1989

Preparing Production Workers to Meet the Demands of the Global Economy and a Computerized Manufacturing Environment

Diane Bounds
Loyola University Chicago

PREPARING PRODUCTION WORKERS TO MEET THE DEMANDS OF THE GLOBAL ECONOMY AND A COMPUTERIZED MANUFACTURING ENVIRONMENT

by

Diane Bounds

A Thesis Submitted to the Faculty of the Graduate School of Loyola University of Chicago in Partial Fulfillment of the Requirements for the Degree of Master of Science in Industrial Relations

October

1989

ACKNOWLEDGMENTS

This thesis is the result of several months of research into the various challenges facing American manufacturing organizations. I would like to express my gratitude to all those who have assisted me and shared the challenges I faced in completing this research.

Special acknowledgment is due Frank Rudolph who has participated in retraining programs and is experiencing the transition of American manufacturing first hand. I am grateful for his willingness to share his insight and experiences with me.

Special thanks to Dr. Lemont Stallworth who provided valuable insight as the reader of my thesis. His recommendations assisted me in refining the concepts and content of my paper.

I am especially indebted to Dr. Arthur Dobbelaere who directed my thesis. He provided support and, most importantly, stimulated me to further develop my own ideas and my own strategies as I formulated my thesis. Also, a special thanks to Dr. Dobbelaere for his patience and his guidance throughout my studies at the Institute. For this, I am very grateful. Finally, thanks to my husband Mark for his continuing support and encouragement throughout all of my professional and academic pursuits.

VITA

The author, Diane Bounds, was born August 24, 1963, in Wilmette, Illinois. She attended St. Francis Xavier Grammer School and Regina Dominican High School, both in Wilmette. She completed high school in June, 1981.

The following August, Ms. Bounds entered the University of Iowa. In May of 1985 she received the degree of Bachelor of Business Administration in Industrial Relations and Human Resources Management.

Upon receipt of this degree, Ms. Bounds began her professional career in the field of human resources management. She entered Loyola University's Institute of Industrial Relations in May of 1988. Ms. Bounds has continued to pursue her professional career in the field of human resources and is currently a practicing management consultant.

TABLE OF CONTENTS

INTRODUCTION

The following thesis describes several external forces effecting the operations of American manufacturing companies. These forces include growing international competition, the shifting economic base of the United States, the changing demographics of the labor force, and rapidly advancing technology. Each of these separate phenomena will influence the way manufacturing firms operate. In turn, they will influence the way many American's work. This thesis will show how leaders in American manufacturing firms can resolve the conflicting pressures being exerted by the competitive environment and the changing labor force.

Growing international competition will force many producers to invest in advanced manufacturing technology, in particular, computer-integrated manufacturing systems. This thesis argues that implementing and operating this type of equipment requires a work force with significantly different skills than were required by traditional manufacturing equipment. Additionally, the technology will alter the structure of many manufacturing firms and again, place new demands on the work force.

This thesis will present evidence to show that implementing computer-based equipment will require

manufacturers to design jobs which require the intellectual input of workers. The machines will place mental rather than physical demands on production workers. This manner of implementing new equipment and designing jobs is the only way for companies to fully utilize the capabilities of the equipment. More importantly, fully utilizing the capabilities of information technology is the only way for producers to remain competitive in the global economy.

Traditionally, manufacturers have used new machines to decrease the input of the work force. The ultimate goal was always to minimize skills needed to perform production related tasks. Today, with the advent of computer technology and international competition, management philosophy is changing. Management is facing a market which demands custom products and quick response time. To meet this demand, they must increase the flexibility and technological sophistication of their operations. The concept of task specialization will be replaced by the concept of a mult-skilled work force. This will require higher skill levels for nearly all production workers.

I have based my analysis on a number of government and empirical studies. Through my research it became evident that increasing foreign competition has lead manufacturers to innovate their operations by investing in advanced technology. Studies show that many employers have found this to be an effective means of gaining and maintianing a

competitive advantage.

Predictions and current statistics compiled by the Bureau of Labor Statistics indicate that major shifts are occuring in the demographics of the work force of the United States. Additionally, other government studies indicate that the future work force will be lacking in basic skills such as math, reading and science. Manufacturers will need workers with these skills to operate modern factories based on information technology and new process controls. The result is a work force severely lacking in the skills required to perform the work available. In the coming decade, the type and level of skills supplied will not match the type and level of skills demanded.

The problem arises as to whether or not manufacturers will be able to find an available work force with the skills and abilities necessary to operate computer-based equipment. The following thesis argues that they will not "locate" a new work force. Rather, leadership in manufacturing firms will invest in training programs to "create" the needed work force. To operate advanced equipment workers will need advanced skills. Evidence is presented which indicates that the changing demographics of the work force and the growing service sector will make it increasingly difficult for employers to recruit production workers with these skills.

This thesis incorporates the findings of studies which analysed the effect of technology on the work place. In

particular, I limited the focus of my analysis to studies of manufacturing organizations who have implemented advanced manufacturing technology in response to pressures from global competition. That is, organizations who have innovated their operations to remain competitive.

Based on the experiences of employers implementing advanced technology, management will find it to their advantage to design training programs to raise the skill level of their incumbent and entry level work force. In the long run, this will be the only effective means of maintaining needed skills and, consequently, the only effective means of remaining competitive. The evidence indicates that recruiting a new work force or designing jobs to minimize skill requirements does not provide the benefits of retraining and raising the skill level of the current work force.

This thesis concludes with a description of one firm's experience in retraining their work force. Packaging Corporation of America implemented advanced technology to compete with foreign producers. They also decided to implement new process controls in order to transform their workplace. Their goal was to create a modern factory based on new management philosophies and new computer-based equipment. Prior to implementation, they also chose to raise the skill level of their work force. Packaging Corporation believed that this would maximize the production

gains which would be derived from the advanced equipment and improved process controls.

My analysis describes their training program and evaluates its structure based on Packaging Corporation's objectives. Through this analysis I summarize the type of program employers should develop to retrain their work force for computer-based technology. Finally, the experiences of Packaging Corporation of America highlight the concerns of many leading American manufacturers and provides an example of one employer's successful response to challenges presented in today's economic environment.

CHAPTER I

THE UNITED STATES ECONOMY

The Changing Economic Base

Shifts or trends in an economy are a natural part of their evolution. As an economy evolves, current theory states that it will progress through three major phases. Each phase is defined according to the "industry" on which the economy is dependent. Phase one is agriculture, phase two is manufacturing or industrial, and finally, the service phase. The United States' economy is in the midst of transition. It is progressing from an industrial to a service economy. During this transition there are many adjustments and challenges for employers to face. Their ability to weather these changes will be enhanced by their understanding of the events taking place.

The United States began its evolution from an agrarian to an industrial economy during the last half of the nineteenth century. The transition to industry was influenced greatly by innovations in transportation and in communications. These advances led to the development of

national markets and to the rise of big business.[1] During the transition to an industrial economy, the number of people employed in agriculture and its portion of our national income declined significantly. In 1870, nearly three-fourths of all Americans lived on farms and agricultural production generated one-third of our national income.[2]

> By 1910, barely one-third of all Americans were actually engaged in agriculture and their produce claimed less than one-fourth of the national income.[3]

As agriculture decreased in importance, industry and manufacturing increased in importance. These industries employed larger portions of the work force and were responsible for most of the economic prosperity of the United States.

A similar transition has been occurring during the last decades of the twentieth century. Recent expansion in the economy has been driven entirely by the service sector. Accordingly, this sector has generated a larger number of new jobs than the goods-producing sector. As a result, the proportion of jobs in the goods-producing sector has been steadily declining. In 1982, 25.9% of all jobs were in this

---

[1]Glenn Porter, ed. Encyclopedia of Economic History (New York: Charles Scribner's Sons, 1980), s.v. "Communications," by James H. Madison. 338.

[2]Ibid., 100.

[3]Ibid.

sector. By 1988 this number had fallen to 24.1%.[4] The goods-producing sector's total employment did increase by 2.6 million jobs, but its share of employment was reduced by 1.8 percentage points.[5] In contrast, the service-producing sector's share of employment (includes government services) increased from 74.1% to 75.9% over the same period. This amounted to a total of 14.7[6] million new jobs; more than five times the number created by the goods-producing sector.

The Bureau of Labor Statistics (BLS) predicts this trend in employment growth will continue. Throughout the 1990s almost all the new jobs will be created by the service-producing sector.

> Although some goods-producing industries are projected to grow, others are projected to decline, with a net employment change of zero.[7]

In 1988, 24.1% of all Americans worked in the goods-producing sector. By 2000, this number will decrease to 22.3%[8]. Employment will continue shifting from the goods-producing sector to the service-producing sector.

---

[4]Wayne J. Howe, and William Parks II, "Labor Market Completes Its Sixth Year of Expansion in 1988," Monthly Labor Review 112:2 (February 1989): 6.

[5]Ibid.

[6]Ibid.

[7]Valerie A. Personick, "Industry Output and Employment Through the End of the Century," Monthly Labor Review 110:9 (September 1987): 30.

[8]Howe and Parks, 8.

The Goods-Producing Sector

In the goods-producing sector, 75.6%[9] of all jobs are currently in the manufacturing division. Given this sizable percentage, the performance of this sector is determined in large part by the success or failure of this division. Not surprisingly, employment in manufacturing has been on a steep decline for quite some time.

> In 1961, 36.6% of non-agricultural jobs were in manufacturing at the end of 1988, however, the share had dropped to 24.1%.[10]

Further, the BLS predicts that overall employment in manufacturing will decline an additional 4% between now and the end of the century.[11] Given these statistics, we can expect manufacturing's negative influence on the goods-producing sector to continue at least until the year 2000.

With manufacturing representing such a sizeable majority of the sector's employment, there is little that other industries can do to offset the decline. Moreover, the construction industry is the only division in the sector which is expected to show any increase at all during the next decade.[12] Here, employment rose by 305,000 jobs in

---

[9]Howe and Parks, 8.

[10]U.S. Department of Labor, Bureau of Labor Statistics, "Projections 2000," Occupational Outlook Quarterly 31:1 (Fall 1987): 27.

[11] Howe and Parks, 7. and Department of Labor, Bureau of Labor Statistics, "Tomorrow's Jobs," Occupational Handbook 1988/89 Bulletin 2300, (April 1988): 10.

[12]Howe and Parks, 7.

1988.[13] Projections by the BLS indicate that employment levels will increase an additional 9.7% by the year 2000.[14] However, this growth will have little impact on the sector as a whole. The construction division only employs 20% of the sector's work force.[15] This portion is not large enough to offset the anticipated decrease in the more dominant manufacturing industry.

The Service-Producing Sector

As the United States continues to progress towards a service based economy, job growth in this sector will continue to increase at a healthy pace. Eventually, the economy will be completely dependent upon this sector. By the beginning of the next century, new jobs in the economy will be generated almost entirely by the service sector.[16]

As noted earlier, 75.9% of the work force in the United States was employed in the service-producing sector during 1988.[17] Over the next 12 years, this sector will generate enough new jobs to increase this percentage to 77.7%.[18] A

---

[13]Howe and Parks, 7 and Dept of Labor, "Projections 2000", 27.

[14]Howe and Parks, 7.

[15]Ibid., 6.

[16]William B. Johnston and Arnold H. Packer, Workforce 2000 (Indianapolis: Hudson Institute, 1987): xiii.

[17]Dept of Labor, "Projections 2000," 2.

[18]Howe and Parks, 5.

majority of this expansion will occur in two divisions: service and retail trade. In fact, the growth in these two divisions "will add more jobs between 1985 and the year 2000 than now exist in all United States manufacturing."[19]

First, high growth rates are anticipated for the service division. This division consists of healthcare, business, legal, social and other miscellaneous services. In 1988, this division accounted for 45%[20] of the service sector's total growth. Further, the BLS predicts an additional 33% increase in this division's employment by the end of the next decade. Such an increase would account for more than one-half[21] of all new jobs in the service-producing sector.

