. However, after many plant tours, the researcher was able to develop a sense of what management was attempting, regardless of responses.

⁸Several maquiladora plant managers complain of poor quality coming from in-house suppliers in the U.S. One manager felt that the attitude in the north was that Mexico was "labor-intensive and cheap;" therefore, it was more acceptable to ship inferior inputs because they would be "cheaper and easier to fix" in Mexico. Some Mexican nationals who were interviewed acknowledged this attitude and stated bluntly that Mexicans in the maquiladora industry cared far more about quality than did the Americans.

plants were "SPC-intensive," with vigorous training of all employees and highly visible charting throughout the facility.⁹

Furthermore, 47% indicated that SPC is used to a greater extent in their plants than in domestic-based operations. Several managers insisted that given the Mexicans' willingness to learn, and the absence of aggressive unions (which in the U.S. have often viewed quality and continuous improvement programs as ways to eliminate workers), that it is easier to implement statistical methods in Mexico than in the U.S.

Thirty-six percent use statistical design of experimenting (DOX) to some extent in production. As with SPC, many plants are in the formative stages of implementation of DOX. However, it is impressive that so many maquiladora firms use this technique insofar as DOX is

⁹The author recalls being given a tour of a U.S. Big Three auto harness plant in Ciudad Chihuahua where the Mexican manager asked that any line operator be randomly chosen to explain the SPC charts on the line. An 18-year-old woman was chosen who very confidently and thoroughly explained the data collection and charting process and the meaning of the control limits, and the quality teams goals. All of the workers had been trained in SPC on the job. Other plants were aggressively pursuing statistical process control in areas besides direct production. For example, the personnel department in one plant was using SPC to chart such "defects" as turnover and absenteeism.

a more sophisticated tool than SPC and is of ostensibly less use in pure assembly than in other stages.¹⁰

Just in time manufacturing (JIT) is of intense interest among management in the maquiladora industry, as shown in Table 4.2.

Table 4.2. JIT Manufacturing			
Question	Possible Response	% of plants	# of plants
Do you currently use any form of JIT (Just In Time) manufacturing?	Yes	57	59
	No	43	45
If you currently use some form of JIT, does it include the "kanban system"?	Yes	59	35
	No	41	24
If you currently use some form of JIT, do you use more, less, or the same degree of JIT as compared with domestic operations of your parent company?	More	49	29
	Less	42	25
	Same	8	5
If you don't currently employ JIT, are you considering implementing it?	Yes	67	30
	No	33	15

Fifty-seven percent of those surveyed said that they used some form of JIT in their plants. Forty-nine percent of the respondents say that JIT is used more in their own plants than in similar domestic operations of their firm. Of those

¹⁰While beginning as assembly operations, several firms in this sample had developed into more fully integrated manufacturing plants. As would be expected, this group reported a much higher use of DOX (100%) than those plants strictly involved with assembly.

using JIT, 59% indicated that they use some form of kanban. The issue of JIT is interesting because it is quite clear that there is no consensus as to what "JIT" actually is. Some managers indicated that their plant was aggressively pursuing JIT, but on inspection of the floor one could see large amounts of work-in-process between machinery and stations. Often several weeks of inventory could be seen in the warehouse, further calling into question what some managers mean by "just-in-time manufacturing." It appears that many managers see attempts at reducing cycle times, inventory, work-in-process as synonymous with "JIT."

Attempts to implement various material "pull" systems, computerized MRP (Materials Requirements Planning) systems, and other methods are often referred to generically as "JIT." On the other hand, several firms are making sustained and rigorous efforts at comprehensive JIT. This is particularly the case in auto related plants and larger electronic plants. Computerized kanban cards with barcodes are read by hand-held wands, which then relay parts information instantaneously to vendors, are increasingly in use. These firms have relocated warehousing facilities closer to their plants and had been able to come close to "just-in-time" delivery of inputs. Often, cellular clusters of machines mixed with dedicated lines according to product,

were able to dramatically reduce or completely eliminate work-in-process inventories.¹¹

Respondents report great progress made in the previous five years on the metrics of scrap reduction rates, and defects as shown in Table 4.3. One hundred percent of the sample responded that they had reduced scrap and defects. Ninety-seven percent replied that they had reduced the rate of rework. Ninety-six percent indicated that they have significantly reduced work-in-process (which implies increased WIP runs) over the past five years. Over the same period lead times have been reduced for 95% of the sample.

¹¹The concept of "cellular" manufacturing is of great interest in the maquiladoras (some firms call this application "point-of-use manufacturing," or "group technology"). The original driving force for this approach was the reduction of lead times, but the method has yielded several positive externalities in terms of reduced defects, scrap, work-in-process, and overall quality control. The problem confronting many firms assembling auto parts, electronics, motors, pumps, and many other products, are the thousands of parts that go in various combinations into many customers' orders. Cellular manufacturing addresses this challenge by dividing part numbers into production families—not marketing families. A production family is a group of parts that follow basically the same flow path in production. This cell is really a mini-production line through which similar parts flow and given the tight proximity of machines in each cluster, obviates the need for containers, storage racks, and fork-lifts. Cell leaders are in charge of areas that were formerly fragmented among several shop managers. The leader and the work group can then be charged with the "ownership" of continuous improvements in quality, cost, delays, flexibility, worker skills, lead times, inventory performance, scrap, equipment "up time," and other metrics (see Schonberger, pp. 10-11).

Table 4.3. Cellular Manufacturing			
Question	Possible Response	% of plants	# of plants
During the last five years has your plant's rejection rate (the number of defects divided by total production) increased, decreased, or stayed the same?	Increased Stayed the same Decreased	0 0 100	0 0 104
During the past five years have lead times increased, decreased, or stayed the same?	Increased Decreased Stayed the same	0 95 5	0 99 5
In the past five years has the average amount of work-in-process (WIP) been:	Reduced Stayed the same Increased	96 4 0	100 4 0
During the past five years has the scrap rate been:	Reduced Stayed the same Increased	100 0 0	104 0 0

III. Transfers of Process and Product Improvements from the Maquiladora Industry

The survey, along with follow-up interviews, yielded some very interesting findings concerning the degree to which process and/or design improvements have been transferred from maquiladora plants to domestic plants within the same firms. A priori, one would expect to see most maquila plants as largely passive recipients of processes that can be "farmed-out" to cheap, labor-intensive operations. This remains true for a large number of plants. However, as shown in Table 4.4, 47% of the firms report that they have developed process or product improvements in their

own Mexican operations that have been transferred to home country domestic operations. In few cases did the author find management or technical personnel in Mexico engaging in radically different, pathbreaking process approaches to quality and continuous improvement. However, it appears that many managers are applying extant methods more rapidly and intensively than their own sister plants in either the U.S. or Europe. Of course, this phenomena flies in the face of the "cheap labor, low quality" stereotype. To a great extent Mexican personnel were the originators of these innovations and improvements. In 100% of the facilities where a Mexican national was the plant manager, transfers of process or product improvements were reported.

Table 4.4. Process/Product Improvements			
Question	Possible Response	% of plants	# of plants
Have any process improvements that originated in your plant been transferred to home company domestic operations?	Yes	47	49
	No	53	55
Have any product or design improvements ever been made in your plant that have been transferred to home company domestic operations?	Yes	19	20
	No	80	84
Are Mexican personnel involved in the design and implementation of new technology in the production process?	Yes	82	85
	No	18	19

In many cases, management indicated that the successful outcomes of experimentation with various approaches in their plant served as a model from which domestic plants copied. Several managers felt that their firm saw less risk to experimenting in maquiladora plants given the lower overhead and the absence of unions and older workers who resist change.¹² In many interviews, plant managers indicated that their plant had pioneered the outright use of, or certain applications of, SPC, including computerized "real time" on-line data collection, certain types of visual aids, kanban cards (often including barcode wands), various arrangements of cellular manufacturing and "pull" systems, and an overall attempt to implement JIT manufacturing. These successful efforts had the predictable effect of reducing work in process, material throughput, cycle times, and inventory and got the domestic headquarters' attention.

Many plant managers and engineers reported the development in their facilities of certain tools that worked

¹²Many managers in U.S. auto-related plants told of significant differences between the openness of Mexican workers to new techniques versus older U.S. workers in U.S.-based plants. Part of this may be attributable to the fact that much younger Mexican workers hold no preconceived ideas or preformed habits as to the "right way" of doing things. U.S. unions have often viewed quality and continuous improvement programs with suspicion. This suspicion has some grounds as several plant managers told the author that U.S. management was too often guilty of "speaking out of both sides of their mouths;" sometimes reducing the workforce or only paying superficial "lip service" to quality and continuous improvement programs. Clearly, such practices could effect workers' attitudes towards continuous improvement and quality.

so well that they were copied by other domestic plants within the firm. The major modification or outright invention of testing equipment is a common example. Other very common examples include the modification or creation of application equipment for paints, dyes, and the like; as well as the retrofitting and arrangement of equipment in new and effective ways, improvements in packaging, and recycling schemes, to name a few. The creativity of Mexican management, technical personnel and workers figured in most improvements.

In one plant, Mexican engineers were confronted by the need to bring incoming materials into the plant to accommodate a new "U-cell" arrangement on the floor.¹³ Existing equipment did not fit the new scheme so these engineers devised a completely new type of conveyor belt for materials. It took them three weeks at a total cost of \$1,500. Visitors from the company's headquarters in Virginia were impressed by the efficiency of the conveyor and decided that they would build one in the home plant. It took the Virginia plant four months to replicate the conveyor at a total cost of \$18,000. Another interesting example is the case of a U.S. auto harness plant producing for a U.S.-Japanese joint venture located in the U.S. The Mexican plant manager told the author that process

¹³"U cells" are a common way of arranging people and machines according to families of parts and tasks into self-contained, "U" shaped clusters of equipment.

improvements made in his plants had been studied intensively by the Japanese half of the parent for adoption in the U.S. plant as well as in Japanese-based plants.

Obviously, production in the maquiladoras represents direct cost advantages, given very low relative wage rates. With mature products that can be produced labor-intensively, cost savings can be prodigious. One manager related that in his plant, ten minimum wage workers (at the time, around fifty cents per hour unburdened, i.e., not including non-wage benefits such as free or subsidized meals, transportation, health care, education, savings programs and so forth) could produce 3,000 units of product per hour. In a related U.S.-based plant a three million dollar machine produced 1,800 units per hour, while being run by three employees whose average hourly wage is \$15.00. The manager of a plant whose parent firm is a large U.S. electronics firm reported that the average cost (or the "cost per standard hour") per three electric motors in his plant was \$17.00 per hour versus \$49 per hour for the same three motors in North Carolina. Clearly, cheap process improvements that increase quality and further cut costs in the maquiladoras widen this gap.

There are fewer cases of actual product or design improvements made in the maquilas which are transferred to domestic-based operations. This is because the majority of maquiladoras are still performing assembly operations.

However, even where plants are still assemblers, useful suggestions regarding product design and improvements have been made to parent companies. Several managers and engineers indicated that significant improvements had come from the analysis of data collected during the testing procedures of the product at various stages of assembly. Further, many maquiladora plants also ship final products directly to customers who have increasing contact with the maquiladoras. In fact, customer feedback is increasingly important to producers in Mexico.

There is a small but growing number of plants in Ciudad Juarez and Ciudad Chihuahua who are no longer technically maquiladora assembly-type operations. These plants began as pure assembly operations and gradually took on more integrated manufacturing tasks. In some cases, the success of Mexican maquiladora plants led firms to close U.S.-based manufacturing plants and move them to Juarez and Chihuahua and integrate the manufacturing process into the assembly plants. Several of these plants are complete "stand alone" manufacturing facilities with full manufacturing and design tasking. This group is much more involved with research and development and improvements in the product design. The use of CAD and CAM (Computer Aided Design, and Computer Aided Manufacturing, respectively) are in much greater use in these plants. In these plants programs to reduce the changeover times of dies are of major concern. Programs

inspired by Toyota's famous "Single Minute Exchange of Dies" (also referred to as "SMED") serve as common prototypes for managers and engineers in these plants. In all cases management felt they were behind in this area. One manager remarked that, "Our Single Minute Exchange of Dies is currently ten minutes." In all cases, Mexican engineering and technical personnel figured prominently in the design and development of products.¹⁴

IV. Continuing Challenges to Continuous Improvement and Quality

We have reviewed several sets of responses to surveys and interviews that indicate positive trends with respect to quality and continuous improvement in the maquiladora industry. These have been achieved largely in spite of the previously discussed obstacles to continuous improvement production in Mexico. However, these hindrances have not been entirely overcome and continue to represent barriers to the implementation of continuous improvement and quality

¹⁴While most managers of maquiladoras felt that Mexican engineers and technicians were not quite up to par with their U.S. or European counterparts, managers of more integrated manufacturing firms reported uniformly high satisfaction with Mexican personnel. This is curious as the demands placed on engineers in a full manufacturing environment would appear more rigorous than in passive assembly operations. There may be better trained engineers who work for fully integrated manufacturing operations, perhaps with more experience and having attended better schools in the U.S.A. and Mexico. Perhaps the exigencies facing engineers in manufacturing plants are more challenging and "bring out the best" in engineers. Mexicans are involved at all levels of design and product improvement in these plants.

systems in Mexico. Before addressing these issues, it is critical to note that it is the role of the plant management and the overall support of management at the highest levels that appear to be the strategic variable in all approaches to production in Mexico.

The three issues of worker turnover,¹⁵ youthful workers, and low wages are all interrelated and all bear an impact on managerial approaches to quality and continuous improvement. Low minimum wages are maintained in part by Mexican legislation and collective preference on the part of the maquiladora industry to lure labor through non-wage competition, in the form of free or subsidized meals, transportation, and so forth. Given that entry level direct workers are confronted with an almost uniform wage, much turnover will be prompted by changes in benefits. Further, the very youth of many workers implies greater instability and transience. In border regions, the ubiquitous appeal of work in the U.S. increases turnover.

¹⁵At the time this study was conducted, the majority of plants were seeing turnover on the line of over 5 percent per month. Rates in excess of 10 percent per month were not uncommon. Turnover was significantly lower in Ciudad Chihuahua than in Ciudad Juarez. This is most likely due to the fact that the majority of direct workers in and around Chihuahua are from the region; whereas, in Ciudad Juarez a good portion of workers are from regions in the interior and migrate back during holidays, harvests, etc. The border locations also see higher attrition due to the proximity of the U.S. border with its lure of jobs (albeit low-paying and most often illegal).

As discussed in Chapter 2, shared information, collective group goals, and cross-functionalism are characteristic of the most successful Continuous Improvement Firms. Work groups, such as quality circles have often been an expression of continuous improvement activity on the shop floor. In the maquiladora industry, turnover is the major reason given by plant managers for the failure or slow start of groups such as quality circles.¹⁶ Table 4.5 contains information about these issues.

Several managers reported that they felt that quality circle-type groups had merit. However, given the rate of turnover, the groups had little longevity and management did not feel that they justified the time required. This had caused several plants to respond by scaling down groups to ad hoc gatherings designed to address issues as they arose, or their complete abandonment. The great majority of managers indicated that groups in their plants were conducted by line supervisors sometimes with other technical staff, because turnover greatly reduced the possibility for worker autonomy within the group.

¹⁶No one in this sample uses the term "quality circles." There are several different names, such as quality assurance teams, quality deployment teams, zero defect groups, and many more.

Table 4.5. Continuous Improvement			
Question	Possible Response	% of plants	# of plants
Do you employ some form of quality circles?	Yes	52	54
	No	48	40
Does your company have a formal employee suggestion system (in the form of a suggestion box or some other mechanism)?	Yes	42	44
	No	57	60
Are line employees encouraged to offer suggestions concerning the more efficient use of worker organization?	Yes	47	51
	No	51	53
Are line employees encouraged to offer suggestions as to the more efficient use of equipment?	Yes	68	71
	No	32	33
What is your estimated monthly direct labor turnover rate?	0-2%	10	11
	3-5%	23	24
	6-9%	41	54
	10% and over	14	15

In fact, high turnover seemed to be viewed by some managers as proof that Mexicans had little loyalty to either their employer or fellow workers. This was seen as a further reason to back away from group creation.¹⁷ While 52% of the respondents said that they employed "some form of

¹⁷The author was told by several managers that their parent companies had backed away from quality circles in domestic plants. The reasons for this are unclear, but it may have to do with firms jumping on the "Quality Bandwagon" and implementing programs that "are supposed to increase quality." Perhaps, when management realized that such efforts involved sustained, sincere effort on their part without immediate results for the quarterly financial statements, such activity lost its luster.

quality circles," these were most often groups conducted by supervisors, often with engineers, in which workers were directed in a "top-down" fashion rather than ideas arising from the bottom-up. While many managers responded affirmatively to questions concerning employee suggestions, the involvement of employees in the use of equipment, worker organization, and the absorption of new technology, it became clear that employee involvement in the process of improvement was often minimal.

Several managers stated that because of high turnover they avoided the cross-training of line workers. This was seen as too costly an investment in time for employees whose tenure was so uncertain. Instead, these managers had broken down the production process to an irreducible minimum series of repetitious steps. In this view, turnover is an exogenous phenomenon whose impact can be reduced by simplifying and routinizing procedures so that the neophyte just off the street can be trained very rapidly. Clearly, such a response militates against trans- and cross-functionalism on the shop floor, and works against the dynamic of continuous improvement. To managers who see turnover in Mexico as inexorable, such a response involves necessary costs, foremost among them, the process of continuous improvement.

A smaller group of managers felt that such a tack actually increased turnover by making work more boring and

repetitious. This group recognized that many factors influence turnover that are beyond their control, but felt that much could be done inside the plant to reduce turnover and retain employees.¹⁸ For those holding this minority view, carefully constructed work groups, including quality-related groups, actually aided in the reduction of turnover and increased employee participation in the process of improvement. It is believed that turnover can be reduced by making tasks more involved and interesting. Giving workers "ownership" or greater responsibility for their part of the process, as in the case of cellular manufacturing, enhances the sense of worker self-esteem and naturally elicits valuable input from line employees. Several managers who hold this view see Mexicans as culturally predisposed towards group work. We shall address different managerial approaches later.

The main factor which has made the maquiladora industry so attractive has actually impeded the progress of quality and continuous improvement in many plants. That factor is low wages. A usual practice for many firms has been to "throw" cheap labor at production. It seems that abundant, cheap labor has allowed many managers to postpone

¹⁸Some common reasons for turnover, such as benefits competition among plants, youth, proximity to the U.S.A., and seasonal migration have been cited. The location of plants and their proximity to bus lines are also a function of turnover. Employees, when confronted by identical wages, will often work in a location that is closer to home.

preoccupation with quality and continuous improvement.

Sixty-three percent of the respondents replied that they use more direct employees as quality inspectors than comparable operations in their home country. In short, many managers admit to "over-inspecting." This has been a direct function of the cost of labor in Mexico. However, everyone reported that the number of inspectors had been decreasing steadily in their plants. Several managers strongly insisted that full scale efforts were underway to continue this trend with the eventual target being the complete elimination of all inspectors. That inspection is declining is evidenced by falling scrap and rework rates. However, it is quite clear that management in the Mexican maquiladora industry has in the past relied heavily on cheap labor in the capacity of inspectors to "inspect-out" problems before the product is shipped.

Experienced maquiladora managers admitted that in the early years of assembly in Mexico, their firms often experienced massive problems with quality. This author was told repeatedly by managers that in the "early days" (for most firms from the late 1960s through the mid-1970s) maquiladora plants acquired a reputation for poor quality. The first reaction was to apply more inspectors to catch defective products. Most managers who had read Deming, Juran, Ishikawa, and the other major contributors to the literature of continuous improvement and quality, realized

that this reaction was a crutch that did not address underlying structural problems within the production process. However, adding more inspection was a cheap, quick fix for many managers that became a way of life in Mexico.¹⁹

However, some managers still seem to confuse cheap labor and the ability to build layers of inspection systems as synonymous with "total quality." On several plant tours managers proudly pointed out redundant quality systems and successive stages of inspection. These quite predictably catch most problems before leaving the plant, but ignore the flaws in the process which allow defects and problems to occur in the first place. Not surprisingly, this group of managers seems to be relatively unbothered by rework and scrap rates, citing instead, a variety of cost indices including "cost of quality" as evidence of superior plant performance. Those plants where management is assiduously trying to build quality in, rather than inspect poor quality out, see inspection as a dangerous addiction from which the process must be weaned. This latter group emphasizes quality training and is moving away from inspection into different measure such as "quality audits." While assuming different forms, quality audits involve roving inspections

¹⁹The phenomenon of "over-inspection" presents findings based on comparisons of "finished product quality" in a new light. It is clear that high levels of quality do not necessarily imply that the organization is engaged in the continuous improvement of the process. Rather, low wage inspectors can be an expedient way of treating the symptoms of faulty systems and processes.

of entire sections of processes, versus final or in-stage inspection of the product itself.

Only 26% of the plants have a formal quality department. At first blush, this appears positive given that a separate quality department is often taken as proof that management has relegated "quality" to a subordinate, compartmentalized silo. However, while it may not be evident from organization charts, interviews revealed that in many plants where there is no formal quality department, the quality control (QC), or quality assurance (QA) manager becomes invested with all the trappings of a "walking quality department." He (in a few cases she) is charged with total responsibility by plant managers with quality control and systems. Many plant managers have clearly relegated all issues of "quality" and "continuous improvement" to these subordinates. Such delegation of responsibility is considered inappropriate for a continuous improvement firm.

In the course of several interviews with plant managers, when questions about SPC, quality-related issues, or inspection would arise, the manager would state that that wasn't "his area." He would then pick up the phone to get the QC or QA manager into his office to answer the question. When speaking with QC and QA managers, it became clear that there existed a great gap between the plant manager's view of reality (with respect to quality and continuous

improvement) and the QC or QA manager's view. In several cases, it was very evident that the plant manager was conversant with only the most basic issues of quality and continuous improvement. In five or six interviews with plant managers it was obvious that the manager was ill-informed or completely unaware of certain approaches to quality. Of that small group, most did not seem to recognize the term "SPC," or "statistical process control." None had heard of statistical design of experiments, Taguchi methods, Single Minute Exchange of Dies (SMED), kanban, andon, or other widely used terms. As one might guess, this group relied heavily on inspection and rework and seemed more concerned about quantitative output and costs of production. While this group was a small minority, a larger group of managers still seemed more comfortable with delegating a large amount of planning and implementation of quality programs to QC and QA managers.

Several firms are shifting from the concept of "quality control" to "quality assurance." The idea is that the old QC function was more concerned with the role of inspection, reducing defects and so forth. Quality assurance is more about building better production systems that build quality into products through the process. Managers of Quality Assurance departments have stressed improvement and better quality through a systems approach. Systems of successive verification along the assembly line, quality audits (where

entire elements of processes are examined versus inspection of the product), 100% quarantines for new products, the implementation of cellular concepts, and other newer ideas often fall under the responsibility of the Quality Assurance manager. Increasingly, the Quality Assurance manager operates independently of the plant manager with a mandate to improve systems of quality and continuous improvement. However, to the extent that plant managers are not on the "same page" with their fellow QC or QA managers, we must be skeptical of highly visible company mission statements, posters, and other written and verbal exhortations concerning quality and continuous improvement. In short, many plant managers still relegate "quality" and "continuous improvement" to those below them. This schismatic approach merely reinforces the view of quality as another subordinate task.

Maquiladora plant managers report that they have increased the amount of training for line employees. This training stresses quality, and as shown in Table 4.6 in 27% of the plants surveyed, initial training includes introduction to some form of SPC. Often, at the beginning level, the new employee is given very basic exposure to attribute charts and elemental concepts such as variation and process control.

Table 4.6. Training Programs			
Question	Possible Response	% of plants	# of plants
Do you provide training before putting new line employees to work?	Yes	90	94
	No	10	10
If you train line employees before they start to work, does the training program stress quality?	Yes	87	82
	No	13	12
If you train line employees before they begin to work, does the training include instruction in SPC?	Yes	27	22
	No	73	60
If you train line employees before they begin to work does the training include instruction in Statistical design of experiments or Taguchi methods?	Yes	0	0
	No	100	82

As stated, many managers have responded to turnover by simplifying work tasks. Even with simple tasks, management is often confronted by a level of experience and education that is so low that plants must intensively train line employees. In the growing number of firms that are adopting cellular-type production lines where workers are often responsible for several machines and tasks, this training mandate increases.²⁰ For the entry level worker, management

²⁰It must be stressed that in most plants at least a third of all new hires "off the street" have never been in a manufacturing plant before. Often, young women and men from agrarian backgrounds have had little or no experience with the most rudimentary of machines and tools. In addition, training often is charged with the familiarization of new employees with scheduling time, communication skills, and the like. Housekeeping in the plant is also stressed. In

reports that their training begins at a more basic level and assumes less about the individual than do their sister plants in the U.S. or Europe.

A tour through a maquiladora plant quickly reveals the presence of visual aids in all aspects of the production process. Many of these aids are large, easily understandable illustrations of very simple tasks. Others are various types of highly detailed control charts, or progress charts showing group or individual goals and performance on a variety of metrics.²¹ Most managers tend to see the profusion of visual aids in their plants as necessary to maintain control of the process given such a young, inexperienced workforce. Most managers state that they use more visual aids in their Mexican plants than related plants in the home country. In some plants there is vast display of visual aids leading one to wonder if there exists a point beyond which employees begin to "tune out." A few plant managers and quality managers indicated concern about this and said that they had reduced the amount of aids to prevent just such an occurrence.

many plants, training deals with many aspects of the employee's personal life including health, sex education and birth control, and personal hygiene.

²¹Even where plants are unionized in Mexico, there seems to be no proscription against the public posting of individual performance charts (on defects, output, etc.) on the line. The author was told that in unionized plants in the U.S.A. this would be strictly forbidden.

Another area that is stressed by managers in the maquiladoras is the need for intensive documentation and verification of plans and procedures. Many non-Mexican managers felt that due to language and cultural problems with their Mexican support staff, it was necessary to carefully "spell things out" and constantly follow-up with redundant verification systems and several stages of documentation. Many U.S. managers felt that Mexican personnel were eager to please and would often "sugarcoat" or gloss over problems when reporting to their boss.

Several plant managers and U.S. quality managers made statements such as "Mexicans don't like to give their boss bad news." The liberal use of documentation and verification is seen by plant management as a way of monitoring the execution of plans and procedures. It is felt that such an approach offers greater structure within which Mexican personnel can operate. It was a common opinion on the part of non-Mexican plant managers that Mexicans were not culturally inclined to working autonomously and were more productive in a structured environment.²² Systemized verification and documentation was seen as a way of maintaining structure. Most managers

²²This does not mean that managers ascribe to stereotypes of "lazy" Mexicans. Quite the contrary, U.S. managers were overwhelmingly full of praise for the work ethic and discipline of their employees. Many of them felt that their Mexican technical and line workers, while less experienced, were actually better workers than U.S. employees in U.S. plants.

believed that they used more intensive documentation and verification-related paper work than U.S.- or European-based plants.

In sum, while the management of U.S. and European plants in the maquiladora industry have to struggle to overcome the infrastructural, geographical and demographic obstacles they face while operating in the maquiladora industry, many have still managed to attain impressive levels of quality. In some cases, plants have implemented more comprehensive quality and continuous improvement systems than older U.S.- or European-based sister plants. The industry has attracted much attention in the broader media as a location for cheap production. Little has been said about quality coming out of Mexican plants.

Such reticence on the part of industry representatives might seem strange. However, in an era of plant closings in the U.S., widely publicized movements to Mexico, and pending negotiations of a North American Free Trade Agreement (NAFTA), any statements to the effect that maquiladoras "do it cheaper and better" could provide additional unwelcome publicity. The CEO of a U.S. auto company publicly praised the quality of his company's upholstery plant in Ciudad Juarez and immediately found himself besieged by rumors (which were untrue) that he was planning on closing the related plant in Detroit.

Several plant managers felt that the relative success of their facilities had caused some tension with U.S. plant managers within their own divisions. Maquila plant managers had been told by their U.S. counterparts that they had an unfair advantage in implementing quality and continuous improvement systems given the lack of unions in their plants. Other managers reported that there still existed a bemused condescension on the part of fellow managers in the U.S. Such condescension was not limited to management, however. A quality team of Mexican line workers and supervisors had gone to a parent plant in the U.S. to compare notes and learn more about approaches to quality. The team leader told this author that the group had gone with great preparation and enthusiasm and were shocked to find that their presence was greeted with hostility by American workers who saw the Mexicans as a threat to their jobs. They were largely ignored and several racial epithets were hurled at them. The leader told the author with sad indignation: "Our workers are trained in SPC [U.S. workers in the plant the Mexican group visited were not] and we have higher quality in this plant. I thought the gringos liked competition." One can only wonder what such a response by American workers says about the state of worker-management relations in that and many firms.

Not all representatives of U.S. firms are silent or defensive about superior performance of subsidiaries in

Mexico. In the summer of 1991 during an interview on Ted Koppell's ABC News Nightline, Robert Stoempel, CEO of General Motors responded to a question about Mexican operations by saying that he felt that Packard Electric's (GM's autoharness division) Mexican operations were truly "world class." His reaction is still the exception among leaders of U.S. industry, but is a frank admission of progress being made in Mexican operations.

V. Turning Obstacles Into Advantages in the Maquiladora Industry

In sum, we see that management in the Mexican maquiladora industry is confronted by significant challenges to production. High rates of employee turnover present difficulties for training, the implementation and continuation of quality programs and quality circles, skill development, and other facets of production. Another of the challenges facing assembly operations in Mexico is the relatively low levels of experience and formal education of the very young labor force. The majority of direct line employees are between 16 and 22 years of age; and while the rapid growth of maquiladora activity in Ciudad Juarez has generated a labor pool that has increasing assembly line experience, about a third of all hires off the street have never set foot in a plant before.

Further, the majority of workers never attain the equivalent of a high school education. Many new hires,

particularly those from agrarian backgrounds, have had little experience with the "culture of the clock," or with basic tools. At first blush, concepts such as efficiency, quality, and improvement might seem foreign to young workers with little formal education from rural Mexico. U.S., European, and Japanese managers in the maquiladora industry often cannot rely on the same store of experience on the shop floor in maquilas that they have in home country plants. In addition, Mexican engineering and technical personnel most often do not have levels of training and experience comparable to their U.S., European, or Japanese counterparts.