This extraordinary expansion will be fueled by an increasing demand for healthcare and business services. This includes computer and data processing services, outpatient care facilities, offices of physicians and personnel supply services. At the very least, the BLS expects these particular industries to show a 70% increase in employment by the year 2000.[22]

Retail trade will be the second fastest growing division in the service sector. During 1988, 22% of the

---

[19]Johnston and Parks, 59.

[20]Dept of Labor, "Projections 2000," 23.

[21]Ibid., 23.

[22]Howe and Parks, 6.

sector's total employment was in retail trade.[23] Projections by the BLS show this division increasing by an additional 27.2%[24] by the year 2000. Of these 4.9 million new jobs, 2.5[25] million will be in eating and drinking places. Much of the growth in retail has been and will continue to be in this particular industry.

The vast majority of Americans will continue to work in the service sector. More significant, however, will be the service sector's ability to create more and more new jobs. This ability will continue to widen the employment gap between the goods-producing and the service-producing sector. The service sector is rapidly becoming the sole source of new jobs in the United States.

The Changing Occupational Structure

An understanding of the transition now underway is vital for all employers who wish to compete in the emerging global economy. The information provided above can be used to predict the type of work American's will be performing. In other words, the changing industrial structure provides valuable insight into the changing occupational structure.

Based on the economy's expected growth pattern, the BLS has devised projections for expected growth in various occupations. Again, these projections are, for the most

---

[23]Dept of Labor, "Projections 2000," 23.

[24]Ibid., 25.

[25]Ibid., 25.

part, calculated by extending current growth patterns into the future. Demand for employees in occupations found predominately in the service sector has increased relative to the expansion in this sector. Similarly, demand for employees in occupations found predominately in manufacturing industries has been declining. This reflects the diminishing role of manufacturing in our economy.

Low Skill Occupations

Generally speaking, the following occupations are considered "low skill" because they require a relatively low level of education or training. They include administrative support workers; farming forestry and fishing workers; operators, fabricators, and laborers; and service workers. With the exception of the service group, these low skilled occupations are expected to grow more slowly than high skilled occupations. This can be attributed to two factors. First, the farming and the operator groups are both concentrated in manufacturing industries. Second, the expansion of technology has increased the complexity of the workplace, thereby raising skill requirements.

During 1988, the low skill occupational categories experienced the following percentage changes in employment: administrative support, -1.5; service, 2.6; operators, fabricators and laborers, 1.7; and farming, forestry and

fishing, 1.5.[26] With the exception of the service group, these rates are below the average 2.1% increase in over-the-year employment for all occupational groups.[27]

Office automation has had a tremendous impact on the demand for administrative support occupations. It has decreased the need for some, such as typists and stenographers, and increased the need for others such as computer operators. Overall, the BLS predicts that two million new jobs will be added to the administrative support category by the beginning of the next century.[28] Its percent of total employment will, nonetheless, decrease from 17.8% in 1986, to 16.6%.[29] According to these statistics, new jobs are being created but the group is decreasing as a percent of all workers.

The decreasing level of employment in manufacturing has led to a decreasing demand for operators, fabricators and laborers.[30] These occupations are found almost exclusively in this division of the goods-producing sector. As noted earlier, this group experienced a relatively small increase in employment during 1988. This trend is expected to worsen

---

[26]Howe and Parks, 7.

[27]Howe and Parks, 7.

[28]Dept of Labor, "Projections 2000," 3.

[29]G. T. Silvestri and J. M. Lukasiewicz, "A Look at Occupational Employment Trends to the Year 2000," Monthly Labor Review 110:9 (September 1987): 47.

[30]Howe and Parks, 7.

in the coming years. "By the year 2000, manufacturing will employ 2.2 million fewer workers than it does today."[31] The shrinking number of manufacturing jobs will lead to further decreases in the demand for operators, fabricators and laborers.

Of the low skill workers, service employees showed the greatest over the year change in employment. The rapid expansion in service industries has generated a higher demand for service workers. With this expansion expected to continue, the demand for low skill service workers should continue to grow at a faster than average pace.[32]

> The projected growth rate [for service workers] of 33% for 1986 to 2000 is faster than total employment and, consequently, the share of total employment accounted for by service workers is expected to jump from 14.8% in 1986 to 16.5% in 2000. Much of the large projected employment gain in this occupational group is concentrated in food service and health service occupations.[33]

The extraordinary growth in service occupations is a major exception to the generally decreasing demand for low skill occupations.

High Skill Occupations

The changing economy and advancing technology have had the opposite affect on the demand for high skill workers. This includes the following occupational groups: executive,

---

[31]Johnson and Parker, 58.

[32]ibid.

[33]Ibid.

administrative and managerial; professional; and technical workers. Employment levels in these groups increased by 5.5%, 4.1% and 4.8% respectively during 1988. These rates were well above the average 2.1% growth rate experienced by all occupational groups.

The BLS expects similar rates of growth in high skill occupations throughout the next decade. Projections for the period of 1986 to 2000 show the following increases in employment for each group: executive, administrative and managerial, 29%; professional, 27%; and technical, 38%.[34] As in 1988, these percentages are well above the projected average increase of 19% for all occupational groups.[35]

The large increases in high skilled employment reflects the changing needs of the economy. For example, the BLS reported that growth in the executive and managerial groups

> ..will be spurred by the increasing complexity of business operations and by large employment gains in trades and services, industries that employ a higher than average proportion of managers.[36]

The growing demand for technical and professional workers is attributed to similar factors.[37]

The growth rate for occupational groups is derived from expected adjustments in the industrial structure of the

---

[34]Dept of Labor, "Projections 2000," 30.

[35]Ibid.

[36]Dept of Labor, "Tomorrow's Jobs," 11.

[37]Ibid.

economy. Therefore, occupations related to service industries will grow more rapidly that those related to goods-producing industries. Similarly, changes in the business environment will effect occupational demand. Business has become increasingly dependent upon advanced technology for daily operations. This dependence is creating a growing need for technicians and professionals who possess the skills necessary to perform in a complex environment.

The Changing Demographics of the Labor Force

Changes in the composition of the labor force are caused by the interaction of two variables; changes in the population and changes in labor force participation rates. The labor force participation rate is the percent of the non-institutional[38] population over 16 either working or looking for work. To analyze expected changes in the labor force, trends in population growth and participation rates must be considered. These two variables form the basis for labor force projections.

Population Growth

According to the Census Bureau, the composition of the United States population is as follows: 78.1% non-Hispanic white, 12.1% non-Hispanic black, 7.1% Hispanic origin and

---

[38]excludes persons confined to medical or penal institutions.

2.7% all other races (i.e. Asian, Pacific Islanders).[39] In 1986, the population of the United States totaled 240,468,000. By 2000, this number will rise to 268 million.[40] The increases and growth rates expected in each of the above groups is listed in Table 1. Despite the expected increase in numbers, the population is expected to grow at a relatively slow pace over the duration of this century. "This slowing reflects the anticipated drop in births, as well as the slight drop in net migration."[41]

Generally, there will be an aging of the population. The median age will increase from 31.5 in 1985 to 36.3 in the year 2000. This is due in large part to the aging of the baby boomer generation (population born between 1946 and 1964). In fact, all members of this group will be over age 35 at the end of the next decade.[42]

Throughout the 1980's, the Hispanic[43] population has grown by an extraordinary amount. In just the first five

---

[39]U.S. Department of Commerce, Bureau of the Census, Projections of the Population of the U.S. by Age, Sex and Race 1988-2080, Series P-25, #1018 (Washington D.C., Government Printing Office): 7.

[40]Ibid.,5

[41]Howard N. Fullerton Jr., "Labor Force Projections: 1986-2000," Monthly Labor Review 110:9 (September 1987): 21.

[42] Dept of Commerce, 6.

[43]Those categorized as Hispanic by BLS or the Census Bureau many fall into black or white racial categories. The term Hispanic refers to a ethnic origin, rather than a racial category. It describes individuals whose ancestral origin is a Spanish speaking country.

years, this population experienced a 22%[44] increase. Much of their growth is a result of immigration. Fifty one percent of the increase in their population from 1980-1985 was comprised of immigrants. Additionally, "Hispanics now account for 30% of the total legal immigration"[45] into the United States.

Higher than average fertility rates have accelerated the expansion of this population. Higher fertility rates apply to all segments of the Hispanic population, regardless of income, education or marital status.[46] Population predictions made by the Bureau of the Census are based on a continuation of current fertility rates. They indicate that from 1985 to 2000 there will be a 46% increase in the Hispanic population.[47] This will effectively raise their percent of the total population from 7% to 9.4%. Hispanic's, both native born and immigrants, will account for the largest portion of our population growth in the next decade.

Asians and Pacific Islanders will also account for a large share of our population growth. Between 1980 and 1985, there was a 37.5% increase in their numbers. Two-

---

[44]Dept of Commerce, 5.

[45]Barry P. Chiswick, "Hispanic Men: Divergent Paths in U.S. Labor Market," Monthly Labor Review 111:11 (November 1988): 33.

[46]Ibid.

[47]Dept of Commerce, 5.

thirds of this amount was the result of immigration. In recent years, immigrants have accounted for increasing portions of the nation's population growth.[48] This trend is driven mainly by the large number of Asian and Hispanic immigrants.

This trend is also apparent given the very low growth rate among the white and black populations. These rates have been declining for nearly 30 years.

> Since 1960, black growth rates have decreased by more than one third and for whites, by more than one half. Blacks will, however, grow faster than whites.[49]

Despite high growth rates, the Asian and other (Asians, Pacific Islanders, American Indians and Alaskan Natives) segment of the population will only comprise 3.6% of our entire population in the year 2000. Further, Hispanics will account for 9.4%, blacks 13.4% and whites 73.1%[50].

By the year 2000, these changes will have altered the composition of our population and consequently, the composition of the labor force. Effectively, this will result in a work force which is older, and one which contains more minorities and more immigrants. As these changes occur, it will be helpful for employers to understand the specific characteristics of each segment of the working population.

---

[48]Ibid., 4.

[49]Ibid.

[50]Dept of Commerce, 7.

Table 1. Population Growth: 1985 to 2000[51]

	1985		Growth	2000	
	Number*	Percent	Rate	Number	Percent
WHITES	187.3	78.1	5.3	197.3	73.6
BLACKS	29.0	12.1	24.1	36.0	13.4
HISPANICS	17.8	7.1	46.0	25.2	9.4
ASIAN & OTHER	6.4	2.7	48.4	9.5	3.6

*numbers in millions

The Youth Labor Force

The decreasing size of the population age 16 to 24 is effectively reducing the size of the youth labor force. The labor force participation rate for this group has remained virtually unchanged throughout the 1980s[52] but their actual numbers have decreased. In July 1988, 25.3 million workers were between the ages of 16 and 24. This was a decrease of 1.6 million workers, or 6.1% since 1984.[53] This is a significant reduction in only four years.

Their numbers are expected to decrease for a few more

---

[51]Ibid.

[52]U.S. Department of Labor, Bureau of Labor Statistics, "Proportion of Youth with Jobs," News USDL 88-422, (August 1988): 4.

[53]Ibid., 4.

years. In fact, "the teenage labor force is projected to drop by 1.5 million between 1986 and 1992 and then increase by 1.4 million between 1992 and 2000.[54] The proportion of our work force in the 16-24 age group will, nonetheless, be reduced. In the year 2000, they will account for 16%[55] of the total work force, compared to 21% today.[56]

The vast majority of young workers are employed in retail trade.[57] The large number of low skill jobs are well suited for young workers who have not acquired job specific skills. Additionally, students are attracted to retail by the availability of part-time work. They need flexible hours which can be adjusted around their class schedule. One-third of all retail employees work less than 35 hours a week.[58] Moreover, much of the recent employment growth in the retail trades has been for part-time employment.[59] Young workers have become one of the divisions primary labor sources.