Another possible impediment to continuous improvement manufacturing and quality programs is the actual location of the plants themselves. First, problems (particularly in busy border locations such as Ciudad Juarez and Tijuana) of overstressed infrastructure have been well documented. In the desert regions of Ciudad Juarez and Ciudad Chihuahua, inadequate drainage can cause flash flooding that effectively stops traffic to and from the plants. International bridges between the U.S. and Mexico are heavily congested with trucks travelling to and from maquiladora plants. Shipments are further slowed by customs

paperwork at border crossings and random drug searches of northbound rigs.²³

Such problems clearly militate against the effective implementation of JIT manufacturing. Many managers indicated that traffic problems on bridges made true JIT impossible. Several stockpiled inventory and then "pulled" material as needed, attempting to simulate JIT. Of course, the ability to obtain materials (a practice referred to as "sourcing" in the industry vernacular) from suppliers within Mexico would circumvent the problems inherent in transshipment across the international boundary. However, very few managers reported being able to satisfactorily procure inputs for their products in Mexico.

Experience with Mexican suppliers has largely proven unsatisfactory in terms of price, quality, and delivery. However, the greatest problem that managers in the maquiladora industry report about Mexican sources is that they simply do not exist. Further, management in the maquiladora industry face problems similar to those of any transnational enterprise. North American, European, and Japanese managers all face language and cultural barriers in dealing with Mexican nationals. Further, the geographical

²³This latter point has become a serious irritant between organizations such as the U.S. Drug Enforcement Agency and businessmen in Ciudad Juarez. The author was told that any product destroyed or unpacked (and requiring rearrangement) was not the responsibility of the drug authorities. Stories of long delays and shipments effectively ruined are not uncommon.

distance of many of the plants to home headquarters, even in the age of instantaneous communications, is seen by some as a disadvantage for the implementation of corporate systems of quality control and continuous improvement. However, despite these obstacles, maquiladora plants have made significant progress. In the hypotheses that follow, it will be argued that what appear as impediments have actually had the unforeseen effect of greatly improving the performance of these plants.

Hypothesis 1: "Continuous Improvement Or Else"

As reported earlier, respondents who had been operating in Mexico for several years recounted massive problems with quality from the early days of production. While firms often allow a certain amount of "slack" during the early start-up phase of an assembly plant, it is expected that with experience the operation will improve. In Mexico, the problems often persisted. Many blamed this on the aforementioned rate of turnover of line workers, levels of experience and education among line workers, relatively low levels of technical education and experience among Mexican engineering and technical personnel, infrastructural problems in Mexico, a dearth of Mexican suppliers, and geographical distance from headquarters support and domestic suppliers, to name some of the more widely cited problems. In short, managers were confronted by a variety of obstacles in a foreign environment.

While managerial responses have varied among the most successful maquiladora plants, there are elements common to most firms.²⁴ Managers in a Mexican assembly plant could not avoid major quality and production "snafus" without constant, intense attention to detail. Given low levels of education and experience among employees in these plants, managers were forced to get "back to the basics." The manager in a comparable plant in the United States had a much more experienced workforce and could often assume that everything was "under control" down on the floor. Managers in maquila plants in Juarez and Chihuahua could assume very little about what was going on in his plant.

In Mexico, managers have responded by implementing intensive systems of checking, rechecking, and documentation. Training started at a much more basic level, but often lasted longer and covered more comprehensive topics than in the U.S. Quality became increasingly stressed in every phase of training. Visual aids were introduced to a far greater degree in Mexican plants than in the U.S. or Europe. At first, such visual aids portrayed the most rudimentary of operations. Eventually, visual aids evolved into all manner of SPC charts, fishbone diagrams, and comparisons of individual and group performance, along with a variety of metrics including measure of quality and

²⁴It should be noted that several firms have tried and failed in the Mexican maquiladora industry. Most people in the industry attributed these failures to poor management.

continuous improvement. The successful American plant had to work hard to develop a cadre of Mexican support personnel and to mold his complement of people and tools in such a way as to overcome obstacles and meet or exceed his goals. Perhaps by necessity more than choice, this manager began to more closely resemble the "hands-on" ideal of Deming and other writers who order managers out of their offices and onto the floor.

This intense managerial effort, when combined with a young, flexible, and increasingly skilled workforce, has allowed several Mexican maquiladora plants to "leapfrog" much more established plants having more experienced workers and newer, more sophisticated capital equipment in the U.S. Once this atmosphere of improvement is well established in the maquiladora plant, it appears easier to continually implement new approaches to continuous improvement and quality in Mexico. The example of more successful plants in the Mexican maquiladora industry may provide lessons for related operations in the U.S. Perhaps management in the U.S. needs to get "back on the floor" and "return to basics." Many U.S. managers interviewed in Mexico said they would refuse to return to the States to run a plant. While they blamed unions and poor work habits among labor, they didn't let management off the hook. One multiplant regional manager of a U.S. auto company told the author: "We managers have been talking out of both sides of our faces for a long

time now. The conditions in U.S. operations are a direct reflection of disconnected management." At the plant level in the maquiladora industry, management can only succeed if it connects at very basic levels. Perhaps management in the U.S. needs to re-connect with their people and their processes.

Hypothesis 2: Relocating Is Rethinking

Another possible reason for increased quality in the maquiladora sector is the simple notion that the act of tearing down an entire operation, moving it, and putting it back together can cause management to reexamine the way that they have been doing things. Many managers who had been involved with plant moved from the U.S. to Mexico have reported that many old practices were jettisoned after relocating. Often, they still had the same equipment but they had completely revamped their processes after the move.

This may seem to contradict the previous observation that early arrivals to the maquiladora industry experienced significant quality problems. This might be due to a prevalent attitude of the time (the late 1960's through the 1970's) that was expressed in an approach that emphasized production targets over quality. However, the exigencies of international competitiveness have shifted the ground to a philosophy that states: "We must build quality from the start." Indeed, given the costs to firms for passing on poor quality to customers, there are no other options.

Moving operations induced changes in practices and also aided firms who moved into newer buildings. Often companies left old buildings in the U.S. to move into brand new assembly facilities in industrial parks in and around Ciudad Juarez and Ciudad Chihuahua. These buildings often offered superior lighting, ventilation, and office space.

Hypothesis 3: Maquiladoras as a Quality Frontier

The maquiladora industry represents a "frontier" phenomenon in the sense that Clarence Ayres used the term.²⁵ Frontiers are places, according to Ayres, where migrants are less constrained by an entire range of cultural and societal impediments. In the case of U.S. maquiladoras, they bring to Mexico their tools and materials, as well as a host of cultural beliefs and folkviews. They leave behind them institutions and managerial systems that are often mired in the past and highly resistant to change.

In the maquiladora industry we find a loose, frontier-type environment which combines a young, flexible labor force that is not only eager to emulate these imported ways of doing things, but also has few preconceived ideas as to how things "used" to be done. The daily challenges of operating in Mexico demand greater flexibility in planning and more "hands-on" management. There is also a greater opportunity to experiment. As indicated previously, several

²⁵See Ayres' The Theory of Economic Progress especially Chapter 7.

managers reported that their States-based headquarters operations were quite ignorant of Mexican operations. While this can mean a lack of critical support at top levels of the organization, it can also mean that management in the maquiladora plant has more leeway to experiment and try new arrangements. At least half of the respondents who reported higher quality in their plants than comparable plants in the U.S. said that implementing systems was easier in Mexico because of the distance from headquarters operations. In addition to unions, U.S. management itself is seen as a major impediment to the implementation of new quality and continuous improvement systems in U.S. plants. Many managers in plants in Mexico felt they had more freedom because of their distance from home operations.

Hypothesis 4: Mexican Labor is Very Good Labor

Overwhelmingly, managers of U.S. and European subsidiaries were very impressed by the pride and work ethic of Mexican direct workers.²⁶ As mentioned before, high turnover confuses many managers. It seems strange that a very hard working, conscientious line employee can one day disappear without a word.²⁷ Turnover aside, the majority of

²⁶There is a small minority who tend to view Mexicans according to more negative stereotypes (e.g., "lazy," "Slovenly," unmotivated by money, etc.). This group also sees turnover as proof positive of disloyalty.

²⁷Regarding turnover, one manager hit the mark when he observed: "Look, the wages and benefits are pretty much the same everywhere. If you get bored or ticked off you can always walk out the front door and across the street [this

managers report a high degree of satisfaction with Mexican direct labor. In the course of over 100 plant tours, the author did not encounter a single "sweatshop" operation; however, the work in Maquiladora plants is often incredibly tedious, exacting, and mindlessly repetitive. In some plants, ventilation can be poor and fumes can be very bad. It is likely that many of these operations would not meet U.S. safety and health standards.

The typical workday is 9 hours, with the typical week being a minimum of 45 hours. As of mid-1991, the starting minimum wage fell just shy of \$4.00 per day. This is not enough money to allow one person to survive; employees often live in communal lodging without the most basic of amenities. Workers often have to negotiate a patchwork of bus lines in order to get to work. Yet most workers arrive on time, are clean and well-kempt, and display an attitude of cooperation without overt signs of dissatisfaction. No manager reported any acts of sabotage that have been seen in some U.S. plants. While there has been a history of militant unionism in Matamoros, this has not occurred in Ciudad Juarez or Ciudad Chihuahua.

Whether the quality of Mexican labor is a function of a "hungrier" labor force in a developing country, or a culture that teaches obedience to authority (particularly for

was easier prior to the recession] and they'll hire you. If this was the situation in the U.S. you'd have high turnover there, too."

women), or some combination, is difficult to say. The fact remains that Mexican labor remains very cheap and very good. Several U.S. managers expressed that they prefer Mexican labor to U.S. because of their work ethic and diligence.

Hypothesis 5: Quality as a "New Idea"

Significant obstacles to the implementation of quality and continuous improvement systems in the maquiladora industry exist in the form of turnover, low levels of education and experience of line workers, and lower levels of technical training and experience among engineering and technical personnel. Despite these apparent hurdles, several managers report what they see as an advantage of Mexican workers over U.S. and European counterparts: Mexican workers have had no experience with past "stop and go" quality programs.

Many managers report a very cynical attitude on the part of U.S. labor to new programs concerning quality and continuous improvement. Part of this is a resistance to change on the part of older workers, particularly as it may relate to learning basic statistical techniques or working in a more team-oriented approach. Part of this cynicism is framed by suspicion in U.S. plants (often in union shops) that "quality" programs are designed to eliminate jobs.

But a large part of this attitude on the part of U.S. labor, according to managers with experience in U.S. plants is that they've "heard it all before." Many managers

recounted the introduction of quality and continuous improvement programs that were unveiled with great pomp and flourish, only to slowly ebb in the face of managerial sclerosis. Other programs were stillborn, talked about endlessly but never seriously pursued. Over time workers began to apply a deep discount to all new quality programs. The behavior of management indicated a continued lack of commitment. However, in the maquiladora industry, managers deal with a labor force who more naturally accept a focus on quality of continuous improvement without reservation. They have simply not been jaded by past campaigns that ended in failure.

Hypothesis 6: "Chica Nada" and the Mexican Cult of Quality

As mentioned earlier in this chapter, many plant managers of U.S. and European subsidiaries report a tremendous amount of creativity and problem-solving ability among Mexicans. This is said to be particularly true among engineers and technical personnel. U.S. plant managers are often very impressed by simple, but creative solutions and improvements made by their Mexican staff. Many cautioned that this creativity should be properly channeled, as it could degenerate into a hodgepodge of "jerry-rigged" approaches to production. However, with direction this creative energy is potent.

This phenomenon is known in Mexican Spanish as "chica nada," which can be roughly translated as "jerry-rigging."

Mexican managers acknowledge this widespread and informal type of improvement with evident pride and not a little bemusement. In processes that require consistency and the strict reduction of variation, this kind of problem-solving may seem of little use. But the ability to come up with quick, clever, and cheap solutions using simple tools and techniques can yield great returns in an atmosphere that is conducive to continuous improvement. Such ability is undoubtedly present in less developed countries (and underdeveloped regions of the U.S.) where individuals need low-cost, creative solutions to keep old cars running, and survive with few resources. Much of the economic activity seen in the "informal sector" of economic development literature is contingent on cheap, effective solutions that are not capital-intensive.

Further, the author found a very fervent commitment to quality and continuous improvement among Mexican engineers and quality managers in the maquiladora industry. This group is overwhelmingly young (under 40) and have eagerly read and studied the major works of Deming, Juran, Ishikawa, Imai and others (most of which are available in Spanish). In fact, this group evinces a more passionate interest in continuous improvement than any other group. In several cases, Mexicans working for U.S. subsidiaries reported frustration with senior American managers who they felt had antiquated ideas and were impediments to quality and

continuous improvement. In those firms that have tapped into this eagerness and commitment (particularly by placing a Mexican as plant manager) the results have been impressive.

VI. Management and Culture in Mexico

The role of the manager at the plant level is the crucial, independent variable in the execution and success of systems of quality and continuous improvement. It is the individual manager's vision, commitment, knowledge, and mien that ultimately set the direction for success or failure at the individual plant level. After touring over 100 maquiladora plants, the impact of a directed and successful manager became clear. Of course, management styles are as varied as personality. Some managers appear to be quite effective working intensely with subordinates who then carry out plans with great effort. Others are constantly on the floor, actively involved with subordinates and "hands-on" at various stages of the process.

Managerial style appears to be colored by the individual's perception of Mexicans and Mexico.²⁸ The individual manager's ability and desire to understand his

²⁸As mentioned, the great majority of plant managers in this study were natives of the United States. Mexican managers were the next most numerous group, followed by Japanese managers, and one manager from Europe (the Netherlands). Two of the U.S. managers were naturalized citizens having come from El Salvador and Cuba, respectively. Several managers of American firms were Mexican-Americans.

Mexican employees, their language and their culture might influence his ability to implement quality and continuous systems. Based on interviews (with managers and often with subordinates), it may be possible to identify three very general "types" of managers operating in the maquiladora industry of Mexico. These are simplistic archetypes, and some managers may exhibit characteristics of more than one type. Although simplistic, they point to very real managerial styles in the maquiladora industry.²⁹ Our three very general types of managers are: the "Universalists," the "Relativists," and the "Hybrids." The Universalist manager tends to make statements such as: "Sound management is sound management. I don't care where you are. I don't do anything differently in this plant than I did in Milwaukee." There is variation in terms of individual managerial behavior within this group. Some plant managers may rarely venture forth from their offices, preferring to "rule" in Taylorist fashion through highly disciplined subordinates. Others may be highly energetic, "hands-on," conciliators who see effective management best exercised through deep involvement with their employees.

²⁹These are derived from contact with U.S. managers. There was only one European, and as stated, the author was unable to get beyond a very formal level with Japanese personnel. However, while the Japanese seemed ill at ease describing themselves, or their own managerial style; their Mexican subordinates characterize this as clannish, aloof and demanding. Nonetheless, the author does not have a basis about which to generalize with the Japanese management.

Universalists share a common conviction that what works for them elsewhere, works in Mexico as well. In the case of turnover (which is undeniably different in Mexico as compared to the United States), this group may treat it as an exogenous parameter to their operations and to manage in the same manner as they would back home.

At the other end of the spectrum are the "Relativists." Relativist managers make the following kind of statements: "Managing down here is a different ball of wax. These are different people, with a different language and culture. You need a different way of operating here or you'll go down the drain." As with all of these categories, there is variation within each group. Relativists can react to a common challenge such as turnover on the line in very different ways.³⁰ Some Relativists may believe that "Mexicans have no loyalty to their employer." This group of managers break down the process to the minimum number of steps per operator. If an employee leaves without warning, he or she can be quickly replaced by a new employee who has no previous experience. Other Relativists may argue that "Mexicans need the warmth and support of groups." This group of managers may respond to high turnover by attempting to create a nurturant "family-type" atmosphere in the plant

³⁰In fact, the word "turnover" represents kind of verbal "Rorschach" for managers in the maquiladora industry. In response to questions about turnover, managers often project much of their managerial philosophy and ideas about workers and work, Mexicans, and Mexico in general.

with more emphasis on work teams and greater responsibility for each worker. Relativists share a common belief that operating in Mexico is fundamentally different than in the U.S.

The third group we can call the "Hybrids." This group represents a "middle path" that would likely agree with the following propositions: "There are certain universal principles of management required to get a lot of people interested in increasing quality and continuously improving products and processes. These principles can be adopted in Mexico provided that management has developed the requisite knowledge and sensitivity about the Mexican people, their language and their culture. These are important things and they do make a difference." As with the Universalists and Relativists, there is great variation within this group.

As stated, these groupings are necessarily simplistic, but are useful for viewing certain managerial approaches. Universalists and Relativists, while in many ways opposites, both display "cultural" problems. The Universalists, by largely denying the impact of cultural differences between North Americans and Mexicans in terms of world view, personal relationships, and language, are most likely to commit errors in these areas. The Universalist group is the least likely to study Spanish or attempt it at work. He is likely to communicate with Mexican subordinates as he would an American in the U.S. He may see himself as an

egalitarian type of manager who prefers an informal and fraternal form of management. Or, he may be the "field commander" who issues orders and demands results. He sees himself as a strong leader and action-oriented. In either case, he would behave this way in Taiwan, the U.S., or Mexico.³¹

Universalists believe that people are motivated by incentives that are largely invariant across geography and culture. For those holding this view, high turnover can be confounding. If people are treated well, they "should not" disappear. With years of experience in the industry, most managers move toward the Relativist or Hybrid camp.

Relativists, on the other hand, often display a certain fatalism about operating in Mexico. This group often sees the phenomenon of turnover as an unavoidable reality. While conceding that social and economic conditions (e.g., wages, youth of workers, transportation) influence turnover, they may hold cultural views of Mexicans as poor team members, disloyal, and unable to delay gratification. Relativists are full of stories about workers who disappear after

³¹An egalitarian, very personal and direct approach can often confuse Mexican subordinates who are conditioned to greater formality in their relations with superiors. This is particularly true for new managers who have not built a personal relationship over time with their Mexican staff. A more aggressive, results-oriented, "just get it done" approach by a U.S. manager without any attempt at establishing personal intimacy, can appear cold and detached. In this author's opinion, Universalists tend to err on both scores.

receiving cash bonuses, Monday absenteeism (often quoting an old Mexican saying, "Not even the hens lay on Monday") and variations of the "backward bending supply curve for labor," argument (with statements such as "money doesn't matter to those people"). Many Relativists see Americans (or Europeans or Japanese) as products of a superior culture and therefore better workers. A smaller group of Relativists see Mexico as a superior place to produce. This argument rests strongly on the belief that Mexicans possess certain cultural characteristics, such as Mexicans' alleged amiability, loyalty, discipline, obedience to superiors, ability to work in groups, attention to detail, manual dexterity, creativity, and so on. These positive impressions of Mexican labor often exist *pari passu* with negative feeling about U.S. labor. This group of Relativists is likely to see American labor as lazy, ignorant, greedy, disloyal, among other negative attributes.

Relativists adhere to both positive and negative stereotypes. If they are having problems with quality and other metrics, they are likely to blame their Mexican personnel (along with the "Mexican nature") for the problem. Relativists tend to fall into two groups as it relates to speaking Spanish. One group avidly attempts Spanish with his Mexican employees. He says things like: "It's the only way to really know what's going on." Or, "They respect you, and you're less of an 'Ugly American' to them." Another

group abjures the necessity of learning Spanish. He says things like: "They know you expect them to speak English." Or, "They want to practice their English; I don't want to insult them." This group represents a boon to language teachers who are recruited to teach English to Mexican employees and Spanish to Anglo-American managers.

Hybrids are the most pragmatic, open, and experimental group. Hybrids display a strong ability to work effectively with Mexican technical and managerial colleagues. Unlike the Universalists, this group is fully cognizant of cultural differences between North Americans and Mexicans. In contrast to Relativists, the Hybrids do not rely on stereotypes about either their own culture or Mexican culture. Rather, they recognize that such differences exist and attempt to honestly address them while at the same time getting things done.

A Universalist manager might introduce a sense of invidious competition among engineers, line supervisors and work teams, just as he would do back in the U.S. A Relativist manager might attempt to "go Mexican" by learning Spanish, fraternizing with employees and hamming it up with the Mariachi band during the company party. In both instances, the individual manager probably feels that he is fair and decent. A Hybrid manager, on the other hand, is likely to slowly build a relationship with Mexican subordinates, and aware of his own "gringo" background, try

to find the most appropriate way of managing in Mexico. The Hybrid is the managerial type most likely to exploit the great strengths of his Mexican employees: tremendous creativity in problem-solving, a strong sense of loyalty and work ethic, an openness to learning, and a strong ability to endure. Most managers in the maquiladora industry fit predominantly into one of these categories. While this study cannot speak to the financial success of these plants, it is suspected that the Hybrids are best capable of implementing systems of continuous improvement and quality in cultures other than their own.

In the next chapter we shall discuss the separate case of Japanese maquiladora plants. Results in this sector differ in significant ways from those found in the sample of U.S. and European firms.

CHAPTER 5

JAPANESE MAQUILADORA PLANTS

Our Japanese sample is much smaller than that of U.S. and European subsidiaries. There were seven wholly Japanese plants surveyed and visited plus four U.S.-Japanese joint ventures. None of the managers of the joint ventures were Japanese, one was American and the other three were Mexican. In all four cases their divisional superiors were American. Of the seven Japanese firms in the sample, four had been in operation for less than five years.

A major difference between the responses of Japanese management of wholly-owned Japanese firms and U.S.-European management surfaced in the course of research. Quite uniformly, Japanese plant managers and technical personnel could not think of performance on any metric in the survey that was better than home plants in Japan. In fact, across a broad range of questions and issues the Japanese were much more critical and less satisfied with Mexican operations.¹

¹It needs to be stressed here that interviews with Japanese managers presented a different set of challenges to the author. Often, language was a problem. Further, the author is not well-steeped in Japanese culture, which presented problems in trying to "get a feel" for what was going on. For example, managers seemed very evasive on certain points. As an American talking to other Americans, the author could often get into very probing and open discussions with this group of management. Many times managers would really "open up" and admit deeper fears, frustrations, and aspirations. Given linguistic and cultural gaps, this was largely impossible with the sample of Japanese managers. However, on all questions comparing

In very few cases could the Japanese managers and technical personnel think of anything that they did as well as Japanese plants in Japan. The relative newness of these plants may play a role in the apparent dissatisfaction of management. For three of the companies, these were their first and only plants in Mexico. Further, if these firms have attained high levels of quality and continuous improvement in their home Japanese plants, then Mexican operations are faced with a high standard of comparison.

However, there may be deeper beliefs operative among Japanese management. When the manager of a plant belonging to an electronics giant was asked if he thought the plant could even attain a level of product quality equal to that of the firm's plant back in Japan, he replied firmly: "Oh no, never." When asked why this could not happen, he replied politely: "The Mexicans are not Japanese." Two Japanese managers in another plant appeared amused by the question of ever attaining quality and efficiency on a par with home operations. Japanese management does not appear to hold a high opinion of Mexican line workers or technical personnel. The Japanese quality manager of a two-year-old plant had demoted all of his line supervisors because, as he stated: "Mexican supervisors won't work as equals with line

Japanese to Mexican operations with respect to quality, conformity to specifications, and an approach to continuous improvement this group emphatically placed the latter in an inferior position.

employees." He decided to remove all supervisors and personally direct all lines himself. He also felt that Mexican direct employees displayed little loyalty or commitment to work.

None of the Japanese managers interviewed used quality circles in the strictest sense in their plants. In two plants, work groups led by engineers and supervisors were organized on an ad hoc basis to deal with issues including quality. In all cases, the Japanese reported relying less on groups and cross-training, than managers in U.S. and European firms.² In all interviews Japanese managers indicated that they felt that both Mexican line workers and technical personnel were not culturally prepared for productive and cooperative work in groups.

What was in evidence in five out of seven Japanese plants was the practice of daily meetings of about ten minutes in the morning before the beginning of work (this is a common practice in plants in Japan, called "chorei"). These meetings allowed management to discuss the upcoming day's activities, plans, goals, and particular problems. Most managers indicated that worker input and feedback are

²It is possible that Japanese managers have a different perception of what constitutes "quality circles" and "cross-training" based on a higher standard. As mentioned previously, U.S. managers often responded affirmatively to questions about their plant that did not bear up upon inspection.

solicited and personal matters are often discussed.³

Clearly, chorei could be viewed as a substitute for quality circles and work teams. Interviews with Mexican employees revealed that these daily meetings provided a valuable source of information and direction. Mexicans who had previously worked for U.S. firms who used work teams and quality-type systems noted that these daily meetings in Japanese companies, while brief and informal, often provided more structure and direction than did U.S. firms with more formal group assignments.

Five of the seven firms in the sample of Japanese plants used fewer statistical methods in production than did their U.S. and European counterparts. All managers reported an over-reliance on quality inspection. All of the plant managers indicated that they intended to increase the use of certain statistical methods, most particularly of on-line software packages for certain types of SPC. On certain lines, they indicated that variability had been controlled by the planning of the process itself and the simplification and very tight specifications of component parts. The intense training of operators allowed them to fit into the process without the need for constant measurement, such as control charts, etc. As mentioned, the Japanese rely less

³The practice of chanting slogans, group exercises, and so forth had been tried in some plants but discontinued. One Mexican engineer in a Japanese plant said sardonically: "That stuff doesn't work with Mexicans."

on cross-training of line and technical employees than U.S. and European firms. Further, training relied much more heavily on individual trainers, along with manuals, videos, and other materials and media. While the survey did not inquire as to the length of training, it appears that Japanese firms in the maquiladora industry provide their employees with more days of training, on average. While Japanese assemblers rely heavily on conventional methods of quality control, they emphasize training of line workers to a greater degree than U.S. and European counterparts. Quality is greatly stressed in the training process.

Only one plant among the seven Japanese plants used kanban cards in a system of JIT. The other firms felt that JIT was not practical in their plants at the time of the interviews. The reasons given were the same for U.S. and European plants: distance from suppliers, and the lack of Mexican suppliers. They all felt that some form of JIT was ultimately necessary in their plants. Japanese management seemed more concerned with reconfiguring assembly lines to increase throughput and cycle times in order to decrease work-in-process and inventories. In terms of integrated JIT manufacturing, no plant had attained that standard.

While the sample of seven Japanese firms is small relative to the U.S. and European sample, there was great variability among the plants. A large electronics plant had a very impressive system of "pokyoke," the assembly line was

configured in such a way as to present the operation with a "foolproof" series of assembly movements. In this plant, an "andon" system was also fully operative ("andon" is a system of colored lights placed above an assembly line that signal workers and managers as to conditions along the line). Each operator had at his or her position a red button and a yellow button. The operator was empowered to push the red button to signal an emergency or any situation in which a defective product was being assembled. Pushing the red button stopped the line until the problem was fixed. The yellow button signaled an impending emergency or problem that would interrupt the flow of the line. This was the only Japanese plant or U.S.-Japanese plant visited with an operator-triggered "andon" light system. This plant was also extremely quiet, clean, with little work in process. The training area was impressive with very new, modern audio-visual equipment and simulated work areas.

This plant was an example of intensive planning with respect to the layout of the production line and the training of employees. Machinery was designed in such a way as to minimize mistakes by the operator, who had been intensely trained. SPC charts were not in evidence on the line indicating that precise control had been "built into the process."⁴

⁴A profusion of SPC charts and graphs is not necessarily proof positive that a plant is engaging in aggressive quality control and continuous improvement. We

One area that represented a significant difference between the majority of U.S. and European plants and Japanese plants, was the attention paid to the working environment and ergonomics of the plant by management in the Japanese firms. In Japanese plants greater care has been taken with respect to lighting, air flow, background noise, and floor surface. For example, along the moving assembly line of a Japanese autoharness plant are placed pads with green astroturf placed on top. This serves the dual-purpose of making standing less fatiguing and allowing the recovery of small clips dropped during the assembly process. They fall underfoot and get pressed into the astroturf where they are protected and can be used. The Japanese also feel the color green is more natural and soothing in a factory environment.

In the great majority of U.S. and European plants, popular Mexican music plays constantly during each shift. Management naturally assumes that workers prefer the music and are therefore more productive. In all but one Japanese plant visited there was no music played in assembly areas. Japanese managers feel that the music distracts workers from their tasks.

must be cognizant that such charts are intended as a diagnostic device to show management where the process should be improved. In some Japanese plants, the process has been improved and the charts are not needed at all, or only on an ad hoc basis.

In terms of visual aids, the Japanese plants are similar to U.S. and European operations. However, where boards detailing the proper sequencing of parts, (as with the detailed placement of wires and clips in autoharness assembly) the Japanese have done a clearer job presenting the "foolproof" and correct way of conducting the assembly operation. In one plant, the chassis of the Japanese automobile sat at the workers' entrance replete with the electrical autoharness that was assembled in the plant.

At the opposite extreme was a plant operated by another large electronics firm. This plant produced a product which required a dirty, noisy process. From the standpoint of cleanliness, fumes, floor organization, noise, work in process, inventory control, and general approach to quality and continuous improvement, this was the worst plant the author toured in the entire sample of 104 maquiladora facilities. The product was very mature and presumably the process was reasonably stable and had not changed much in years.⁵ The quality assurance manager of this plant, a

⁵This begs the observation that those companies that have relocated the assembly/production of mature products with stable production technology and processes (in some cases not having changed for decades) are most clearly in Mexico because of cheap labor. Such operations uniformly display less concern for continuous improvement and tend to meet quality goals through more traditional means (e.g., inspection). This seems to apply to Japanese firms as well. Conversely, firms producing components for highly dynamic and competitive markets (e.g., automobiles, consumer electronics, computers, etc.) tend to show a greater commitment to increasing quality, efficiency, and continually improving the product and process.