As such, their shrinking numbers will be a particular

---

[54]Fullerton, 22.

[55]Ibid.

[56]Dept of Labor, "Proportion of Youths with Jobs", 4.

[57]Steven Haugan, "The Employment Expansion in Retail Trade 1973-85," Monthly Labor Review 109:8 (August 1986): 13 and Ann McDougell Young "Fewer Students in Work Force as School Age Population Declines," Monthly Labor Review 107:7 (July 1984): 84.

[58]Haughan, 13.

[59]McDougall Young, 84.

concern for retail employers. Extraordinary increases in the number of low skill service jobs and the declining pool of young workers may require the use of alternate labor sources or new methods to improved efficiency which decrease labor requirements. The shifting composition of the labor force will require increased flexibility in the hiring practices of many retail organizations.

The Female Labor Force

The changing role of women in the work force is not the result of a change in their population; rather, it is due to their increasing participation rate. In 1960, for example, the labor force participation rate for women of prime working age (25 to 54) was 36.8%, compared to a rate of 96.5% for men.[60] Since 1960, their participation in the labor force has been steadily increasing. In fact,

> women accounted for 60% of the job growth in the United States labor force since [that time] and they are expected to account for 64% of the total growth in the next decade.[61]

To date, the labor force participation rate for women over age 16 has already reached 57.2%.[62] This rate is expected to continue increasing throughout the 1990s. By 2000, the

---

[60]Susan E. Shank, "Women and the Labor Market: The Link Grows Stronger," Monthly Labor Review 111:3 (March 1988): 7.

[61]Women Employed Institute, Occupational Segregation, (Chicago: Women Employed Institute, 1988), 2.

[62]Dept of Labor, "Current Labor Statistics: Employment Data," Monthly Labor Review 112:2 (February 1989): Table 4, 69.

labor force participation rate for the female population over age 16 will reach 61.5%.[63]

Mothers are responsible for much of the influx of women into the labor force. In the last 15 years, they have rendered obsolete many of the traditional stereotypes of working women.

> As recently as 1975, a Bureau of Labor Statistics study found sharp differences in participation rates of women, by marital status, and presence and age of children.[64]

Today, women in the work force cannot be categorized along traditional lines.

In 1975, only 55% of mothers with school age children (ages 6 to 17) worked. By March 1987, this percent was up to 72%.[65] The numbers are just as startling for mothers of young children (five years old and under). In 1975, only 31% of all wives with husband present and children less than one year were in the labor force. In just ten years the percent climbed to fifty.[66] For women with children less than five years old, 62% were now in the work force.[67]

---

[63]U.S. Bureau of the Census, Statistical Abstract of the United States: 1988, 108th Ed.,(Washington, D.C.: Government Printing Office 1987), Table 608, 366.

[64]Ibid., 3.

[65]Women Employed Institute, 2.

[66]Howard Hayghe, "Rise in Mothers' Labor Force Activity Includes Those with Infants," Monthly Labor Review 109:2 (February 1986): 43.

[67]Ibid.

Traditionally, mothers, especially those of young children, had very low labor force participation rates. Today, a majority of these women have opted to remain in or return to the work force.

With the increased participation of women, there is obviously a corresponding increase in their portion of the work force. In their projections for 1986-2000, the Bureau of Labor Statistics states that 14 million more women will be in the labor force by the year 2000.[68] This will result in a total of 66 million female workers and effectively increase their portion of the work force to 47%.[69] Based on these numbers, in the year 2000, slightly less than half of our work force will be comprised of women.

The increased participation of women age 55 and over has also been particularly interesting. Typically, few women in this segment of the population were employed outside the home. Over time, however, women over age 55 have increased their rate of participation. The opposite has been true for their male counterparts. Over the last twenty years, an increasing number of men over age 55 have opted for early retirement.[70] The combination of these two trends has resulted in a substantial increase in the

---

[68]Dept of Labor, "Projections 2000," 9.

[69]Ibid.

[70]Helen Axel, ed., Employing Older Americans: Opportunities and Constraints (New York: The Conference Board, 1988), 10.

proportion of women in the older work force.

> In 1950, only 2 out of 10 workers age 55 and over were women. Since then, early retirement by men and an increased labor force participation rate for women in their mid fifties have expanded that proportion rapidly. As a result, women age 55 and over are now 4 out of every 10 workers.[71]

At this time, it is unclear if this trend will continue. In the coming years, increasing numbers of women in this age bracket will have work life experiences similar to men. Women may, in turn, follow the male pattern toward early retirement.

> For women age 55 to 64, there is no indication of a trend toward early retirement except for a leveling off in their participation rate since 1970. Participation rates of women at all younger ages have been increasing....Perhaps what we are observing is a tendency for more women to remain in the labor force throughout their work lives being balanced out by one age group (55 to 64 years old) whose patterns are becoming more similar to those of men.[72]

Whether women age 55 and above will maintain their current participation rates and whether they are following the male pattern is yet to be determined.

We have determined that women are still entering traditionally female occupations. The Women Employed Institute reports that

> In 1960, 52% of all employed women were clerical workers, saleswomen, waitresses and hairdressers; today, 46% of all working women can still be found in these four occupations. In 1960, only 12% of women were professional and technical workers and more than

---

[71]Diane E. Herz, "Employment Characteristics of Older Women," Monthly Labor Review 111:9 (September 1988): 3.

[72]Axel, 10.

> half of these were teachers and nurses; today, the percentage of women working in professional and technical positions has risen to 17.5% but still more than half of these are teachers and nurses.[73]

In 1987, 29% of working women were in clerical positions. This was the largest concentration of women in any occupational group. Next was the service group employing 18.1%, followed by sales with 12.8%, and professionals with 14.3%. The smallest concentration was in the managers and officials category which employed 10.1% of all working women.[74] It appears that women may be moving very rapidly into the work force but they are moving very slowly into non-traditional occupations.

The Hispanic Labor Force

As previously noted, the Hispanic population has grown markedly in the last 10 years. This growth has manifested itself in a rapidly expanding labor force. In all, "their employment increased 2.6 million from 1980 to 1988."[75] Further, "they have been the fastest growing labor force group throughout the 1980's."[76] During the period of 1980 to 1987, the size of their work force grew by 39% while the

---

[73]Women Employed Institute, 5.

[74]Ibid.

[75]Howe and Parks, 9.

[76]Ibid., 12.

size of the non-Hispanic work force increased only 10.4%.[77] By the end of 1988, their labor force had expanded another 5% compared to less than 1% for the rest of the population.[78]

The increasing size of the Hispanic population has led to a corresponding increase in the size of their labor force. The increases have been accelerated by the groups increasing labor force participation rate.

> The rate of labor force growth for Hispanics has consistently exceeded that of their population and during the current expansion (1983 to present), their labor force participation rate surpassed that of whites for the first time. In 1988, it continued to be the highest rate among all race and ethnic groups.[79]

This combination of a growing population and rising participation rates have allowed Hispanics to seize a major portion of the opportunities created by the economic expansion which began in 1982. Since that time, this population accounted for more than 15% of the gains in employment.[80] Undoubtedly, Hispanic's will continue to play a dominant role in the expansion of the work force of the United States.

---

[77]Peter Cattan, "The Growing Presence of Hispanics in the U.S. Work Force," Monthly Labor Review 111:8 (August 1988): 9.

[78]Howe and Parks, 11.

[79]Ibid., 12.

[80]Ibid.

> The Hispanic labor force will rise from 8 million in 1986 to 14 million in the year 2000. Growth will occur because of immigration and the rise in the native born Hispanic population.[81]

The 6 million new workers will represent a 74% increase in the size of the Hispanic labor force between 1986 and 2000. In turn, they will represent 10% of the labor force as compared to 7% in 1986.[82]

The penetration of Hispanics into the work force has not led to a corresponding penetration of this population into all occupational groups. They are still "somewhat more likely than the overall work force to be employed in lower skilled and lower paid occupations."[83] As of 1987, three-fifths of hispanic women were still employed in low skilled administrative support and service occupations.[84]. Also, Hispanic women have moved into non-traditional occupations at a slower rate than non-Hispanic women.[85] While occupational segregation is a common characteristic among all women, it is somewhat magnified among the Hispanic population.

Similar problems are faced by Hispanic men.

> Job growth for Hispanic men was concentrated in occupations requiring intermediate skills. Operators,

---

[81]Dept of Labor, "Projections 2000," 12.

[82]Ibid.

[83]Cattan, 13.

[84]Ibid.

[85]Ibid.

> fabricators and laborers (have) accounted for nearly one third of their employment. In contrast, job growth for non-Hispanic men was concentrated in managerial, professional positions and accounted for more than one quarter of their employment.[86]

In the decade ahead, Hispanics will represent a larger portion of the labor force and comprise a majority of its growth. Their concentration in low skill jobs may present them with employment problems in the future. If more and more of the job growth is for positions requiring higher skill levels this population may lack the qualifications to perform these jobs. The Hispanic population may need to improve their job skills, if they wish to maintain their current employment levels.

The Immigrant Labor Force

Reflecting their important role in anticipated population growth, immigrants will also represent an appreciable portion of labor force growth. Before reviewing their expected contributions, please note that numbers for net migration must be interpreted carefully. They have been taken from the Bureau of the Census' middle scenario. As such,

> these numbers include undocumented workers who were added into this scenario for the first time in 1986. Also, emigration numbers are higher than previously, due to greater return of foreign-born persons to their native countries.[87]

---

[86]Ibid.

[87]Fullerton, 20.

Also, immigrants are categorized as either white, black or Asian and others (Asian, Pacific Islander, American Indian, and Alaskan Native). Hispanics are included within black and white racial categories and are not accounted for separately.

Keeping these facts in mind, immigrants are projected to account for 23.4% of labor force growth over the 1986 to 2000 period. Specifically, 14.4% of this growth will be white, 2.3% will be black and 6.7% will be Asian immigrants.[88] While their contribution will be significant, their numbers are not as dramatic as those for Hispanics as a whole.

They will, however, present unique challenges to employers because they are not a homogeneous population. Immigrants come from vastly different cultures and religions. Further, "immigrants tend to be of working age and have different educational and occupational backgrounds."[89] For this reason, they will effect the culture and environment of the workplace to a greater degree than other more homogeneous populations. Their effect will extend beyond merely that of changing the composition of the labor force, they will also affect conditions in the workplace.

---

[88]Fullerton, 27.

[89]Dept of Labor, "Projections 2000," 8.

The Black Labor Force

As with Hispanics, the size of the black work force has grown faster than that of whites. Since 1972, the black labor force has grown by 4.3 million. The Bureau of Labor Statistics projects their employment to increase an additional 3.1 million by the end of the century.[90] At that time their total employment will reach 16.3 million.

Using these statistics, the black work force will increase by 23% over the next 11 years while the white work force will only increase 10.8%.[91] The greater percentage increase for the black population, as compared to whites, is primarily due to their higher fertility rates.[92] However, their effect on the work force will be significantly less than that of the Hispanic population which is expected to increase the size of its work force by 74% during this same period.

Whites will account for a smaller portion of labor force growth than blacks, hispanics and immigrants. The increasing size of the minority work force may provide them with new employment opportunities. In the future, employers may be required to fill traditionally "white" jobs with members of the minority population. These circumstances may present employers with new staffing and manpower concerns,

---

[90]Fullerton, 23 and Howe and Parks, 11.

[91]Dept of Labor, "Projections 2000," 11 and Fullerton, 23.

[92]Dept of Labor, "Projections 2000," 11.

making affirmative action programs a matter of survival.

The legal status of several affirmative action strategies have recently come under the scrutiny of the Supreme Court. The court has prohibited the use of minority set aside programs which were used by employers to increase the number of minority employees in their organization. As a result, employers may come under greater attack from white plantiffs claiming reverse discrimination in employment.