Mexican-American, explained that morale was very low in his plant. He felt that his ideas concerning quality and continuous improvement were of no interest to his Japanese superiors. He stated: "Everything here comes from the top-down. They never ask us anything. We are just told what to do." This manager had worked for U.S. maquiladoras and believed that North Americans were much more accepting of Mexican employees and technical personnel. "The Japanese will only let a Mexican go so far in the ranks of management," he told this researcher.⁶

It is clear that there exists a significant cultural problem between Japanese managers and their Mexican subordinates. Mexicans chafe at a perceived top-down, condescending style of management while the Japanese tend to view Mexican subordinates as unmotivated, inferior workers. Mexicans tend to see the Japanese as clannish and unwilling to engage in information sharing with Mexican personnel.⁷

⁶Shaiken and Browne (1991) visited and surveyed 13 Japanese plants in the Spring of 1990. They discovered a similar attitude on the part of Mexican employees. However, their study did not compare Japanese firms with U.S. and European subsidiaries in Mexico. See Shaiken, H. and Browne, H. "Japanese Work Organization in Mexico," in Manufacturing Across Borders and Oceans Japan, the United States, and Mexico. G. Szekely, editor (Center for U.S.-Mexican Studies, University of California, San Diego, 1991).

⁷It is important to recognize that the Japanese probably feel this way about American workers and technical personnel as well. While no Japanese managers told this author directly that they felt American workers were inferior, several reported quality problems with U.S. subsidiaries. The Mexican perception that the Japanese stay to themselves is fed by stories such as the one that the

Needless to say, such an environment is not conducive to a spirit of cross-functionalism, team work, and continuous improvement. Turnover among line and direct workers is on average higher in Japanese plants than in U.S. and European counterparts. While data was not collected on the turnover of managerial and technical personnel, most Mexican personnel told this author that they believed that it was higher in their Japanese plants than in U.S. and European plants. It is possible that the aforementioned atmosphere of estrangement has influenced turnover rates.

As previously mentioned, wage and salary packages were not addressed in the survey given their sensitive, proprietary nature. However, two Japanese managers, as well as several Mexican engineers working for Japanese firms, mentioned that they paid higher starting wages at the line level, and higher starting salaries at the technical and engineering level than the industry average. The Mexican quality manager in one of these plants related that in his firm this was true, but that raises came much more slowly. He felt that in the longer run that U.S. and European firms paid better salaries.

Mexican manager of a U.S.-Japanese plant related to this author. Apparently, Japanese employees of maquiladora plants in the Ciudad Juarez area had created a walled, completely separate living community for Japanese personnel. This exclusivity led to rancor among many Mexican workers. This Mexican manager's laconic observation was: "Not even Texans do that." For reasons that are not known, this Japanese community has evidently disbanded.

Japanese companies did not practice lifetime employment in the maquila plants studied.⁸ Further, they are as likely to lay off personnel as were their U.S. and European counterparts. One area in which Japanese management practices diverged from a growing trend among U.S. and European plants, was that of upward mobility of Mexican personnel within plants. It is the explicit goal of several U.S. firms to place Mexican managers in all of their maquiladora plants. The American manager for Mexican operations of a U.S. autoharness operation expressed this view: "Give me a plant with Mexican workers and Mexican management and I can do anything." Indeed, the plants toured in this firm appeared among the best from the standpoint of quality and continuous improvement systems. Morale and active involvement among Mexican engineers and technical personnel seemed quite high.

None of the Japanese firms surveyed had a Mexican manager, although the newest plant had a Mexican-American plant manager. None of the other plants had a Mexican-American plant manager. None of the other Japanese managers indicated that they or their firms had any plans to place Mexican nationals as plant managers. As mentioned, of the four U.S.-Japanese joint ventures surveyed and visited, one

⁸On this point there is considerable controversy as to the extent that the Japanese practice lifetime job security in Japan (see for example, Itagaki, p. 127; Johnson, p. 38; Hasegawa, p. 11).

was managed by an American, with the other three managed by Mexicans. In this regard, the influence of the U.S. half of the parent seems to be dominant. In assessing the operation of the plants themselves, it was difficult to discern what was the American influence, Japanese influence, and increasingly the Mexican influence in these plants. The U.S. firms in these joint ventures had been operative in the maquiladora industry for several years. The Japanese half of the joint ventures either did not have any other wholly Japanese-operated plants in Mexico; or if they did, they were located outside the region confined to this study and therefore not studied. The author did visit all plants in the region operated by the U.S. companies in these joint ventures. Based on this research, it appears that the U.S.-Japanese joint ventures are influenced more by the U.S. parent.

In sum, Japanese firms studied are not using most of the vaunted practices of continuous improvement (or "kaizen") which have brought their companies such success. As mentioned, this sample of plants has been in Mexico for less time than their U.S. counterparts. However, they have certainly been in operation long enough to implement these systems if they so desired. One might postulate that the firms in this sample are engaging primarily in routine, labor-intensive assembly and therefore can more easily rely

on more traditional quality control and work organization to achieve internationally competitive quality.

In some cases Japanese management and engineers have gone to great lengths to "foolproof" systems. However, the Japanese either do not believe that Mexicans are yet capable of emulating the synergism found in many Japanese plants in Japan, or they do not care to invest the effort and time to effect such a transformation. Based on this author's numerous conversations with current and former Mexican employees of Japanese plants in Mexico, this approach can be seen as very costly in the form of disgruntled employees who do not feel allegiance to the organization. To the extent that continuous improvement implies shared information flows, both up and down, cross functionalism, and a cohesive team approach based on a shared sense of mission, Japanese maquiladoras are poorly positioned to reap any such benefits.

The Japanese unwillingness to place Mexican personnel in charge of plants sends a strong message to non-Japanese subordinates that there is an upward limit to their aspirations. Clearly, this engenders an attitude among Mexican personnel that is inimical to the ceaseless driving curiosity that yields constant, incremental improvement. Ironically, it is often the largest U.S. firms (with serious and well-documented problems in U.S. plants with respect to quality and continuous improvement), that are most committed

to "Mexicanizing" the operations. When Mexican personnel are adequately prepared, this becomes an efficient and self-sustaining way of tapping into the great reservoir of commitment, creativity, and intelligence that exists in Mexico.

CHAPTER 6

IS CONTINUOUS IMPROVEMENT AN "APPROPRIATE TECHNOLOGY" FOR DEVELOPING NATIONS?

I. Technology, Appropriate Technology, and Continuous Improvement

Few firms in this study's sample approximate all key aspects of the archetypal continuous improvement firm. However, there have been significant improvements in product quality and production processes in many maquiladora plants.¹ In almost all cases, Mexican personnel either developed these improvements on their own or were involved with their creation and implementation. It appears that much of the improvement in the maquila industry has been a function of sustained managerial attention to improvement and detail. Improvement has taken place in many plants that utilize equipment that is more than 20 years old (in some plants machinery that pre-dates World War II is still in use). The greatest returns with respect to quality and continuous improvement appear to come from investments primarily in people and time, and not in capital equipment. This is of great relevance to the contemporary settings of

¹Many maquiladora managers of U.S. plants report that conditions in related U.S. plants are no closer to the ideal of continuous improvement. As noted, in several cases maquiladora plants have implemented more improvements than U.S. counterparts.

many less developed countries (LDCs). We shall return to this seminal point later.

We now turn to the question of whether continuous improvement, which includes soft technologies such as shared information and transfunctionalism, as well as analytical tools such as SPC is an "appropriate technology" for less developed countries. First, we should discuss the word, "technology." The term "technology" is frequently used. One dictionary defines technology as the "(Science of) practical or industrial art(s); [the] ethnological study of the development of such arts; [the] application of science" (Concise Oxford Dictionary, 1976, p. 1188). Unfortunately, definitions such as this are of limited use (see Willoughby, Chapter 2). The French sociologist, Jacques Ellul, sees efficiency as a predominant feature of "technology:" "[Technology is] the ensemble of the absolutely most efficient means at a given moment....Whenever there is research and application of new means as a criterion of efficiency, one can say that there is a technology" (Ellul, p. 26). Others see technology as a fund of knowledge: "Technology is really the sum of knowledge--of received information--which allows things to be done, a role which frequently requires the use of machines, and the information they incorporate, but conceivably they may not." (MacDonald, p. 27). Scriven defines technology as "the systematic process, and product, of designing, developing,

maintaining and producing artifacts," (Scriven, p. 25). An artifact, according to the American Heritage Dictionary, is, "An object produced or shaped by human workmanship; especially a simple tool" (American Heritage Dictionary, 1976, p. 75).

The above definitions emphasize technology as a process of applying knowledge in order to improve things and processes. This helps us get beyond the popular English language use of "technology" as tools, machines, gadgets, etc. However, some have expanded the definition of technology to include "organizational forms":

Technologies are thus not only objects and material processes, but also organizational forms, methods of knowledge production, decision-making techniques and so on. For example, the common organizational form of the pyramidal bureaucracy is as much a technology as the word-processors, microcomputers, filing systems and calculators which facilitate the work of the organization. One only has to consider the current search for more effective and efficient organizational forms to appreciate this" (Hibbard and Hostika, 1982).

In accord with these definitions and their respective stress on "efficiency," "knowledge," "systematic process," and "organizational forms;" the process of continuous improvement can itself, be seen as a technology. Allowing a definition of technology to include elements that transcend tangible things (or artifacts), must also include the managerial-organizational approach embodied in the Continuous Improvement Firm. We must do this because the impact of this approach is every bit as powerful as the

application of tangible tools. In this sense, then "technology" must be defined by what it does.

For example, in the popular vernacular, we might identify the innovative tools involved in the revolutionary Toyota system of "Single Minute Exchange of Dies" (also known by its acronym, SMED) as "technology."² However, it was not these tools that made SMED possible, but rather it was the process of innumerable, incremental advances made over many years of continuous improvement that gave rise to these tools. It is the technology of continuous improvement, including the soft technologies of shared information, transfunctionalism, and incentives to improvement; as well as the analytical tools of SPC, , histograms, Pareto charts, and the like, that gave rise to physical tools such as SMED. Indeed, when very significant differences in performance arise due to different organizational-managerial methods such as those subsumed within continuous improvement, and not due to differing

²Our problem here is not only a conceptual one, but one of English semantics as well. The use of the word "technology" is employed in the English language to mean several different concepts. The French language distinguishes as between "technologie" and "technique," the former is the science of analyzing and describing technique or techniques, whereas the latter are the object of study of the former. In German, a similar distinction is made between "technologie" (technological science) and "technik" (technology or technical things). English uses the word "technology" to mean both the science and its object of study (Willoughby, pp. 25-28; Ellul, pp. 23-33; and Ströker, pp. 323-36).

complements of physical capital, we can then consider the former a form of technology as much as the latter.

An emphasis on the technological role of capital, which excludes managerial and organizational systems from consideration, can prove misleading. For example, in the late 1980s, Toyota's number 9 Kamigo engine plant was equipped with American-made equipment that was on average 20 years old. Comparable U.S. plants had newer and more sophisticated machinery. The American plants employed, by the popular definition, more "advanced technology" than did the Toyota plant. Yet, the Kamigo plant was widely recognized as the most efficient engine plant in the world (Schonberger, Chapter 4). The differences in plant performances were because of the rigorous application of continuous improvement technologies at Toyota. Managers, maintenance workers, and line operators all shared important information on how to improve the arrangement of their machines, maintenance schedules, and the reduction and eventual elimination of machine down-time. The application of continuous improvement technologies to physical capital augmented its efficacy to a great degree. It appears that the technologies of continuous improvement are what determine the effectiveness of physical tools, not the other way around.

Is continuous improvement technology (CIT) an "Appropriate Technology" (AT) for developing countries?

There are several definitions of AT in the literature (see Willoughby, pp. 21-22). Harrison states: "'Appropriate Technology' means simply any technology that makes the most economical use of a country's natural resources and its *relative proportions of capital, labour and skills...*" (Harrison, p. 140, emphasis added). Others argue that: "An appropriate technology is [one that] *relies primarily on people's skills, not on automated machinery...*" (National Center for Appropriate Technology, p. 1, emphasis added). Wade sees AT as being: "...labour-intensive, accessible to its users, frugal of scarce resources," (Wade, p. 40). The United Nations Industrial Development Organization (UNIDO) sees AT as a "dynamic and flexible concept which must be responsive to varying conditions and changing situations in different countries (United Nations Industrial Development Organization, 1979, p. 4). Among other characteristics, Jéquier and Blanc see in AT a "high adaptability to a peculiar social or cultural environment" (Jéquier and Blanc, OECD, p. 10).

II. The Case for the Appropriateness of Continuous Improvement Technologies in Developing Nations

On the basis of the information gathered and analyzed in this dissertation and the characteristics cited above, we will argue that CIT appears, on balance, to be an appropriate technology for LDCs. We base this argument on the following propositions:

A) Continuous improvement technology is labor intensive in that labor is the key to continued improvement. It is the skill of people and not the use of automated machinery that animates the process of continuous improvement. Machinery cannot improve itself nor improve people. Many contemporary developing nations are endowed with a large supply of labor. Many of these LDCs have made significant strides in improving literacy rates and producing numbers of well-trained engineers and technically trained persons (World Bank, in Todaro, 1983). In this regard, our study of the Mexican maquiladora industry gives a strong indication that even inexperienced workers possessing only primary school education can be trained in the basic concepts and application of statistical quality control.³ As mentioned, managers in the maquiladora industry report a strong work ethic coupled with high creativity among Mexican workers and managers. Mexican labor is very young and displays an openness to new approaches and techniques. While cultural factors vary across the globe, there is no a priori reason for believing that other contemporary LDCs do not offer similar strengths in youth, creativity, hard work, and supervisory ability.

³It also appears that many Mexican workers are motivated to further their own schooling. Several plants in this study's sample provided classroom instruction for their employees wishing to complete their secondary education. There was evidence that these classes were well attended.

B) Continuous improvement technology saves on the relatively scarce resources of capital, and therefore of foreign exchange. The role of capital within CIT is downgraded relative to its role in the standard view. This is one reason why the implementation of CIT does not require large financial outlays. Imai states:

One of the beautiful things about KAIZEN (the Japanese word for "continuous improvement") is that it does not necessarily require sophisticated or state-of-the-art technology. To implement KAIZEN, you need only simple, conventional techniques such as the seven tools of quality control (Pareto diagrams, cause-and-effect diagrams, control charts, histograms, scatter diagrams, graphs, and check sheets)...[while] KAIZEN does not necessarily call for a large investment to implement it, it does call for a great deal of continuous effort and commitment (Imai, pp. 24-25).

It is people that animate the process of continuous improvement. People are the source of solutions to problems. The problems, as seen in the context of continuous improvement, are the production system and the capital equipment.

Continuous improvement technologies save on scarce capital equipment by keeping existing machines in service for longer periods. As Schonberger reported, Toyota was able to extend the life of their machinery through preventive maintenance and continual retrofitting to meet the evolving needs of their production process. In the maquiladora industry many firms have kept and maintained older equipment. This is largely the case because newer, more labor-displacing equipment has not been deemed

necessary given relatively low wages in the maquiladora industry.⁴ Firms moved processes that could be made more labor-intensive to Mexico in order to take advantage of low wages. However, as management set out to improve processes and improve product quality, many saw increases in overall productivity without significant changes in either capital stock or the number of line employees. In several cases, this occurred with a decline in the number of line employees.

These efficiencies have been wrought by the application of continuous improvement technologies to the production process.⁵ In many plants, constant evaluation of the

⁴Of course, automation and the use of sophisticated capital equipment (e.g., robots) can have a major advantage over human beings in the reduction of variability in terms of uniform motions, uniform cycle times, and uniform quality. This is the primary reason why the use of such technology is justified in critical procedures in such industries as automobiles and computer hardware manufacturing. However, as our maquiladora study suggests, the profitable and efficient employment of relatively old machinery in assembly operations has been effected with high levels of quality.

⁵There are many terms that plants use to describe the various approaches taken to improve processes; among them are "continuous flow manufacturing," "cellular manufacturing," "pre-automation," "JIT manufacturing," and various types of "pull-systems." These approaches all share a common goal of streamlining processes to increase throughput with the reduction of inventories. The manner in which approaches such as these are implemented differs across plants. In some plants, the execution of such programs resembles the traditional industrial engineering approach, i.e., management and engineers change the process in a top-down fashion without the involvement of line workers. In other plants, line workers and supervisors are integrally involved.

process is undertaken based on widely shared information, a transfunctional view among managers, and the cross training of line workers. On the line, a typical approach might be to make human assembly movements very easy to perform. This is done by shortening reach and flow distances, as well as by placing parts and tools in exact locations close to the operator. Further, the design of packages, containers, racks, and fixtures are undertaken in order to maximize the application of tools and assembly operations by operators on the line. In many cases, work stations involving similar products or processes are arranged in clusters (sometimes called "cells") along the line.⁶

Often workers within each cluster, or cell, are cross-trained in several jobs and periodically rotated among different positions. Workers within each cluster often are formed into groups which actively seek ways to improve the process. Individual group members are given full responsibility for their position, and are encouraged to communicate with the operator "upstream" who passes them work in process (WIP) and the operator "downstream" to whom

⁶It must be emphasized that this kind of job simplification is not the same as that pursued by those managers attempting to mitigate the disruptions of high turnover. Often in these cases the basic configuration of the line, placement of tools, and so forth, remains the same; only the actual number of movements of the operator is reduced. This sometimes results in more people on the line doing very simple movements. The approach discussed here, while simplifying individual tasks, is much more comprehensive and allows the operator to do more than one simple activity with greater responsibility.

they pass on their own WIP.⁷ In many plants, Mexican engineers working with operators have developed simple "fail safe" devices on many lines (which the Japanese call "pokyoke"). Preventive maintenance has been emphasized with the goal of eventual elimination of machine downtime.

What began as an attempt on the part of many managers to substitute labor for complex equipment based on relative factor prices, has resulted in often greater performance in improvements and quality for the more "labor-intensive" maquiladora operations. For some managers who had studied the literature of quality and continuous improvement, this outcome was anticipated. For many other managers, advances in quality and improvement were seen as an additional "benefit" to attained production targets. Planned or not, it appears that many managers have achieved high levels of improvement with little capital input for space and machinery, reduced labor costs per unit through process simplification, and effectively utilized worker creativity and feedback. This has been the outcome of the application of the continuous improvement technologies of shared

⁷Quality circle-type groups are often formed out of the employees in these production cells. In the industry vernacular, empowered line operators are encouraged to assume "ownership" of their position and its part in the production process. Further, they are to see their upstream operator as their "supplier," and their downstream operator as their "customer." In this manner, operators are encouraged to accept greater involvement with product quality and make greater contributions to the process of improvement.

information, employee involvement, cross-training, more transfunctionalism on the part of management, intensive training, and the rigorous use of analytical CITs such as SPC, fish-bone diagrams, and Pareto charts. Given very low wages in Mexico, we can postulate that managers who aggressively implement continuous improvement technologies are able to greatly lower the break-even points in their plants.

Continuous improvement technology further economizes on the use of capital because the process of continuous improvement creates new capacity as a matter of course. Cole, Mogab, and Sanders (1992) argue this point using the following scenario. Assume two firms that in the initial period feature identical cost functions for products that are considered by consumers to be almost perfect substitutes. Further, assume that both firms (which we will call "A" and "B," respectively), began as mass producers. Now, assume that the "B" firm receives an infusion of continuous improvement capability so that incremental improvements begin to emerge internally as a normal part of day-to-day operations. For example, the work stations in the manufacturing plant implement internally generated improvement which reduce product variation in terms of conformance to engineering specifications. One result is that the costs associated with inventories, rework, and scrap are reduced. This results in a fall in unit costs;

and an ability to produce a larger output in any given time period with the same resources, plant, labor force, materials and energy. In other words, there is reduced input, materials, capital and labor, per unit of effective throughput. Not only does the "A" firm now enjoy lower costs per unit than does the "B" firm, but it has also simultaneously increased its capacity to cater to the expansion in its market size that will come about as a result of improved product quality and lower cost (Cole, Mogab, and Sanders, pp. 22-5). To reiterate, such a process arises without new capital or financial infusions. It is an outcome of the process of continuous improvement which generates incremental improvements internally.

Another reason why CIT could save scarce capital, and therefore foreign exchange, is that the potential role of used capital equipment may be great. While this study did not specifically address the issue of used equipment in the maquiladoras, it appears that many plants are successfully using older equipment in their operations. By applying continuous improvement technologies, these plants have extended the life and augmented the productivity of their older equipment. The Toyota Kamigo plant example illustrates that it is not the age of equipment per se, but the way in which it is maintained and used that are the primary determinants of its effectiveness.

In this regard, contributions such as James (1974) need to be extended. In his study of used machinery and its role in economic development, James observed that employing used machinery may yield generous returns. Based on a case study of a Mexican paper firm (Papelera de Chihuahua), he writes:

A saving of at least 25 percent [by purchasing used equipment] on capital equipment will do to begin with, but perhaps even more significant are the returns on innovation. Through relatively small cash outlays combined with relatively intensive use of entrepreneurial talent, the rated capacity at Papelera was increased from 25 to 40 tons a day or by 60 percent! It is highly doubtful if this could have been done with more expensive new equipment; the latest innovations already have been engineered into it (with a price tag embodied in the acquisition price of the equipment), and the equipment is less amenable to post-acquisition alterations (James, pp. 70-71).

James' contention is that the maintenance demands imposed by older, used machines present greater opportunities for improvements and learning:

The employment of used machinery is likely to enhance the production of maintenance abilities for several reasons. There is likely to be greater exposure to maintenance problems due to more frequent breakdowns or threats of breakdowns. Since learning appears to be a positive function of relevant experience, it will take place at a faster rate. In addition, the earlier technological vintage of used machinery implies less mechanization in the production process, thus allowing more scope for learning. The earlier vintage implies a more labor-intensive method, which means the *breadth* of exposure is greater (James, pp. 45-46).

In short, if a firm employing used equipment pursued the rigorous application of continuous improvement technology, there would appear to be good opportunities for

internally generated, incremental improvements.⁸ Shared information and intensive training might generate creative externalities in the form of new improvements upon the equipment and its uses. The "hands-on" experience derived from the preventive maintenance and repair of older equipment and its continued adaptation to the needs of production would provide impetus to creative solutions. In many LDCs, particularly in smaller countries, there is a dearth of trained maintenance and mechanical personnel.

James makes the observation:

The raw human material for maintenance training is assuredly far more homogeneous than the capital for which it substitutes. A small country such as Honduras has a much better chance of assembling capable trainees for an advanced maintenance course than it has of producing equipment for, say, an automated glass bottle plant (James, p. 41).

C) Continuous improvement technology is an appropriate technology for LDCs because it is highly dynamic and flexible.

The incremental improvements spawned by the application of CIT to the production process have lent a high degree of flexibility to some firms. In its most advanced expression, this new system "combines the specialist advantages of a job shop for small-batch production with the scale advantages of

⁸James reported that much of the resistance to used equipment was due to the biases of engineers who prefer state-of-the-art technology. Also, there was the feeling among some academics and policy makers in Third World countries that policies advocating the utilization of used equipment were part of a plot to unload unwanted equipment and maintain LDCs in a state of technological backwardness.

a flow line for high-volume production" (Best, p. 156). The process of continuous improvement facilitates ever greater flexibility. Where Toyota had once targeted a "single minute change of dies," the new objective is to be able to change dies within seconds to approach runs of one unit that have the same average cost as a run of thousands of homogeneous units. This phenomenon is a facet of what has been termed, "economies of flexibility" (Cole, Mogab, and Sanders, pp. 22-5).

This observation applies to a company that is a leading automobile producer and archetypal CIF, Toyota Motor Company. Another earlier example from Toyota, has direct relevance for the smaller scale producer in a developing country. Recalling the Number 9 Kamigo plant, Schonberger observes:

If a machine makes a bad part or breaks down, the giant overhead electric *jidoka* signboard lights up and summons help to fix the problem right away. Quality problems are nipped in the bud, so there is little rework to do and little need to keep buffer stocks in case of bad quality....the plant runs just two shifts, and preventive maintenance goes on between shifts and during the one-hour lunch breaks. When a machine is scheduled to run, it runs right. *Most machines can be set up in one or two minutes, so there is no reason to run large batches* (Schonberger, p. 58, emphasis added).

Continuous improvement technologies create great production flexibility and improvements in metrics such as quality, deliverability, and functional design. This flexibility is also combined with the advantages of small-batch production. This would allow producers in smaller

developing countries to meet the demand mix of a small domestic market with much less total capacity than would be required under traditional mass production. Flexible small batch production permits the enterprising firm in a LDC to rapidly respond to changes in both domestic and dynamic global markets. This degree of flexibility might make it easier for a firm in an LDC to search for and fill specialty niches in the global market.

D) Continuous improvement technology is appropriate for many contemporary LDCs because there can be advantages to operating in less "advanced" conditions.

Contrary to what one might believe, a priori, many managers in the maquiladora industry report that the implementation of CIT has been easier in Mexico than in home plants located in the U.S. Mexican workers have often had no previous experience with other approaches to production. Many accept continuous improvement technology without reservations. Mexican managers and engineers have not had experience working for large mass producers in the United States and are eager to apply continuous improvement technology to their plants.

Yoshida (1989) argues that the Japanese were more culturally predisposed to internalize and apply the lessons of Deming than were his fellow Americans. It is quite possible that traditional mass production as a technology is completely interwoven with deep cultural aspects of Western

society. Perhaps this is a reason why many Western managers have difficulty grasping the continuous improvement approach. As Yoshida points out, tools such as SPC were intended to be used by management in order to gain a more general, systems-based view of their operation. In the Japanese experience this is what happened. However, as discussed in Chapter 2, Western firms have often used such tools within the unaltered structure of mass production.

It is possible that contemporary LDCs, not having a cultural bias towards mass production principles, may have cultural traits that are amenable to the process of continuous improvement. Various forms of groupism, attitudes toward cooperation, and identification with the organization (or group) may exist that make certain cultures in developing nations ripe for adopting CIT. The identification of an "informal sector," as a reservoir of hard work and entrepreneurial talent under severe conditions is evidence of the existence of much creative activity in LDCs (ILO, 1972; Cole and Sanders, 1985). Such talent and energy might be well directed within a continuous improvement framework.

E) Continuous improvement technology is appropriate for LDCs because it develops endogenously.

Once CIT is being applied within an organization, ongoing improvements are likely to be generated endogenously. For the producer within the LDC, this

reliance on progress from within will probably loosen the ubiquitous constraints of foreign exchange. With lifetime employment (or relatively secure employment), widely shared information, and incentives for improvements, members of the organization may feel more committed to common goals. The continued progress of the organization is based on the effort and creativity of its management and members, and not on outside consultants or equipment.

The process of continuous improvement evolves daily. Over time this process may become more indigenous to the firm and more appropriate with respect to the local culture, educational, and resource endowments. While the process may have been started with imported capital (whether new or used) and ideas, it should gradually become more internal and synergistic with local conditions.

In our Conclusions chapter, we must discuss several caveats to the above propositions. Included in these are an inquiry into the results of the Japanese portion of our sample, the costs associated with starting continuous improvement, the supply of managerial and supervisory personnel in LDCs, and cultural attitudes that may be inimical to the process of continuous improvement, among others. A discussion concerning Mexico under a possible North American Free Trade Agreement (NAFTA) will be undertaken as well. Explicit attention will be paid to the role of employee turnover, employee involvement, wage

policy, supplier relationships, and what role continuous improvement could play in all of it.

CHAPTER 7

CONCLUSIONS

I. Continuous Improvement Technology and Developing Countries: Some Caveats

The previous chapter set forth several propositions which constitute the argument that CIT is an appropriate technology for LDCs. There are certain provisos we should recognize in making this argument.

A) Attempts to generalize from a study of 104 assembly plants in northern Mexico may draw objections due to the specific circumstances and location of the sample. Included in this sample are some of the world's largest transnational firms. Such a group can bring significant resources to bear on any problem. Further, Ciudad Juarez and Ciudad Chihuahua are both located in a Mexican state that shares a long border with the U.S. The region has experienced a long history of cultural and economic exchanges between the two nations. Most Mexican managerial and technical personnel have travelled extensively in the U.S., and many have attended schools and universities there. Mexicans who are natives of northern states that border the U.S. (referred to as "norteños") often share a strong identification with the U.S. In general, Mexican managers and engineers are openly pro-business, pro-trade, and eagerly seize new production methods. While it is argued in previous chapters that

findings from this study of the maquiladora industry may provide insights relevant for firms operating in other LDCs, it is true that environments may differ radically in other developing countries.

B) When the firm has internalized the soft technologies and analytical tools of continuous improvement, costless, incremental improvements are spawned as a matter of course in the productive process. However, if a firm is in a pre-continuous improvement mode (e.g., a traditional mass producer), then the transition to continuous improvement is not costless. As has been mentioned, many firms in the West have adopted many of the analytical tools of CIT; foremost among them, statistical process control, design of experiments, Pareto charts, and the like. Even without a full organizational and managerial shift into the soft technologies of continuous improvement, there may be significant costs involved. For example, consultants may be brought in to the organization to train management in the use of various statistical methods. In addition to expenditure for materials and equipment, this training involves the commitment of time and the opportunity costs associated with present production. There may be significant financial outlays and investments in time in such transitions.

Changing the entire organization from a pre-continuous improvement mode involves more sweeping shifts than the

adoption of analytical tools. Altering the orientation of management can involve threats to cherished traditions and institutions. Changes of this magnitude have proven very difficult for Western enterprises. There is no reason to believe that some managers in LDCs might not also be threatened by the prospect of new roles and methods. The reordering of incentive structures and performance measurements may be strongly resisted by those who benefitted most under the ancien régime. The time and training involved in effecting such a transition represent significant costs to any enterprise.

C) Our study of the Mexican maquiladora industry suggests the presence of highly motivated, creative, and well-trained Mexican management and supervisory personnel. Further, there appears to be a hardworking labor force that is open to new methods and challenges. This may not be the situation in some contemporary LDCs. It appears that in some developing nations there exists a "management gap," or a shortage of qualified managerial and supervisory personnel. Part of this is due to the rapid growth in the number, size, and complexity of public sector institutions in LDCs. These organizations have drawn from a small pool of managerial and supervisory talent. However, of this group, many are not "managers" in the Western sense (nor are they managers oriented to the process of continuous improvement). In many instances, people are appointed based

on functional skills and professional association (e.g., physicians, lawyers, and engineers) as opposed to their managerial capabilities. These managers are likely to have received little, if any, formal management training and do not pursue self-study. For this manager, professional identity is more likely to be tied to the agency or company in which he or she is employed than to the task that is performed (Mehrabian, pp. 85-87).