Given the recent Supreme Court decisions, employers run the risk of discriminating against whites in their efforts to comply with Title VII and executive orders. The statistics sited above imply that affirmative action programs may become obsolete as a result of population shifts which will significantly decrease the viability of discriminating against minorities. Employers may no longer have the "liberty" of selecting candidates from a work force overwhelmingly comprised of whites. Instead they will find increasing numbers of qualified minorities and decreasing numbers of qualified whites. Together, trends in population growth and the legal environment may eliminate the need for affirmative action programs.[93]

---

[93]See recent Supreme Court decisions: Wards Cove v. Atonio 109 S.Ct. 2115 104 L.Ed.2d 733(1989); Richmund v. Crosom 109 S.Ct. 1010 102 L.Ed.2d 854(1989); Martin v. Wilks 109 S.Ct. 2180 104 L.Ed 2d 835(1989); and Patterson v. McLean 109 S.Ct. 2363 105 L.Ed.2d 132(1989).

The Labor Force Over Age Fifty-Five

The aging of our population will also raise new issues in the workplace. The maturing baby boom generation will substantially increase the number of middle aged Americans in the year 2000.

> Between 1986 and 2000, for example, the number of people age 35-47 will jump by 38 percent, and the number 48-53 will leap by a staggering 67 percent, compared with overall population growth of only 15 percent.[94]

Overall, there will be 25 million[95] more workers in these groups combined by the end of the century. The entire work force is only expected to increase by 26 million over the same 16 year period.[96] The aging baby boomers and the decreasing number of young workers will raise the percent of the labor force in prime working years (25 to 54) from 67% to 73%.[97]

This phenomena will effect work in America in several ways. According to the Hudson Institute, they may positively effect productivity but have a negative effect on the flexibility of our economy.[98] Older workers are not as mobile as younger workers and they are more resistent to

---

[94]Johnston and Packer, 79.

[95]Ibid.

[96]Ibid.

[97]Martha Farmsworth Riche, "America's New Workers" American Demographics 10:2 (February 1988): 35.

[98]Johnston and Parker, 82-83.

retraining and changing occupations. In the age of rapid technological advancement and global competition, this inflexibility could be a hardship for employers struggling to remain competitive.

Another issue employers must face is the growing trend toward early retirement. As discussed earlier, older men are retiring earlier. Whether women age 55 and above will maintain current participation rates or whether they will begin to fall is still not clear. Some, such as the Hudson Institute, feel they may also begin to retire early. If so "...about 500,000 fewer women would be in the labor force in the year 2000 than are currently projected by the Bureau of Labor Statistics."[99]

The early retirement figures represent a sizeable drain from the shrinking labor pool. The decreasing size of the lower age groups and the early departure of older works will be a serious problem for employers desperately in need of manpower. In the future, employers may change policies and retirement programs in an effort to keep the increasing number of older workers on the job longer.

Radical shifts are occurring in the United States' economic structure. The service sector is rapidly becoming the sole source of new jobs in the United States. Manufacturing is playing a reduced role in our economic expansion. Employers in these industries must determine

---

[99]Ibid, 87.

what their role will be in the emerging economy.

The changing composition of the labor force represents another external pressure on the manufacturing industry. Non-traditional sources of labor are accounting for the majority of labor force growth. Employers must determine what effect the changing work force will have on their future. The shifting economic structure and the changing demographics of the United States' labor force have already begun to alter the operation and structure of many manufacturing firms. Additionally, forces in the global economy are also exerting pressure on manufacturing enterprises.

CHAPTER II

THE GLOBAL ECONOMY

Forces outside the United States are also having an effect on the structure and operations of manufacturing firms. As the United States progresses from an industrial to a service economy other countries around the world are experiencing similar transitions.[100] In particular, less industrialized countries (LICs) such as Taiwan and South Korea, are moving through the early stages of industrialization while industrially advanced countries (IACs), such as West Germany and Japan, are moving into the final stages of industrialization. For a variety of reasons, the progress of these countries has eroded the competitive status of American manufacturers.

American manufacturers have had to face increasing levels of foreign competition over the past twenty years.[101] Achievements in communications and transportation have

---

[100]See The Conference Board, Manufacturing: New Concepts and New Technology to Meet New Competition, Report no. 844. ed. James K. Brown (U.S.A.: The Conference Board, 1984); Johnston and Packer, Workforce 2000; and Economic Report of the President, Transmitted to the Congress January 1989. (Washington D.C.: United States Printing Office, 1989).

[101]President's Commission of Industrial Competitiveness, Global Competition and the New Reality, (Washington D.C.: United States Government Printing Office, January 1985).

created a world-wide marketplace. Goods can now flow more freely between trading nations. As a result, international trade plays a central role in the success or failure of the United States' economy.

This transfer of goods has intertwined the economies of trading nations. The United States is now part of a global economy. In addition to technological advances,

> the growth in world trade is attributable to a number of factors, including dramatic declines in tariff barriers throughout the industrial world and the reduction in internal barriers in Europe with the formation of the European Community.[102]

This phenomena is not limited to the industrialized world and Europe. The most successful developing economies have also expanded their level of manufactured exports and their level of imports. During the period of 1963-85, Singapore and Hong Kong increased their level of manufactured exports by more than 14 percent.[103]

Prior to the 1970s, the United States was seen as the world's economic leader. The United States dominated world trade and managed to maintain its economic independence. This was possible due to the relatively small portion of its GNP that was attributed to exports.[104] Since only a small portion of all goods and services produced (GNP) were traded internationally, the United States' economic health was not

---

[102]Economic Report of the President, 149.

[103]Ibid., 150.

[104]Johnston and Packer, 4.

dependent upon that of foreign countries. Our international strength was visible in other ways as well.

> American companies dominated international commerce, the American dollar was the international medium of exchange, and American technology was unrivaled.[105]

Up until the 1970s the United States enjoyed a strong competitive status and dominance in world markets.

The economic strength of the United States was evidenced further by a positive balance of trade. A positive balance indicates dominance or strength in world markets because, as a country, more goods are being sold internationally than are being purchased. A negative balance, conversely, implies that foreign markets are buying less imported goods and economic position is weak relative to that of other countries.

Based on the balance of trade, the strong economic position of the United States began to erode in the 1970s. In 1971, merchandise trade had a negative balance for the first time since WWII.[106] The Country's competitive position in merchandise trade began a down hill slide that continues today. While the depreciation of the dollar masks a portion of the deficit problem, the Department of Commerce has reported that the volume of imports purchased by American's

---

[105]Ibid.

[106]U.S.Bureau of the Census, Statistical Abstract of the United States: 1988, Table 1342, 768.

is still increasing.[107]

The appeal of foreign goods is do in part to a deterioration of the United States' quality image. Even in the United States, people began to believe that manufactured goods produced outside the United States were superior to those produced by American manufacturers.

> American competitors continued to loose market share during the 1980's, not because of higher cost structure had resulted in higher prices, but because they were making inferior products that could not compete even when they were sold more cheaply than imports.[108]

American's began buying more and more manufacturing goods produced outside the United States. As a result, the merchandise trade deficit has grown progressively larger since 1971.[109]

The United States' domination in world markets was further eroded by the progress being made in other IACs. By the 1970s, these nations had gained a level of economic superiority which enabled them to compete in advanced manufacturing industries.

> Other nations, who entered the 1950s with vastly inferior infrastructure, capital plant, equipment, knowledge, and technologies gradually acquired the resources they needed to bring their manufacturing capabilities up to the world standard set by the United

---

[107]U.S. Department of the Commerce, Bureau of Economic Analysis, "U.S. International Transactions, Fourth Quarter and Year 1988," Survey of Current Business 69:3 (March 1989), 30.

[108]Johnston and Parker, 18.

[109]U.S. Bureau of Census, Statistical Abstract of the United States: 1988, Table 1342, 768.

States.[110]

Such was the state of affairs faced by American manufacturers . The United States had to face up to new economic rivals. By the close of the 1970s, it was time for American manufacturers to react to the pressure being exerted by external forces. These changes included new competition in high-volume standardized production from the less industrialized nations; new competition in flexible, high-skill production from industrially advanced countries; and a growing dependence on advanced manufacturing technology.

Less Industrialized Countries

The position of the United States in high volume standardized production markets has been severely weakened due to the entrance of less industrialized countries (LIC). Similar to the United States, LICs are in the midst of economic transition. They are progressing from an agricultural- to an industrial-based economy. Consequently, many of their manufactured goods began to enter United States markets during the 1970s and 1980s for the first time. The economies in LICs have been expanding as they increase their level of industrial, as opposed to agriculture, production.

In just a short period of time they have made great

---

[110]Johnston and Parker, 15.

inroads into the global economy. Moreover, they have had a particularly strong impact on the economies of industrially advanced countries.

> Indeed, while in the mid-1960s OECD's manufactured exports to the [LICs] exceeded imports by more than threefold, by 1983 the OECD countries began to register a deficit which, in 1985, amounted to nearly $18 billion.[111]

The United States alone accounted for $12 billion[112] of the deficit. Their success in these markets can be attributed to two factors; productivity and labor costs.

Labor costs in LICs are very low relative to the United States. Table 1 highlights this relationship. The numbers listed represent hourly compensation costs as a percent of average United States' costs for production workers in manufacturing. The producers included in the composite are Hong Kong, Korea, Singapore, and Taiwan.

CHART 1: Hourly Compensation Costs
As a Percent of United States Costs[113]

YEAR	ASIAN LICs
1980	12
1985	13
1986	13
1987	15
1988	19

---

[111]Irving Jaffe, "The NIC's Climb Up the Industrial Ladder: Challenge and Opportunity for the Developed Countries," OECD Observer 147 (Aug-Sept 1987): 11.

[112]Ibid.

[113]U.S. Department of Labor, Bureau of Labor Statistics, International Comparisons of Hourly Compensation Costs for Production Workers, 1988 Report 766 (March 1989), Table A, 3.

United States manufacturers have little hope of competing with LICs in labor intensive industries given the LICs overwhelming advantage in labor costs.

Relative to more advanced economies, LICs are also experiencing rapid gains in productivity. Such gains are typical of economies in the early stages of industrial development. The LIC's are able to achieve large productivity gains and hold down the price of their goods in United States markets. Productivity levels are positively affected by the following conditions: an expanding economy; an increasing education level of the work force; and increasing investment in physical capital.[114] All of these conditions are present in the LICs.[115] The United States, a more mature industrial economy, can not match these gains.

The entrance of LICs into high-volume, labor intensive industries has eroded America's competitive position in these markets. The labor costs and productivity gains in less advanced economies have enabled LICs to become major players in world wide markets. The United States, and other industrially advanced countries, will find it increasingly difficult to remain competitive in high-volume, labor intensive industries.

---

[114]Campbell R. McConnell and Stanley L. Brue, Contemporary Labor Economics, 2nd Ed., (New York: Mcgraw-Hill Book Company,1980), 474-478.

[115]Johnston and Packer, p.11.

Industrially Advanced Countries

With their status in standardized, semi-skilled production severely weakened by LICs, United States manufacturers must turn their attention to flexible, skill-intensive production. Major players in these industries are primarily European and Japanese companies. By virtue of the industry, such production is primarily limited to economies possessing advanced technology and a high-skilled work force.

America's competitive position relative to IACs has also been declining. However, the relationship here is not as clear as that with LICs. Nonetheless, the United States did experience a decline in productivity relative to these nations during the twenty-two year period ending in 1982.[116] The relative changes in productivity are listed in Chart 2. If the United States fails to match productivity gains, or reduce costs through other means, prices of their goods will remain high relative to those produced in competing countries.

---

[116]Edwin Dean, Harry Boissevain and James Thomas, "Productvity and Labor Cost Trends in Manufacturing, 12 Countries," Monthly Labor Review 109:3 (March 1986): Table 1, 4.