To the extent that an organization attempts to shift to the soft technologies of CIT (such as trans- and cross-functional management, shared information, job rotation, and the like), the cultural characteristics of the organization and the broader culture of which it is a part are relevant. As discussed, CIT could be viewed as a threat by individuals based on the previous culture and structure of the organization. There may also be a broader cultural ethos in a nation or region that could impede the implementation of CIT. Social prestige systems in many developing countries often are based more on "ascriptive" rather than achievement-related variables. Under ascriptive incentive systems, managers tend to be rewarded based on who they are versus what they accomplish. Family position, educational level, organizational level, organizational rank, and personal contacts are more important than results or organizational improvements. The ascriptive manager spends much time and energy building networks of allies and

supporters. Often this kind of manager will distribute organizational rewards to members who share his own ascriptive characteristics. Thus family, tribe, or religious relations may take precedence over job related competence and performance. Diehl argues that employment and promotion based on ascriptive characteristics may be considered not only acceptable but morally commendable in some LDCs (Diehl, 1981, pp. 12-16).

As mentioned, many developing countries have made significant progress in terms of formal education. However, in the poorer nations of the Third World the failure to address "basic needs" still impedes improvement in literacy, health, and skills. This reason, coupled with a broad lack of experience, in several contemporary LDCs skilled labor is in short supply.¹ Streeten suggests that producers in some LDCs may face labor that is "unskilled, underfed, unhealthy, unreliable, undisciplined and perhaps hostile" (Streeten, in Colman and Nixon, p. 234). In such scenarios, attempting to produce based on continuous improvement (or any mode of manufacturing) may prove difficult.

D) Many plant managers in the maquiladora industry reported satisfaction with Mexican managerial, technical,

¹In fact, a shortage of skilled labor has been seen by some as leading to greater capital-intensity in LDCs. Winston's study of choice of technique in Nigerian manufacturing firms, provided evidence that firms chose more capital-intensive methods to circumvent the shortage of skilled labor.

and line personnel. Many plant managers felt that Mexicans worked well together and were capable of engaging in ongoing improvements. However, among our smaller sample of Japanese firms, no manager could report any area where they felt that their maquila operations compared favorably with Japanese plants.

These operations were, on average, much newer than their U.S. and European-based counterparts. It is possible that lower levels of experience in Mexico contributed to some Japanese managers' sense of frustration. However, when facing the same Mexican labor force as U.S. managers, Japanese managers still register different impressions. Japanese managers and engineers reported that Mexican engineering, technical, and line employees, displayed lower levels of competence and experience than did their Japanese counterparts. Managers of Japanese plants indicated that Mexican engineers lacked initiative and required constant guidance. Contrary to the perception of many U.S. managers, the Japanese tended to see Mexican workers as lacking loyalty and commitment to work. Japanese management felt that Mexicans were generally not predisposed towards working in groups.

It is possible that some of these Japanese firms have achieved very high standards in their home plants. By these standards, Mexicans (and possibly Americans and Europeans) might be seen as relatively deficient. Conversely, it may

also be true that poor labor relations in U.S. plants make Mexican operations and workers look relatively good to U.S. managers who have experienced production in both the U.S. and Mexico. The reasons for the divergence of opinion between U.S. and European plants, on the one hand, and Japanese plants on the other, are not known with certainty. In terms of managerial perceptions of Mexico and Mexicans, the findings are mixed according to firm nationality.

E) It has been argued that CIT is an appropriate technology for LDCs because it is "labor intensive in that labor is the key to continuous improvement." However, many firms in this study's sample (regardless of national origin) report relatively high rates of turnover. Further, most plants report levels of group work, information sharing, job rotation, transfunctionalism and employee suggestions that are below that which we associate with the continuous improvement firm.

It is true that numerous firms report solid progress with the implementation of CITs such as SPC, Pareto charts, and the like. A smaller group is also aggressively implanting the softer CITs of transfunctionalism among managers, suggestion systems, job rotation on the line, and more widely shared information (especially in the form of posted visual aids, indicating plant progress on a variety of measures). In those plants that have made the most

change, turnover has also fallen.² In plants that evidence the highest degree of continuous improvement, turnover is often relatively low. Nonetheless, the problems of turnover and low employee involvement continue to impede efforts at the full implementation of CIT in the maquiladora industry.

While the above provisos should be recognized, they do not, on balance, vitiate the proposition that CIT is appropriate for LDCs. While it is true that situations will differ in other LDCs, the case of the Mexican maquiladora industry is based on themes common to many developing nations. A very youthful, inexperienced, and mobile labor force is employed in this industry. Many of these workers come from agrarian backgrounds with little or no industrial experience. The majority of line workers live in conditions of poverty, with many inhabiting shanty towns where there exists little or no electricity, indoor plumbing or running water. Local infrastructure and transportation systems often present significant barriers to individual workers attempting to get to work on a daily basis.

With respect to difficulties encountered in shifting to continuous improvement, it is important to remember that the implementation of fundamental changes have been difficult for Western firms employing highly paid workers. It may be

²Whether in the majority of cases turnover has fallen because of the implementation of CITs, or the latter were made possible by the decline in turnover is difficult to assess.

the case that managers of firms in some LDCs would be able to effect the transition to a continuous improvement mode of production more easily than their Western counterparts given that they have less cultural experience with Western mass production. The recent collapse of Communism in the former Soviet Union and Eastern Europe, along with a wave of economic liberalism in many LDCs, are changes that many thought impossible. It may be that at the organizational level, fundamental change may also take place under the whip of strong competition.

The issue of basic needs is serious and is a definite problem for producers in the poorest LDCs. However, in such countries any productive activity is problematic due to low levels of nutrition, health, and so forth. In such LDCs, comprehensive attempts to provide the basic needs of the populace will nourish the human capital necessary for continuous improvement. Given that CIT economizes on capital and foreign exchange demands, resources might be made available to address basic needs.

The reasons for Japanese dissatisfaction in Mexico may be attributable to both high standards based on home plant performance and some form of groupism which precludes the admission of non-group members. Frequent statements by Japanese managers indicating that performance in Mexico could never attain levels found in Japan because "Mexicans are not Japanese," or, "This is not Japan," may reveal deep

feelings of exclusivity. Further, the fact that Japanese firms seem reluctant to place Mexican nationals in plant manager's positions may be evidence that the Japanese have difficulty relinquishing direct control over their operations. As reported, those U.S. plants headed by Mexican managers have achieved significant improvements. Continued Japanese reluctance to cultivate Mexican managers may further frustrate any attempts at implementing CIT. Mexican personnel will perceive an upward level beyond which they cannot ascend which may dampen their contributions to the improvement process.

No plant can expect to fully internalize continuous improvement technology when it experiences employee turnover rates in excess of five percent per month. High rates of turnover are probably attributable to the precariousness of the employee's existence at very low wages, the youth and mobility of the labor force (many workers have migrated from familial and social networks and often return home with no notice), the existence of readily available employment at other plants, and the role of the border maquiladora industry as a stepping stone to illegal migration to the U.S., or to other jobs in Mexican urban areas. It is probable that wage increases will significantly reduce turnover. Also, where production facilities employ workers from surrounding areas there is less turnover. With reduced turnover, the implementation of the soft technologies of CIT

such as group work, shared information, suggestion systems, job rotation, and the like, may be made easier. A more stable work force would develop a greater base of experience and skill which would enhance the process of improvement. It is possible that events such as these may be hastened under a North American Free Trade Agreement (NAFTA). We shall address this issue next.

II. Continuous Improvement and NAFTA

At this writing, a North American Free Trade Agreement (NAFTA) has been drafted. While the details of this accord are not yet public (and are pending Congressional ratification), it will specifically address the general goals outlined in the joint letter by President George Bush and President Carlos Salinas de Gortari in June of 1990:

The FTA will be a process of gradual and comprehensive elimination of import tariffs; the elimination or fullest possible reduction of non-tariff trade barriers, such as import quotas, licenses, and technical barriers to trade; the establishment of clear, binding protection for intellectual property rights (trademarks, patents, etc.); fair and expeditious dispute settlement procedures; and other means to improve and expand the flow of goods, services and investment between the United States and Mexico (Fatemi, p. 10).

It seems likely that the favorable tariff treatment provided to the maquiladora industry by items 9802.00.60 and 9802.00.80 of the Harmonized Tariff Schedule of the United States would end under such an agreement. These two tariff schedules favor articles assembled abroad from U.S. components. Upon return to the U.S., duties are charged only on the value added to these articles in Mexico or any

other country. In the case of the maquiladora industry, the value added to these articles is comprised largely of low-cost Mexican labor.

If these tariff advantages are lost, it is possible that less efficient maquilas may not survive. There may be an acceleration of the trend towards moving full manufacturing facilities to Mexico to take advantage of cheaper labor. The elimination of tariffs will make the non-maquiladora industry in Mexico more competitive by reducing import tariffs on U.S. components. Of course, the elimination of barriers would also eliminate the protection Mexican suppliers have erected against U.S. components. The impact of competition by U.S. manufacturers on the non-maquiladora industry in Mexico will depend on the nature of goods being exported to Mexico. If U.S. manufacturers export goods that are complementary to those produced domestically, a rise in U.S. exports to Mexico stimulated by NAFTA should have a positive impact on the Mexican non-maquiladora industry. If the goods are substitutes, the impact may be negative. Whether U.S. or Mexican producers predominate will be partly a function of the degree to which the elimination of import taxes affects relative prices. Two possible scenarios may occur: inefficient produces both in the United States and Mexico will be wiped out and/or Mexican producers already operating in Mexico will establish joint ventures with U.S. manufacturers (Echeverri-Carroll,

p. 30). In any case, to the extent that NAFTA generates foreign and domestic investment in Mexico, the demand for Mexican labor will rise. This should place upward pressure on Mexican wages (Echeverri-Carroll, p. 31).

For firms that aggressively pursue continuous improvement, the individual worker becomes more productive. Intensive training, job rotation, participation in groups and suggestion systems, ability to collect and analyze data; all help increase the workers marginal product. The worker is further prepared to provide ongoing input into the process of continuous, incremental improvements. Relative job security and strong organizational support for the worker should help him or her to contribute and increase their own productivity. However, assuming that effort and commitment are positively related to wage rates, then the manager desiring continuous improvement must value his worker by paying higher wages than those which have prevailed in the maquiladora industry. It is further believed that increases in wages will decrease employee turnover. Regardless of how well planned campaigns at improving quality and continuous improvement may be, employees who struggle daily to survive on very low wages cannot be expected to fully commit to the enterprise.

As mentioned in Chapter 4, maquiladoras have not procured inputs for their products (or "sourced") to any large extent from Mexican suppliers. That could change

under NAFTA. Promising joint ventures between U.S. and Mexican parts and components producers might initially fill a competitive void not served by viable Mexican producers. Given time to respond to market signals, it is possible that Mexican producers in the larger industrial bases such as Mexico City and Monterrey would also respond. For producers who seriously pursue JIT manufacturing, the proximity and close contact with suppliers is crucial. Mexican and U.S. entrepreneurs who can respond to the derived demand for materials and inputs in post-NAFTA Mexico will be well rewarded.

Much speculation exists as to the eventual location of suppliers, as well as assembly and manufacturing operations under NAFTA. It is argued by some that NAFTA will spur a relocation of manufacturing and assembly enterprises to interior locations because of access to the broader Mexican market, the availability of more technical personnel, and superior infrastructure. Others see larger investments in infrastructure along the border coming in the wake of NAFTA which will intensify the geographical advantages of the U.S.-Mexican frontier. Echeverri-Carroll argues that in the evolution of flexible manufacturing, the spatial proximity of border to the U.S. market will play a critical role (Echeverri-Carroll, p. 31).

On balance, evidence gathered during the research of over 100 plants in the maquiladora industry supports the

contention that Mexico is well endowed with the requisite elements for continuous improvement manufacturing. The maquiladora industry has trained thousands of technicians and managers, as well as many more line workers. For both foreign producers and Mexican entrepreneurs who are willing to implement continuous improvement technologies under NAFTA, they should reap the benefits of Mexico's competitive advantage: youthful, intelligent, hardworking people. There are reasons to believe that producers could utilize continuous improvement technologies to positive ends in other developing nations as well.

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APPENDIX:
SURVEY INSTRUMENTS

Production Process

1. In terms of finished product quality, how does your plant compare with domestic operations of the parent company?
 1. much better
 2. better
 3. about the same
 4. worse
 5. much worse
2. Does your plant use Statistical Process Control methods in production?
 1. Yes
 2. No
3. Does your plant utilize DOX?
 1. Yes
 2. No
4. In terms of conformity to specifications how does your plant compare with domestic operations of the parent company?
 1. much better
 2. better
 3. about the same
 4. worse
 5. much worse
5. Is your product inspected at different stages of production?
 1. Yes
 2. No
6. Is the final product inspected for defects?
 1. Yes
 2. No
7. Does your plant use more Quality Control inspectors than in a parent company domestic plant?
 1. Yes
 2. No
 3. Don't know
8. Do you currently employ some form of JIT (Just In Time) manufacturing?
 1. Yes
 2. No

9. If you don't currently employ JIT, are you considering implementing it?
 1. Yes
 2. No
10. During the past five years has your plant's rejection rate (the number of defects divided by total production) increased or decreased?
 1. Increased
 2. Decreased
 3. Stayed the same
11. During the last five years has the scrap rate increased or decreased?
 1. Increased
 2. Stayed the same
 3. Decreased
12. Is your production seasonably variable or reasonably stable through the year?
 1. Variable according to season
 2. Stable through the year
13. If production varies, in order to reach production targets will your plant: (circle the appropriate answers):
 1. hire additional workers
 2. add additional shifts
 3. use overtime for existing workforce
 4. subcontract?
14. Is your plant subject to exclusive supply arrangements through your parent or other companies?
 1. Yes
 2. No
15. Is the purchasing department the only group responsible for choosing suppliers?
 1. Yes
 2. No
16. Has your firm (at the plant or parent company level) actively sought out Mexican suppliers for your operations?
 1. Yes
 2. No
 3. Don't know
17. Does your plant use any inputs/supplies from Mexican suppliers?
 1. Yes
 2. No

18. If your plant does use inputs/supplies from Mexican suppliers, what kinds of items do you use? Circle appropriate answers.
1. materials used as inputs into product
 2. building/construction materials
 3. office supplies and furniture
 4. packaging and shipping materials
 5. office machinery
 6. heavy machinery/equipment tools
 7. food items
 8. Other (please specify)
 9. Do not use Mexican inputs/supplies
19. Are you satisfied with the overall performance of Mexican suppliers?
1. Yes
 2. No
 3. Don't use Mexican suppliers
20. If you've had problems with Mexican suppliers, which of the following areas did you encounter trouble? Please choose the appropriate answers:
1. Quality of product
 2. Price
 3. Financial stability of supplier
 4. Delivery times
 5. Other (please specify)
 6. Don't use Mexican suppliers
21. Does your plant purchase any services from Mexican providers?
1. Yes
 2. No
22. What kinds of services does your plant consume from outside Mexican service firms? Please choose appropriate answers?
1. Labor recruiters
 2. Legal counsel
 3. General administrative/secretarial services
 4. Maintenance and repair
 5. Transportation services
 6. Food services
 7. Medical
 8. Business consulting
 9. Other (please specify)
 10. Don't use Mexican services