TABLE 2: Annual percent changes in manufacturing productivity, 1960-1982[117]

YEARS	UNITED STATES	ELEVEN FOREIGN COUNTRIES[118]
1960-73	2.8	6.9
1973-80	1.7	3.9
1981	2.2	3.4
1982	2.2	2.8
1983	6.6	5.7
1984	4.9	5.5

As previously acknowledged, foreign countries have significantly raised their level of manufacturing capacity relative to the United States In part, this is reflected in Table 2. Much of the disparity in productivity gains can be attributed to their advancing economies. As other countries approach a level of economic development equivalent to that of the United States they are making dramatic gains in productivity. However, they are still trailing the United States in level of economic development. The productivity gains made in the United States appear less impressive relative to advancing countries, when in fact, given the level of economic development, the gains may be significant.[119]

By the early 1980's the progress in these countries had begun to slow down. In fact, Table 3 shows that in 1986 the

---

[117] Ibid.

[118] Includes a weighted average of Canada, Japan, France, Germany, Italy, United Kingdom, Denmark, Netherlands, Norway and Sweden. The weighted average is used to reflect each countries role as a manufacturing trade competitor in 1980.

[119] Ibid., 8.

United States had a larger increase in productivity than all but one of these countries. Similarly, in 1987, the increase in United States productivity was greater than all but five.

Further evidence of the growing similarity in the economies can be found in Table 3. Productivity in IACs, including the United States, has followed a similar trend since the early 1970s. During the period of 1973 to 1979 all the countries shown experienced a drop in productivity. Then, from 1979 to 1985, all but four experienced an increase. These countries now appear to be on a more even footing with the United States and the gaps in productivity are closing.

TABLE 3: AVERAGE ANNUAL CHANGES IN RATES OF PRODUCTIVITY[120]

	1960-73	1973-79	1979-85	1986	1987
United States	3.2	1.4	3.4	3.7	2.8
Canada	4.5	2.1	2.7	-0.2	1.7
Japan	10.3	5.5	5.8	1.7	4.1
Belgium	6.9	6.0	6.0	4.0	*
Denmark	6.4	4.2	1.8	0.1	2.1
France	6.5	4.8	3.3	2.2	3.7
Germany	5.8	4.3	2.9	1.7	1.3
Italy	7.5	3.3	5.4	0.8	3.7
Netherlands	7.4	5.5	4.4	-0.3	*
Norway	4.3	2.1	2.6	-0.3	7.7
Sweden	6.4	2.6	3.5	0.2	2.6
United Kgdm	4.2	1.2	4.7	2.8	6.9

*data not available

---

[120]U.S. Department of Labor, Bureau of Labor Statistics, "International Comparisons of Manufacturing Productivity and Labor Cost Trends 1987," News USDL: 88-326, 6 July 1988, Table 1.

The upturn in United States productivity can be attributed to several factors which will be described later. In summary, competition between the United States, European nations, and Japan is becoming more intense. Competition in global markets will remain fierce during the next decade and beyond.

> For the United States, [this] means that maintaining world leadership in any industry...will be a ceaseless struggle that will require extraordinary individual and collective national effort.[121]

Manufacturers have been forced to face the challenges presented by international competition and poor quality products. In the years ahead, manufacturers in the United States will struggle to sustain a competitive advantage in flexible, high-skill industries. Some producers have already begun to prepare for these new challenges by investing in new technology and embracing new manufacturing principles.

Modernizing Manufacturing Operations

Advanced technology, in particular information technology, will play a vital role in our economic future. For the manufacturing sector, competitive status will be dependent, in large part, on advanced manufacturing systems. It is this technology, in conjunction with process control changes, that has aided in the revitalization of many manufacturing operations during the mid-1980s. As the

---

[121]Johnston and Parker, 48.

twenty-first century approaches, it will be necessary for all producers to incorporate advanced technology and new manufacturing philosophies into their operations if they are to survive in the emerging economy.

Early innovators have always enjoyed a market advantage as a result of advancing technology. If the United States implements advanced systems at a faster pace than foreign producers it will enhance its competitive position through productivity gains and decreased production costs. If, however, foreign producers implement new systems faster, the position of the United States will be weakened due to slower gains in productivity and higher production costs.

Historically, technology developed in one country was only slowly adopted by competing nations. Put another way, the rate of diffusion into new countries was slow. Today, the situation has changed.

> The rate of technology transfer across national boundaries has grown....Moreover, technology 'gaps' (the time it takes another country to become competitive with United States industry or for United States firms to absorb foreign technologies) are likely to be shorter in the future.[122]

For this reason, the global economy will necessitate rapid adoption of advanced technology for producers to sustain even an existing advantage.

Technological innovation has become an important

---

[122]Panel on Technology and Employment. Committee on Science, Engineering and public Policy. Technology and Employment: Innovation and Growth in the U.S. Economy (National Academy Press, Washington D.C.)1987: 5.

determinant of competitive status. These advances are forcing radical shifts in the way Americans do business. American manufacturers are combining computerized manufacturing systems with new approaches to plant operations and process control in order to meet the challenge of global competition. According to Michael E. Porter, a noted authority on competitive strategy,

> Because of the power of technological change to industry structure and competitive advantage, a firm's technology strategy becomes an essential ingredient in its overall competitive strategy. Innovation is one of the principle ways of attacking well entrenched competitors.[123]

Information Technology on the Shop Floor

Today's systems are the result of the evolution of computerization in manufacturing. Computerization was first introduced in manufacturing with the advent of computerized numerical control (CNC). This technology marked the introduction of micro-computers to the shop floor. Here, mini- or micro-computers are installed directly on the machine tool. Storing instructions, in the form of a program, on the machine itself reduced time and preparation formally required by numerically controlled (NC) equipment. With NC equipment instructions were stored on paper or magnetic tape and fed into a control device. The advent of CNC equipment increased utilization rates and decreased down

---

[123]Michael E. Porter, Competitive Advantage (New York: Collier Macmillan Publishers, The Free Press, 1985), 176.

time.[124]

The application of CNC technology led to the development of direct numerical control (DNC) systems. DNC took the technology one step further by developing a network of computerized equipment. Under this application, an entire system of machine tools is controlled by one central computer. Again, this results in greater control of operations. The computer stores the program for every part made in the plant and also controls the instructions for every machine in the shop.[125]

This ability increases the flexibility of the entire system. The flexibility results from the reprogramming capabilities inherent in computer controlled production. This capability has significant implications for small batch manufacturing. It allows cost-effective production of a greater variety of parts in smaller quantities. These applications have reintroduced the concept of custom products.

Another breakthrough in technology came with the development of computer-aided-design (CAD) systems. Here, new parts are designed with the aid of computers. The time and expense formally associated with designing new products,

---

[124]Collin Gill, Work, Unemployment and New Technology. (Oxford: Cambrige Policy Press, 1985), 77.

[125]Harley Shaiken, Work Transformed: Automation and Labor in the Computer Age. (New York: Holt, Rinehart and Winston, 1985), 138.

or modifying current ones, has been greatly reduced. The CAD systems can tailor parts to customer specifications with incredible ease. More advanced systems utilize computer-integrated manufacturing (CAM) in conjunction with CAD.

Under the control of a CAD/CAM systems, the new design is programmed into the computer by design engineers and the instructions for the production process are sent directly to the shop floor via a computer network. The instructions would include specifics on required machines, tools, and raw materials as well as constraints of the available manufacturing technology[126] The result is radical reductions in lead time for new products. With these systems, new products can be designed, manufactured and marketed in a fraction of the time it use to take.[127] CAD/CAM systems lead to quick product change over, lower overhead, and lower production costs. These improvements are shifting the focus of manufacturing away from standardized products and toward more custom designs.

Related technology can be applied to nearly all plant functions. Computer-aided testing, for example, has simplified the testing of new products and materials. Also, systems have been developed which control inventory and material flow. Computer aided process planning (CAPP)

---

[126]Robert T. Lund and John S. Hanson, Keeping America At WOrk: Strategies for Employing New Technologies (New York: John Wiley and Sons, 1986), 65.

[127]Ibid., p.66.

directs the manufacturing process to maximize operating time and minimize bottlenecks. Through time, organizations can incorporate these additional components into their production system; progressively increasing the level of integration in their plant.

Operations with comprehensive computer systems directing most of the production processes are known as computer-integrated manufacturing systems (CIMS). Ultimately, CIMS would lead to a 'factory of the future' with "...a complex of NC machine tools, automatic shuttles to move parts between them and centralized computer control for the entire process."[128] In other words, it leads to the complete integration of all manufacturing operations through the central control of one computer system.

In its purest form, CIMS would be too expensive for all but a few manufacturing firms. Generally speaking, CIMS will be installed in pieces; increasing the level of integration and the level of benefit at each stage.[129] Manufacturers wishing to remain competitive in the 1990s and beyond will have some form of CIMS. In the future, many firms will also have computer networks connected to their suppliers and their customers. Advanced technology will be necessary to function in this type of business environment.

---

[128]Shaiken, 140.

[129]Hal Mather, Competitive Manufacturing (New Jersey: Prentice Hall, 1988), 226.

The fusion of microelectronics and telecommunications is commonly referred to as information technology. New information technologies enhance operations, increase flexibility, improve product quality, reduce inventory requirements, decrease throughput time, and decrease product change over time.[130] Following the advent of information technology, organizations will become leaner, produce more custom products, and respond more rapidly to changing market and production demands.[131] These systems are making radical changes in the way American's work. It is redefining the tasks workers perform and transforming the organizations in which they work.

Rapid progress in communication and transportation is increasing the diffusion of information technology world wide. With foreign competitors adopting technology at nearly the same pace as the United States, producers must do more to enhance their market position. These new challenges pose a grave threat to American business.

> ...Technological change is so rapid that it is beyond the capacity of any single firm or nation to manage. There is no patent so valuable, no production system so advanced, and no market share so dominant that it prevents competitors from challenging an entrenched position. Because of technology, the economy of the future will be a race to stay ahead or a race to catch up.[132]

---

[130]Lund and Hanson, 81.

[131]Ibid., 31.

[132]Johnston and Packer, 37.

For the nation as a whole, "our niche in the global market is to be high-technology, precision production."[133] In these industries, advanced technology has a significant affect on competitive status. Manufacturers in the United States must be able to exploit the full potential of new manufacturing systems in order to meet the demands of flexible, high-skill production.

Reorganization of Operations

In addition to implementing new technology, competitive manufacturers have modernized production techniques and reorganized their production processes to increase productivity and reduce costs. These approaches differ significantly from traditional manufacturing philosophy. They result in more efficient operations but require changes in the manufacturing process and organizational structure.

These new techniques developed out of the push for quality which began in the late 1970s and early 1980s. After Crosby published his ground breaking theory in Quality is Free[134], manufactures around the country turned their attention inward and began investigating potential improvements in their manufacturing process. For years management had clung to the belief that their process, based

---

[133]John Nora, C. Raymond Rogers, and Robert Stramy, Transforming the Workplace, (Princeton, NJ: Princeton Research Press, 1986), 4.

[134]Crosby, Philip B. Quality is Free: The Art of Making Quality Certain (New York: McGraw Hill, 1979).

on the assembly line and the principles of scientific management, was the most efficient means of operating a plant. As our competitive status eroded in the face of LICs and Japan, many began to put this belief aside. In an effort to rebuild their competitive position they took a new approach to managing production.

There were also those who did not believe that American manufacturing was on the decline. Instead, they felt that foreign competitors were on the rise. These leaders acknowledged that "although our quality remained consistently good, our competitors were getting better." [135] In response, they too implemented extensive quality improvement plans. Continuous improvement in production processes was "required to achieve the quality necessary for a strong competitive stature in the global economy."[136] Producers who recognized the need for change developed quality circles and other employee involvement techniques to improve customer satisfaction.