23. If your plant uses any goods or services from Mexican suppliers, have you made visits to the suppliers' production facilities to assess their manufacturing and quality control methods?
1. Yes
 2. No
 3. Don't use Mexican suppliers
24. Does your plant use any form of Single Minute Exchange of Dies (SMED) technology?
1. Yes
 2. No
25. During the last five years, has the amount of rework increased, stayed the same or decreased?
1. Increased
 2. Stayed the same
 3. Decreased
26. During the last five years, have lead times increased, stayed the same or decreased?
1. Increased
 2. Stayed the same
 3. Decreased
27. During the last five years, have work-in-process (WIP) inventories increased, stayed the same or decreased?
1. Increased
 2. Stayed the same
 3. Decreased
28. In your plant, do line operators ever perform preventive maintenance?
1. Never
 2. Some of the time
 3. Always

Technology and Technology Transfer

1. In general, has your plant implemented more sophisticated technology over the last five years?
 1. Yes
 2. No
2. Is the technology in use in your plant more or less advanced than that for similar operations?
 1. More advanced
 2. Same
 3. Less advanced
3. Does your plant currently use or plan to use CAD/CAM-type techniques in production?
 1. Yes
 2. No
4. Does your plant use or plan to use robotic production technology?
 1. Yes
 2. No
5. Are Mexican personnel involved in the design and implementation of new technology in the production process?
 1. Yes
 2. No
6. Does your plant conduct joint research and development with Mexican organizations, particularly Mexican Technical Institutes?
 1. Yes
 2. No
7. Does your plant conduct joint training activities with any Mexican organizations, particularly Mexican Technical Institutes?
 1. Yes
 2. No
8. Are line employees encouraged to offer creative suggestions as to the more efficient use of equipment?
 1. Yes
 2. No

9. Are line employees encouraged to offer suggestions concerning the more efficient use of worker organization?
1. Yes
 2. No
10. If so, have any of these suggestions been followed?
1. Most of the time
 2. Some of the time
 3. Never
11. Are manuals used when introducing new technology and worker organization?
1. Yes
 2. No
12. If manuals are used, would you describe them as "general purpose" or "detailed"?
1. General purpose
 2. Detailed
 3. Manuals not used
13. When technology, in the form of both equipment and new "ways of doing things" is transferred from your parent company to your plant, what are the most important ways of implementing the changes? Please rate the following on a scale of 1-5, where 5 is "most important" and 1 is "least important"?
1. Manuals
 2. In-house training
 3. Training at parent company
 4. Use of experienced employees
 5. Cross-functional groups (e.g. engineers/technicians working with line workers and supervisors)
 6. Other (please specify)
14. In transferring new equipment from the parent company, are trainers more or less important than manuals in implementing the technology?
1. Trainers are more important than manuals
 2. Manuals are more important than trainers
 3. Both are equally important
 4. Neither are important

15. In transferring new methods of production, from the parent company to your plant, in terms of new ways of organizing and sequencing machines, are trainers more important than manuals in implementing the new methods?
 1. Trainers are more important than manuals
 2. Manuals are more important than trainers
 3. Both are equally important
 4. Neither are important
16. When implementing new technologies and ways of organizing workers and production, do you encourage self-help groups among employees to aid in the absorption of new technology?
 1. Yes
 2. No
17. When introducing new technology and ways of organizing things, do you encourage greater sharing of technical information between and among engineers, technicians, and workers on the line and other departments?
 1. Yes
 2. No
18. When implementing new technologies and ways of doing things do you encourage greater interaction between highly skilled workers and engineers?
 1. Yes
 2. No
19. In your company is it possible for trained technicians and skilled workers to transfer to engineering, production, or process control departments?
 1. Yes
 2. No
20. Do workers on the line talk freely to engineers and technical personnel?
 1. Yes
 2. No
21. Have any process improvements made in your plant been transferred to home company domestic operations?
 1. Yes
 2. No
22. Have any process improvements been made in your plant that have been transferred to other maquiladora plants in your company?
 1. Yes
 2. No

23. When implementing new process technology from your home operating to what extent are instructions "written down" (manuals, written guidelines, etc.)
1. Most of the time
 2. Little of the time
 3. None of the time
24. When machine technology has been transformed from the parent company to your plant, does its implementation take a different form than that in parent plants?
1. Yes
 2. No
25. If machine technology has been adopted to suit the needs of your particular plant, how important has the participation of Mexican workers and technical personnel been in its modification?
1. Very important
 2. Important
 3. Unimportant
26. In the last five years has funding for R&D targeted at your operation increased or decreased when adjusted for inflation?
1. Increased
 2. Decreased
 3. Remained the same
27. Is more R&D funding targeted for your plant in the next five years?
1. Yes
 2. No
 3. Do not know
28. In the last five years has your plant received increasingly or decreasingly sophisticated machine technology?
1. Increasingly sophisticated
 2. Decreasingly sophisticated
 3. Unchanged level
29. Is new equipment in your plant installed primarily to:
1. Increase output
 2. Increase product quality
 3. Decrease costs
 4. All of the above

30. Of the following, which characteristics of your labor force do you feel are most conducive to the diffusion of new technology (please rate from a scale of 1-5 where 5 is "most important" and 1 is "least important"):
1. A high employee sense of "belonging" _____
 2. Broad knowledge across work areas _____
 3. Strong sense of job security among employees _____
 4. High level of job experience _____
 5. High levels of training _____
 6. Other (please specify) _____
31. Does your plant receive any technical assistance from companies other than your parent?
1. Yes
 2. No
32. Does your plant participate in any joint technological ventures (such as shared R&D, etc.) with any of the following (circle any answer):
1. Other maquiladora plants in your company
 2. Other maquiladora plants in your industry
 3. Other domestic firms in your parent's company
 4. Other domestic firms within your parent's industry?
33. Does your current rate of labor turnover adversely effect the continued implementation of advanced technology?
1. No
 2. Yes
 3. No effect
34. Do you believe that the completion of a Free Trade Agreement between the USA and Mexico will affect the kind of machine technology in your plant?
1. Yes
 2. No
 3. Don't know
35. When your home company domestic plant implements new process technology, would say that your plants receives this technology:
1. Rapidly
 2. Slowly
 3. Not at all
36. Have engineers and technical personnel at the home country developed new process technology specifically for your plant (or plants) in maquila operations?
1. Yes
 2. No

37. When implementing new process technology from home plant operations, is oral discussion between engineers and technical personnel (face to face discussions, telephone discussions) or written discussions (FAX, letters, computer mail, etc.) more frequently used?
1. Oral discussions are most frequent
 2. Written discussions are most frequent
 3. Both are used equally
38. In your plant, is your use of visual aids greater, less or about the same than in comparable home-based plants?
1. Greater
 2. Less
 3. About the same

Personnel Management

1. What is your estimated monthly labor turnover rate?
 1. 0-10%
 2. 10-25%
 3. 25-50%
 4. 50% or more
2. Has attracting sufficient numbers of entry level line workers become more or less difficult in the last five years?
 1. More difficult
 2. Less difficult
 3. Unchanged
3. Has attracting sufficient numbers of Mexican technical and engineering personnel become more or less difficult in the last five years?
 1. More difficult
 2. Less difficult
 3. Unchanged
4. Do you offer supplemental income and fringe packages as incentives to either attract or retain workers? If so, which of the following do you offer?
 1. Free or subsidized meals
 2. Vacation plans
 3. Free or subsidized transportation
 4. Child care/day care
 5. Free or subsidized housing or barracks facilities
 6. Savings plans
 7. Flexibility in work hours
 8. Educational/Training benefits (Vocational, Technical, or Language)
 9. Medical benefits of any kind
 10. Other (please specify)_____
5. Do you satisfy your total recruiting requirements by hiring at the "gate"?
 1. Yes
 2. No
6. Do you use newspapers and radio advertising to attract employees?
 1. Yes
 2. No
7. Do you use recruiters when hiring?
 1. Yes
 2. No

8. If you have faced a labor shortage, have you raised your wage above minimum for entry level line workers?
 1. Yes
 2. No
 3. Have not faced a labor shortage
9. Have you observed significant amounts of inter-plant competition for labor using wages and/or fringe packages as inducements to workers?
 1. Yes
 2. No
10. Are the majority of your workers from this city and state or from another region in Mexico?
 1. A majority are from this city and state
 2. A majority are from another region
 3. Don't know
11. Assuming competence and honesty, would you rehire a worker who has quit work at your plant previously?
 1. Yes
 2. No
12. What percentage of your workers are female?
 1. 80-100%
 2. 60-80%
 3. 40-60%
 4. less than 40%
13. What would you estimate is the average age range of your female employees?
 1. 16-22
 2. 18-24
 3. 20-26
 4. 22-28
 5. 24-30
 6. Over 30
14. What would you estimate is the average age range of your male employees?
 1. 16-22
 2. 18-24
 3. 20-26
 4. 22-28
 5. 24-30
 6. Over 30

15. On average, how many employees are your first line supervisors responsible for?
1. 1-5
 2. 5-10
 3. 10-15
 4. 15-20
 5. 20-25
16. What percentage of your plant's technical and engineering personnel are Mexican nationals?
1. 0-10%
 2. 10-20%
 3. 20-30%
 4. 30-40%
 5. 40-50%
 6. over 50%
17. Are first line supervisors trained in such methods as SPC?
1. Yes
 2. No
18. In general, compared to workers in home country operations would you say that Mexican workers are:
1. More productive
 2. Less productive
 3. The same level of productivity
19. In terms of disciplinary problems, compared to domestic operation workers, would you say that Mexican workers are:
1. Better disciplined
 2. At the same level of discipline
 3. Worse disciplined
20. Compared to domestic workers, are Mexican workers more or less open to new ideas and ways of doing things?
1. More open
 2. Less open
 3. The same
21. Are your Mexican workers more or less prepared than home country operations workers in the following areas?
- | | | |
|----------------------|------------|------------|
| 1. Literacy | More _____ | Less _____ |
| 2. Numeracy | More _____ | Less _____ |
| 3. Technical ability | More _____ | Less _____ |

22. Do Mexican workers cooperate and work in groups better or worse than domestic workers in home country operations?
1. Better
 2. Worse
 3. Same
23. Do you employ graduates of Mexican Technology Institutes in your plants?
1. Yes
 2. No
24. If so, are these graduates comparable in technical skill and training to those of parent company technical employees?
1. Yes
 2. No
 3. Don't employ these graduates
25. Do you rotate line workers from one position to another to broaden their knowledge base?
1. Yes
 2. No
26. Do you rotate technical and engineering personnel to broaden their knowledge base?
1. Yes
 2. No
27. If two individuals are equally trained with the same level of productivity, but one has a higher level of education, are the wages of the two workers the same?
1. Yes
 2. No
28. Regardless of education levels, if two workers differ in terms of individual productivity, are their wages different?
1. Yes
 2. No
29. For two workers possessing identical levels of productivity in the same job, but with differing lengths of employment in your plant, will their wages differ?
1. Yes
 2. No

30. In the last five years, if your plant has implemented improved technology or production methods which displace labor, has the general policy of your company been to:
1. lay off the worker
 2. retrain or move the worker to a new job?
31. When a new position becomes available, does your company generally:
1. Hire a new worker
 2. retrain an existing employee
32. Aside from a minimum wage, do you face any regulations concerning wage policy?
1. Yes
 2. No
33. Are any of your workers members of a union?
1. Yes
 2. No
34. If your plant is unionized, do you regularly confer with union representatives about decisions in personnel management?
1. Yes
 2. No
 3. No union
35. Are workers trained by a:
1. professionally trained trainer (who may also be an experienced worker) or,
 2. an experienced worker?
36. Does your plant rely on "internal trainers" (i.e. an employee within your plant) for the majority of employee training?
1. Yes
 2. No
37. Does your plant rely on "external trainers" (i.e. a trainer brought in from outside the plant) for the majority of employee training?
1. Yes
 2. No
38. Are the majority of your plant's trainers, both internal and external, Mexican nationals?
1. Yes
 2. No

39. Are the majority of your trainers from the home country operations?
1. Yes
 2. No
40. For lengthier and more technical levels of training, are trainers most likely to be:
1. Parent company/home country personnel
 2. Mexican nationals
 3. No particular pattern
41. When installing new technology in the plant, are trainers in the use and repair of the new equipment most likely to be:
1. Parent company/home country nationals
 2. Mexican nationals
 3. No pattern in training
42. In your plant, have parent company trainers and Mexican trainers worked together in the design and implementation of training programs?
1. Yes
 2. No
43. In general, are workers trained only in their specific jobs?
1. Yes
 2. No
44. Does your plant send Mexican personnel to the parent company headquarters for training?
1. Yes
 2. No
45. Does increased training of employees increase the likelihood that they will leave your plant to take another job outside of your company?
1. Yes
 2. No
 3. Don't know
46. Does increased training of employees increase the likelihood that the employee will be transferred to another plant within your company?
1. Yes
 2. No
 3. Don't know

47. Overall, would you say that training increases or decreases labor turnover in your plant?
 1. Increases turnover
 2. Decreases turnover
 3. Don't know
48. Do you use numerical production quotas for workers?
 1. Yes
 2. No
49. Do you use piece-work?
 1. Yes
 2. No
50. Do you encourage workers' suggestions?
 1. Yes
 2. No
51. If so, do you implement
 1. many suggestions
 2. few suggestions
52. Does your plant have Quality Control (QC) Circles?
 1. Yes
 2. No
53. If so, are these groups comprised of just workers or workers and supervisors?
 1. Workers only
 2. Workers and supervisors
 3. No QC Circles in plant
54. Does your plant have a Quality Department?
 1. Yes
 2. No
55. Does the plant provide QC groups with materials, manuals, or other aids concerning quality and continuous improvement?
 1. Yes
 2. No
56. Do you believe that greater employment stability encourages worker's concern for quality improvement?
 1. Yes
 2. No
 3. Don't know
57. Are employees required to read or recite the company's philosophy, goals and/or creeds?
 1. Yes
 2. No

VITA

Steven Rone Wilson was born in Camden, New Jersey on November 4, 1956. After graduating from Pawocas Valley High School in Mt. Holly, New Jersey in 1975, he entered the United States Army. As a graduate of the Defense Language Institute, he served in several areas including Panama and Ft. Bliss, Texas. He received his B.B.A. degree from The University of Texas at El Paso in 1983. He worked for Pfizer Pharmaceuticals in Albuquerque, New Mexico for a year. He received a Master of Arts in Economics in 1986 from The University of Texas at El Paso, and then attended The University of Tennessee at Knoxville, receive a Ph.D. in Economics in December, 1992.

He is presently employed as an Industrial Development Officer with the United Nations Industrial Development Organization (UNIDO) in Vienna, Austria.