Additionally, many reorganized their production processes. Plant operations were redesigned to increase efficiency and hold down costs. These changes involved reducing waste, both of time and resources, with the concept of just-in-time (JIT) production flows and improving quality

---

[135]Lawrence Scheim and Melissa A. Berman, eds., Total Quality Performance, Report no. 909 (New York: The Conference Board, 1988), 22.

[136]Ibid., 3.

with an advanced statistical technique known as statistical process control (SPC).

New operating principles have aided in revitalizing many manufacturing firms hard hit by increased foreign competition. Investments in advanced manufacturing equipment and changes in the organization of production should improve the performance of manufacturing industries relative to foreign competitors. Relying on these two elements, some producers are hoping to build what they call a 'World Class Manufacturing System'. The changing nature of the competitive environment will continue to exert pressure on manufacturers to reduce costs, improve quality, and exploit new markets. The new systems are being implemented to meet these challenges and restore the competitive status of the United States.

The pressures being exerted on manufacturers in the United States are not unlike the challenges faced by industry at the end of the nineteenth century. They too experienced an economic transition as the United States progressed from an agrarian to an industrial economy. Also, rapid advances were being made in transportation and communication. These innovations were expanding local markets to national ones. Further, applications of new technology to the production process (steam engine, metal working machines) required significant changes in the way products were produced.

The large capital investments created pressure to expand the scope of production and to increase management control over the pace of work.[137] In response, new tasks and methods of management had to be developed. Together, technology and new managerial structures created the vast industrial operations which characterized manufacturing over the last one hundered years.[138]

The early industrialists met the challenge of expanded markets and new technology with vastly different, yet more effective, production methods. Today, leaders in manufacturing must again meet these challenges with an open mind toward new innovative methods of organizing work and producing products.

---

[137]Porter, 301-302.

[138]Ibid., 103.

CHAPTER III

MAXIMIZING THE BENEFITS OF CIMS

CIMS Capabilities

The use of advanced manufacturing technology has created new opportunities for American manufacturers. Many producers have used this new technology to survive in the increasingly competitive international markets.[139] However, the equipment has been utilized in very different ways. The application of CIMS technology varies from organization to organization. It is only those organizations which are able to exploit the full potential of this technology that will survive in the coming years. Leadership in these organizations must understand the opportunities presented as well as the very important choices to be made during implementation.

There is much latitude in the arrangement of production around CIMS. The way work and the organization is designed will determine the degree of flexibility and the level of utilization derived from its application. The changes in the nature of work and the organization are a matter of

---

[139]Examples of firms which has successfully innovated operations to remain competitive will be discussed in Chapter Four.

management choice and, as such, a matter of policy. It will be up to the leadership in an organization to recognize the impact of implementation decisions. They must carefully design jobs and the organization to enhance CIMS. The choice made will determine the organization's ability to compete in a global economy.

These choices will involve many traditional beliefs regarding management and workers. Historically, jobs were designed to maintain management control and minimize worker input. The goal was to increase efficiency and reduce dependence on skilled labor. This goal was accomplished by using automation and job design to control behaviors thereby reducing skill requirements. Today, this idea must be set aside.

> Computers and micro-electronics lay the basis for highly productive manufacturing systems that fully utilize the capabilities that humans have to offer.[140]

Maximizing the benefits of CIMS will require enlightened leadership willing to trade a certain degree of control in return for increased flexibility.

The implication is that job design should be considered simultaneously with applications for advanced technology. Several empirical studies on the application of information technology have focused on the choice between building upon the skills and experience of workers or reducing skill requirements to their lowest level possible. However,

---

[140]Shaiken, 15.

"there is little evidence of an unilinear tendency toward deskilling."[141] Many factors appear to influence managements decision to deskill or to upskill. They include product markets, labor markets, organizational structure, and union influence.[142]

It is only through careful analysis of their competitive environment that management can determine the best job design for their particular organization. The concepts of Taylorism and scientific management[143] can no longer be assumed as the "one best way" to design jobs. The philosophy of reducing skill to its lowest point and leaving workers with no responsibility is no longer in managements' best interest. Today, managers who analyze their environment will realize they need a flexible production system. Much of the empirical evidence indicates that information technology cannot meet this need if it is used in manner which decreases the human skill requirements.

Shoshana Zuboff studied the effect of information technology on both manufacturing and service organizations.[144] The manufacturing facilities were pulp and

---

[141]Gill, 84.

[142]Ibid.

[143]See Taylor, Fredrick Winslow, Shop Managment, introduction by Henry R. Town (New York, Harper & Brothers, 1911).

[144]Shoshana Zuboff, In the Age of the Smart Machine: The Future of Work and Power (New York: Basic Books, 1988), Introduction.

paper mills. She describes her research as "field intensive and longitudinal."[145] The goal of her research was to determine how work and organizations changed with the implementation of new information based technology. She concluded that this equipment can only provide a competitive edge when an organization chooses to exploit its unique capabilities.

Zuboff describes two capabilities of new technology: (1) the ability to automate and (2) the ability to informate. The ability to informate is what she believes sets the new technology apart from the old. Historically, innovations would automate the work place. This reduced the physical requirements of the job. Automation refers to equipment used to reproduce an activity formally performed by the worker. This allows greater management control of repetitive tasks.

According to Zuboff, the ability to informate can have a radical impact on the nature of work and on the organization.

> ...when technology also informates the process to which it is applied, it increases the explicit information content of tasks and sets into motion a series of dynamics that will ultimately reconfigure the nature of work and social relationships that organize productive activity.[146]

To informate means the technology "not only imposes

---

[145]Ibid., 425.

[146]Ibid., 10.

information (in the form of programmed instructions) but also produces information."[147] This ability to provide feedback on the process is a unique characteristic of information technology. Organizations equipped to utilize this feedback and take advantage of this unique ability will be set apart from their competitors.

Leaders who are able to understand the potential of this technology will choose to exploit its capabilities. In turn, they will create a "new vision of work and the organization."[148] Those who do not will proceed by advancing only the automation capabilities and suffer the consequences. To the extent they choose to ignore the informating capabilities, organizations reduce their capacity for flexible operations. Producers who do not sacrifice behavioral control for increased flexibility will find it increasingly difficult to compete in international markets.

CIMS as a Competitive Edge

Full utilization of information technology will offer producers many advantages in international markets. Here, the demand for standardized products has been replaced with the desire for custom products. Organizations wishing to compete must be able to efficiently produce lower volumes of

---

[147]Ibid., 9.

[148]Ibid., 12.

specialized products. The philosophy of minimizing unit costs and maximizing production volume is no longer applicable.

> These assumptions don't hold today with factories based on recent advances in CIMS technology. Nor do they hold with global competition which favors product customization, which in turn plays hob with traditional approaches to standardization, inventory, product positioning and the like. Even at the operational level, new technology demands new ways of thinking.[149]

Put more simply, "a company's competitive edge will lie in its manufacturing systems."[150] New flexible systems and the decreasing technological gap will enable competitors to copy new designs and products at a very rapid pace. Product design or market dominance will not be enough to sustain a competitive position for very long.

> The technological developments are proceeding so rapidly that the life-cycle of products is becoming much shorter than previously. This means that a premium is placed on flexibility in production and marketing planning.[151]

Management must evaluate the opportunity costs of not investing in or not fully utilizing advanced technologies. Only then will a firm realize the potential gains in flexibility and decreased response time. Management must realize that a decision to implement these systems based on the concepts of scientific management is a decision to

---

[149]Joel D. Goldhar and Mariann Jelinke, "Plan for Economies of Scope," Harvard Business Review 61:6 (Nov-Dec 1983): 141.

[150]Ibid., 148.

[151]Gill, 17.

forfeit the many benefits which CIMS has to offer.

Ramchandran Jaikumar studied 95 flexible manufacturing systems[152] (FMS) in Japan and the United States over a three year period. He considered these systems to be "natural laboratories in which to study CIMS, which is rapidly becoming the battleground for manufacturing supremacy around the globe."[153]

Jaikumar found the application of this technology in the United States to be a great disappointment. Rather than utilizing the computer capabilities to enhance flexibility, American Manufacturers were using FMS as another form of automation. They used the machines to enhance high-volume, standardized production and ignored the information capabilities.[154] He describes the application of Taylorism to FMS as mastering "narrow purpose production on expensive FMS technology designed for high-powered, flexible usage."[155]

Japan, on the other hand, was implementing the equipment in a manner which enhanced operational flexibility. In particular, Jaikumar found that in the United States FMSs produced 10 different types of parts per system, compared to 93 in Japan. Also, for every new part

---

[152]Computer-controlled grouping of semi-independent work stations linked by automated material-handling systems.

[153]Ramchandran Jaikumar, "Post-Industrial Manufacturing," Harvard Business Review 66:6 (Nov-Dec 1988): 70.

[154]Ibid., 71.

[155]Ibid.

introduced in the United States, 22 were introduced in Japan. Finally, he found that the utilization rate for FMSs in the United States was only 52% compared to Japan's rate of 84%.[156] In summary, Jaikumar found that the Japanese were more fully utilizing the advanced capabilities of these systems. For this reason, Japan is more able to compete in the global market which demands custom products and more flexible operations.

Clearly, if industries in the United States wish to compete globally, they must learn to maximize the potential of this equipment. By implementing this equipment according to the Taylor's theory of scientific management, manufacturers in the United States are eliminating the potential for significant gains in productivity and flexibility which this equipment can offer. In time, this will further erode our competitive status relative to other IACs who are maximizing their gains from CIMS.

The Impact of CIMS on the Workplace

The proper application of these systems creates a need for radical organizational changes. Only by integrating organizational changes into the new systems can their potential be fully realized. Simply using CIMS for further automating the work place will displace the need for many skilled or semi-skilled workers. This occurs as a result of

---

[156]Ibid., 70.

the increase in routinized and fragmented jobs. However, empirical evidence indicates that making necessary organizational changes and using the equipment's informating capabilities, will result in demand for a higher skilled work force.

The Committee on Effective Implementation of Advanced Manufacturing Technology [157] studied 16 sites where advanced manufacturing technology (AMT) had recently been implemented. Through their research the Committee discovered similarities among those organizations who had successfully implemented AMT to remain competitive.

> A growing number of U.S. manufacturers are concluding that they must employ AMT to survive and prosper. The experience of those who have started to use AMT suggests that companies best benefit from these investments if they make complementary changes in organization and management.[158]

These changes apply to the following areas: human resources planning; plant culture; plant organization; job design; compensation and appraisal; selection, training and education; and employee relations. The

---

[157]The project was approved by the Governing Board of the National Research Council whose members are drawn from the councils of the National Academy of Sciences, and the National Academy of Engineering. It was produced by the Manufacturing Studies Board and the Commission on Engineering and Technical Systems.

[158]Committee on the Effective Implementation of Advanced Manufacturing Technology, Manufacturing Studies Board, Commission on Engineering and Technical Systems, Human Resource Practices for Implementing Advanced Manufacturing Technology, (Washington D.C.: National Academy Press, 1986), 1.

potential of this new generation of technology can only be fully realized when implementation is accompanied by corresponding changes in these elements of their human resource policies and programs.[159] Organizations which make "systematic changes" in these areas will adapt more rapidly to the changing context and order of work. In essence, management will increase the organizations capacity for innovating change.

The necessary adjustments to management policy and organizational structure are a direct result of the changes in the nature of work due to the implementation of advanced manufacturing technology. The Committee found these changes in the nature of work to include:

- greater interdependence among functional areas;
- higher average skill requirements;
- higher capital investment per employee;
- more costly consequences of malfunctions;
- output which is more sensitive to variations in human skills, knowledge, and attitudes; and
- output which is determined more by mental rather than physical effort.[160]

Further, the Committee found that the new characteristics of work have led to changes in organizational objectives and strategy. Similar objectives were found in

---

[159]Ibid., 2.

[160]Ibid.

the organizations studied. They included the following:

- a work force characterized as highly skilled, flexible, interacting, committed and able to problem solve
- a management organization with fewer levels
- management personnel who are flexible, humane and innovative
- a higher retention rate of well trained workers
- strong partnership between management and workers[161]

In summary, the report concluded that successful implementation of advanced manufacturing technology will require corresponding changes in a variety of areas. The implementation of AMT will alter the nature of work. This change will require changes in management policy and in organizational structure in order to function effectively in the new environment. Further, organizational objectives and strategies must reflect this changing nature of work. These changes will present substantial challenges to organizational leadership and to traditional management theory.

Knowledge Intensive Tasks

To a large extent these new challenges are presented to management because of the knowledge intensity of CIMS. Paul S. Adler has studied the effect of computerized technology on a variety of work environments. His research into the

---

[161]Ibid.

area of FMS has led him to conclude that the relative importance of knowledge, as compared to that of labor or capital resources, increases with the implementation of information technology. He attributes the increased importance of knowledge to the need for flexibility in operations and the programming requirements of the equipment.[162]

In other words, the need for quick response time in running CIMS necessitates more knowledge at the operations level. Responding quickly to changes in operations and the competitive environment can only be achieved if those at the point of operation have the intellectual ability to do so. They must be able to evaluate the information generated by the equipment and effectively determine the appropriate course of action. Hal Mather, author of Competitive Manufacturing, describes this as the "ability to make smart decisions and get fast results." [163] He reinforces the notion that organizations must change their structures to enhance the capabilities of CIMS.

Managing these changes will represent a great challenge to American manufacturers. However, these changes will be necessary if they are to survive in new competitive and high-tech environment. These changes will require them to

---

[162]Paul S. Alder, "Managing Flexible Automation," California Management Review 30:3 (Spring 1988): 34.

[163]Mather, 220.

set aside old beliefs and sacrifice a certain level of operational control. Further, they must build a culture conducive to their new organizational goals and new manufacturing strategies.

The Need for Higher Skills

The new organizational goals and new manufacturing strategies will only be successful if jobs are designed to enhance worker abilities. The Committee on Effective Implementation of Advanced Manufacturing Technology concluded that jobs should be designed to "reflect the contributions that workers can make to the production process."[164] An upskilled and knowledgeable work force is a critical element in the successful implementation of CIMS.

Technology is constantly changing and the rate of change is expected to continue. This type of environment requires a more knowledgeable work force. Nelson and Phelps investigated the relationship between workers' education levels and the diffusion of changing technology. They concluded that education has a positive influence on the work force in environments characterized by rapid changes in technology.

> Educated people make good innovators, so that education speeds the process of technological diffusion....The rate of return to education is greater the more

---

[164]Committee on Effective Implementation of AMT, 36.

technologically progressive is the economy.[165]

Bartel and Lichtenberg came to a similar conclusion through their research on the impact of educated workers on the implementation of new technology.[166] They concluded that educated workers do in fact have a comparative advantage over less educated workers. They found "...the productivity of highly-educated relative to less-educated workers is greater the more uncertainty characterizing the production environment."[167]

Each of these theories applies to innovations in technology and a dynamic environment. The 1990s will be characterized by a very dynamic and rapidly changing business environment. Further, firms will be required to keep pace with advancing technology. Organizations will adopt CIMS slowly by continually integrating additional manufacturing functions; factories will become more and more integrated through time as new investments in information technology are made. The work force will be asked to continually adjust to changes in the nature of their work as a result of new technological innovations.

---

[165]Richard R. Nelson and Edmund S. Phelps, "Investment in Humans, Technological Diffusion and Economic Growth," The American Economic Review 56:2 (May 1966): 60,74.

[166]Anne P. Bartel and Frank R. Lichtenberg, "The Comparative Advantage of Educated Workers In Implementing New Technology," The Review of Economics and Statistics 69:1 (February 1987).

[167]Ibid., 3.

According to empirical research, more educated workers will be better able to perform in this type of environment.

Additionally, there are strong financial incentives to have a more knowledgeable work force running advanced equipment. Paul Adler studied the results of deskilling the work force in a major French bank.[168] While this research was conducted in a service company, the conclusions reached have strong implications for manufacturing firms. This bank employed over 30,000 employees and was in the midst of a five-year conversion to what was termed a "world class computer system". Initially, the decision was made to deskill low level clerical jobs. Management felt this would maximize the payoffs from the new system. In time management came to regret this decision. They realized the devastating impact of errors made at the operator level.

> ..People at extremities of the vast system would have to be absolutely reliable, any data entered would be fed instantaneously into all the banks accounts and the corresponding funds transferred instantaneously.[169]

Slowly, management realized the importance of training low level clerical workers in computer operations and in the logic of accounting and banking procedures. The impact of operator error is greatly increased with integrated computer systems.

Also, the large investments made in advanced

---

[168]Paul S. Adler, "New Technologies, New Skills," California Management Review 29:1 (Fall 1986).

[169]Ibid., 10.

manufacturing systems have created financial incentive to operate the equipment at full utlization and to minimize down time. As much as fifteen minuets of lost production time represents a significant financial loss.[170] This creates a new dependence on maintenance personnel. Robert Hall, author of Maintaining Manufacturing Excellence, recommends training operators in preventative maintenance to minimize needless and expensive downtime.

> Operators who help care for equipment understand it better, and they are less likely to abuse it. Those who clean things see things missed by those who do not, and they became sensitive to any minute change.[171]

Knowledge of the equipment and the manufacturing process provides other benefits. Production does not take place in a perfect world; imperfections in the system will arise. Only trained workers will be able to react to varying circumstances and conditions. One plant manager interviewed by the Committee on Implementation of AMT put it this way:

> In one way, I am more involved in the details of the process because they bubble up faster and are more consequential. In another way, there is more delegation, again, because those close to the process have to think and act fast.[172]

Knowledge of the process and the ability to understand feedback will allow operators to evaluate options and

---

[170]Shaiken, 86.

[171]Robert W. Hall, Attaining Manufacturing Excellence (Homewood, IL: Dow Jones-Irwin, 1987), 36.

[172]Committee on the Effective Implementation of AMT, 33.

determine the best response. Lacking the ability to respond, workers would be forced to call on supervisory or maintenance personnel for assistance. This would undoubtedly increase the amount of down time.[173]

There are also financial incentives to train workers in a variety of tasks. Multiskilled workers increases management flexibility in assignment of tasks. This can lead to decreased idle time and greater utilization of human capital. According to the Committee on Implementation of Advanced Manufacturing Technology, many of the plants studied broadened the scope of work to include these additional responsibilities:

- routine machine maintenance and service;
- simple trouble shooting and debugging;
- simple NC machine programming;
- increased responsibility for quality; and
- increased decision making on scheduling and machine use.[174]

Their research indicates that the organizations who had multiskilled workers "derived considerably greater benefits from AMT...."[175]

It takes enlightened leadership to take this step away from tradition and upskill its work force. However, leaders

---

[173]Ibid., 33,36.

[174]Ibid., 38-39.

[175]Ibid., 39.

who take this step will reap the rewards. Additionally, employees will receive gains in the quality of their worklife as well as increasing their job security.

> Managers gain decreased cost, increased quality, greater flexibility, decreased cycle time, improved equipment up time, and greater ability to bring technology on line. Employees gain better information, learning and retraining opportunities, higher skilled jobs, marketable skills, advancement opportunities, more opportunities to feel part of the business and exercise influence, and, on balance, a more secure employment environment because of the increased competitiveness of the enterprise.[176]

Breaking with the traditional industrial philosophy creates new challenges for management as well as for the work force. However, opportunities arise which can also further the goals of both. Manufacturers who recognize these opportunities will increase their investments in both physical and human capital. During implementation of CIMS, employers will design jobs that require upskilling their work force rather than deskilling it. Once this decision is made and jobs are designed, worker tasks and responsibilities can be outlined. Only then can employers determine the type of skills their work force will need for effective performance.

Specific Skill Requirements

When advanced technology is introduced, it performs many of the tasks formally performed by operators. At the same time, it creates new tasks to be performed. The advent

---

[176]Ibid., 6.

of information technology has created new more knowledge intensive tasks. In order to implement and operate CIMS, workers must be able to perform these new tasks.

Application of computerized equipment varies from one organization to another, yet the evidence indicates that similar skills are required under a variety of circumstances. They are defined in a variety of ways but generally refer to the same abilities. After years of research into the effect of new technology on the work place, Lund and Hansen defined eight abilities and attributes the work force will need to perform effectively. They include:

- visualization
- understanding of process phenomena
- conceptualization
- statistics
- attentiveness
- individual responsibility
- communication skills
- flexibility and self reliance [177]

Other researchers have developed similar lists.[178] The above list is, however, the most comprehensive and defines the skills in the least ambiguous terms.

Visualization, understanding of process phenomena and

---

[177]Lund and Hanson, 209-211.

[178]See Panel on Secondary Education for the Changing Workplace, High School and the Changing Workplace: The Employers View (Washington D.C.: National Academy Press, 1984) and Panel on Technology and Employment, Committee on Science, Engineering and Public Policy, Technology and Employment: Innovations and Growth in the U.S. Economy (Washington D.C.: National Academy Press, 1987)

conceptualization all describe the ability to understand the theory of the new manufacturing processes. Operators "physical" involvement in the process is reduced with the introduction of new technology. They must now use computer feedback to picture what is actually occurring in the process. One plant manager contrasted the old skills from the new in the following manner:

> The workers [had] an intuitive feel of what the process [needed] to be. Someone in the process [would] listen to things and that [was] their information. All of their senses [were] supplying data. But once they are in the control room, all they have to do is look at the screen. Things are concentrated right in front of you. You don't have sensory feedback. You have to draw inferences by watching the data, so you must understand the theory behind it. In the long run you would like people who can take data and draw broad conclusions from it. They must be more scientific.[179]

The physical reality is no longer there. Workers trade sensory feedback for computer data.

Operators must be able to conceptualize the entire process. They are called upon to analyze and draw inferences from computer generated feedback. To do so, they must create an inner vision of the system as it operates. Then they are better able to evaluate and integrate the data and select an appropriate course of action. Finally, they must translate their decision into "the terms of the information system."[180] A theoretical understanding of the process provides a framework for this analysis.

---

[179]Zuboff, 72.

[180]Ibid., 71.

> If something is happening, if something is going wrong, you don't go down and fix it. Instead you stay up here and think about the sequence. You get it done through your thinking. But dealing with information instead of things is very...well intriguing. I am aware of the need for my mental involvement now. I am also wondering: Where am I at? What is happening? It all occurs in your mind now.[181]

In summary, employers will need workers who can understand the theoretical and conceptual aspect of the manufacturing process. Workers actions can no longer be based on physical cues or sensory feedback. Additionally, computerization links the various stages of the process together. Therefore, actions taken at one phase will effect all others. As one plant manager put it:

> ...You can no longer make a decision just based on local data. There is so much going on in the plant...you have to derive your decision from interrelationships among the variables.[182]

This requires operators who understand the internal structure of the system and its capabilities. Only then are they able to use the system "as a source of learning and feedback."[183]

Increased interdependence among functions has created the need for other skills as well. Workers must be able to communicate clearly and quickly with persons employed at all levels of the organization.

Decisions once made by people in functions that were

---

[181]Ibid., 75.

[182]Ibid.

[183]Ibid., 73.

> relatively independent must now be made jointly. Efforts to design the product and process simultaneously, for example, require product engineering and manufacturing engineering to work closely together.[184]

Clearly, cooperation between various levels of the organization will be facilitated by workers with better communication skills. "As new technology integrates data across functions, a new quality of communication and collaboration [becomes] necessary."[185]

The third set of new skill requirements are those related to intellectual and mental abilities. Workers must be able to understand statistics, decode information, and diagnose a problem. Physical tasks are being replaced by mental tasks. "Operators program, set up, observe, test and respond to error messages." [186] Lines between separate tasks are increasingly blurred. Operators now perform activities previously performed by more skilled craftsman, such as set-up and maintenance workers. This underscores the need for more advanced skills at the operational level.

The increased reliance on mental skills is not only due to the need for a multiskilled work force, but also due to the nature of the new advanced systems.

---

[184]Committee on the Effective Implementation of AMT, 29.

[185]Zuboff, 20.

[186]Panel on Technology and Employment, Committee on Science, Engineering and Public Policy, Technology and Employment: Innovations and Growth in the U.S. Economy (Washington D.C.: National Academy Press, 1987), 117.

> People in industry will make the transition from operating simple machines manually to monitoring groups of complex machines or using simulation to decide on the best way to solve complex problems.[187]

To make this transition workers will need more advanced mental capabilities. "Intellectual skill is the basis upon which data are translated into meaningful information, and finally into knowledge."[188]

Again, the large investment in these systems requires an effective and a systematic problem solving approach. To trouble shoot and problem solve, workers must have the mental ability to understand the computer feedback. This will enable them to diagnose the problem and to integrate the data provided. Otherwise, down time will increase and utilization will decrease when operations are put on hold until supervisory or maintenance workers can resolve the problem.

This illustrates the added value of more knowledgeable operators. They will be able to participate more fully in the production process. Working at the operations level, there is great opportunity for them to have a direct influence on the process. Increasing the mental abilities of the work force will increase their ability to add "value through insight and innovation."[189]

---

[187]Mather, 228.

[188]Zuboff, 182.

[189]Ibid., 183

Related to the issue of problem solving and trouble shooting, is the need for alert, responsible and self-reliant workers. These qualities will be important for new tasks involving maintenance and monitoring of the systems. "The need for such activities is unpredictable so the workers must be constantly alert to how the machine is performing."[190] Being self-reliant and responsible, employees will be more apt to react quickly and effectively to varying conditions.

> ...Your mind is working twice as hard [now]. Production has increased by about 40 percent. More is being processed and much more quickly. There is a greater flow of data, and so you have to be continuously monitoring and paying attention to stay on top of it.[191]

To keep the system running optimally, operators must be self reliant and responsible. This will maximize the machines' utilization as well as productivity gains.

Finally, workers must have the mental ability to adapt to the changes which will continue to occur in the work place. The rate of economic transition and the rate of technological innovation is increasing.

> Economies that are in constant technological and structural evolution need labor forces not only suitable trained in the skill requirements of today but also possessing the general aptitude to adapt to changing demands of the market place.[192]

---

[190]Committee on the Effective Implementation of AMT, 35.

[191]Zuboff, 189.

[192]Anders Reutersward, "Educating and Training Tomorrow's Work force," The OECD Observer 149 (Dec 1988-Jan 1989): 22.

Employers struggling to keep pace with changes in the economy and in technology will need a flexible work force. This work force must have the intellectual capacity to adapt and evolve as changes occur inside and outside the work place.

Locating the Needed Skills

After an organization decides to implement CIMS, it must find a work force with the skills required to perform in the new environment. Employees may come from either its existing work force, the internal labor market, or from outside the organization, the external labor market. In the past, employers were able to terminate current employees who lacked the needed skills and hire skilled laborers from the external market. The labor market of the 1990s may reduce the feasibility of this solution. The evidence indicates that employers may need to invest in upskilling their current work force and also provide basic training for new hires.

As outlined in Chapter One, the labor market in the 1990s will contain more females, more blacks, more Hispanics and more immigrants. In fact, the majority of the growth in the labor force will be comprised of these groups. Also, the rate of growth in the labor force will decrease significantly during the coming decade; shrinking the pool of available workers.

To determine what impact the changing demographics will

have on manufacturing, employers must determine what their traditional source of labor was and also determine if the requisite skills are available. After this analysis, management can determine what action, if any, it should take to ensure a quality work force.

Large numbers of Hispanics and blacks are employed in manufacturing industries. In particular, they are employed in the less skilled job categories.[193] For Hispanic men, nearly one-third are employed as operators, fabricators and laborers.[194] With Hispanics and blacks accounting for the largest portion of labor force growth, the supply of these laborers would not appear to be a problem.

The number of workers age 16 to 24 may, however, present a supply problem for manufacturers. "...About one half of teens working are employed in service, operator, fabricator or laborer occupations."[195] Their declining numbers will increase the competition for young workers between service and industrial employers. Rapid job growth expected in service and retail occupations will create substantial increases in the demand for this population.

The military will also be competing for the reduced supply of high school graduates. During the 1980s, the

---

[193]Johnston and Packer, 90.

[194]Cattan, 13.

[195]Thomas Nardone, "Decline in Youth Population Doesn't Lead to Lower Jobless Rates," Monthly Labor Review 110:6 (June 1987): 37.

military employed one in eight high school graduates who did not continue their education. The number of high school graduates demanded by the military is expected to remain constant, but given their reduced supply, the military is expected to employ one in three by 1995.[196] This will represent a sizable drain on the pool of labor force entrants; further intensifying the competition for high school graduates.

A Shortage of Qualified Workers

Predictions of a shortage of youth laborers and reduced labor force growth tell only half of the story. Labor force statistics reveal that what is occurring is more than just a reduction in the quantity of new workers. While the competition for young workers is increasing, their population is characterized by "relatively high unemployment rates, low participation and employment ratios."[197] These numbers would suggest a decreasing, rather than increasing, employer demand.

Similarly, black and Hispanic populations continue to have higher unemployment rates, lower participation and

---

[196]Jerome M. Rosow, and Robert Zager, Training--The Competitive Edge (San Francisco: Jossey-Bass Publishers, 1988), 174.

[197]Nardone, 39.

employment rates than the white population.[198] Not unexpectedly, minority youth also have higher unemployment rates than their white counter parts.[199] While these statistics have shown some improvement in the recent past, they have not improved as much as would be expected given the current economic expansion.[200] Why do these groups continue to have such high unemployment rates, while many employers are searching for more workers?

The answer to this question can be found by more clearly defining the type of shortage we are experiencing. The problem goes beyond the decreasing rate of labor force growth. Employers are facing problems in both the quantity and quality of available workers. Competition for available workers will intensify but the real problem will result from a shortage of skills.

> ...Labor shortages that arise over the 1986-2000 period are expected to be a mismatch of education and skills of workers among various occupations and regions of the Country, rather than due to a general shortage of labor.[201]

In fact, signs of a more complex problem have been surfacing in recent years. Many city governments and community groups are involved in training the economically

---

[198]U.S. Department of Labor, Bureau of Labor Statistics, "Current Labor Statistics," Monthly Labor Review 112:2 (February 1989): 71-72.

[199]Ibid.

[200]Ibid.

[201]Ibid., 32.

disadvantaged (includes poor, high school dropouts, and unemployed workers who become discouraged and stop looking for work) so they too may enjoy the benefits of the expanding economy. These groups realize that the uneducated and economically disadvantaged will remain unemployed, while jobs remain open, if they lack the skills required in the advancing economy.[202]

Similarly, in certain areas of the United States, suburban employers have difficulties finding entry-level workers while city youth remain unemployed. In many instances, suburban employers have been providing transportation for city youth to their workplaces. Additionally, the wages for these positions have risen above minimum wage to provide incentive for the youth to commute to the remote locations. This indicates the existence of regional, as opposed to national, shortages.[203]

The American Society of Personnel Administrators (ASPA) conducted an employment survey in the final months of 1988.

---

[202]See Patricia Galagan, "Joining FOrces: Business and Education Take on Competitiveness," Training and Development Journal 47:4 (July 1988): 27-29; Craig Mellow, "Motown's Manpower Renewal," Across the Board 24:6 (June 1987): 31-39; and Thomas Rohan, "Blue-Collar Skills: A Vanishing Resource," Industry (6 June 1988): 41-46.

[203]See Harry Bacas, "Desperately Seeking Workers," Nation's Business 76 (February 1988): 16-23; Dirk Johnson, "Labor Scarcity is Forcing Up Low-Level Pay," New York Times, 17 March 1986, B(1);
and Martha Brannigan, "A Shortage of Youth Brings Wide Changes to the Labor Market," Wall Street Journal, 2 September 1986, 1-2(E).

Their results confirm the existence of a skills shortage. The results indicate that applicants are severely lacking in basic skills. The following shows the percent of respondents who indicated that applicants were lacking in specific skills.[204]

TABLE 3: ASPA EMPLOYMENT SURVEY RESULTS

PERCENT OF RESPONDENTS	DEFICIENT SKILLS
50%	Writing
43%	Verbal Communication
36%	English Language
31%	Math
27%	Basic Reading

ASPA also stated that employers acknowledged a skill rather than a labor shortage.

> Throughout the quantifiable responses to the essay-type questions in the survey, the message was the same: The difficulty in recruiting is not so much population changes, but is a lack of quality education and training among employees.[205]

ASPA went on to indicate that the "lack of basic skills and the lack of quality education"[206] was limiting the employability of many applicants.

Other surveys have been conducted to determine the primary concerns of manufacturers today.[207] The results

---

[204]Martha I. Finney, "The ASPA Labor Survey," Personnel Administrator 34:2 (February 1989): 39.

[205]Ibid.

[206]Ibid.

[207]Coopers & Lybrand, Made in America II: A Survey of Manufacturing's Future (U.S.A.: Coopers & Lybrand 1989).; National Association of Manufacturers, NAM Small Manufacturers

reinforce the conclusions which ASPA reached following their employment survey. Coopers & Lybrand, the National Association of Manufacturers and Touche Ross & Company have all published reports in 1989 which indicate that manufacturers believe the available work force is lacking in the skills necessary to perform job in their organization. Further, manufacturers report that the low level of work force skills poses a grave threat to their future.

These surveys reinforce the notion that the available labor force in the United States lacks the skills necessary to perform much of the available work. Employers implementing AMT will be seeking workers with strong basic skills. The data presented indicates that employers may not find these skills in new labor force participants. Employees hired as entry-level operators would have to be trained in basic and technical skills in order to perform effectively in the new environment.

The Education Level of Production Workers

Manufacturers must now compare the education and skills of their current work force to the external market. In 1982, 58.6% of 1981 and 55.2% of 1982 high school

---

Operating Survey (Washington D.C.: The National Association of Manufacturers, 1989).; and Touche Ross & Company, 1989 Small Business Survey Results, (U.S.A.: Touche Ross & Company, 1989).

graduates[208] were employed in blue collar occupations. Of the 240,000 dropouts for 1981 and 1982, 59.5%[209] were working in blue collar positions. Only 33.1%[210] of the 16 to 24 year olds enrolled in school worked in similar positions. This provides some indication of the education level of most production workers.

According to the Bureau of Labor Statistics, in 1988, craft and unskilled workers[211] had completed the following years of education:

PERCENT	YEARS COMPELETED
29.8	11 or less
51.3	12
14.5	13 - 15
4.4	16 or more[212]

Given these statistics, the quality of high school education will determine, in large part, the skill levels of the current manufacturing work force. Firms must evaluate the quality of this education to determine what their training needs may be. Next, they must determine if it will

---

[208]U.S. Department of Labor, Bureau of Labor Statistics, Students, Graduates, and Dropouts, October 1980-82, Bulletin 2192. (Washington D.C: Government Printing Office, 1983), 25.

[209]Ibid.

[210]Ibid.

[211]Includes precision production; craft and repair; operators, fabricators and laborers; and handlers, equipment cleaners, and helpers.

[212]U.S. Department of Labor, Bureau of Labor Statistics, Educational Attainment of Workers March 1988, [photocopy] (July 1988).

be more cost-effective to train their existing work force as opposed to hiring a new work force.

Unfortunately, the quality of high school education has been deteriorating at the same time that the need for higher skilled workers has been increasing. The advances made in the number of workers receiving high school diplomas[213] has not led to a corresponding increases in their skill levels.

> The educational foundations of our society are presently being eroded by a rising tide of educational mediocrity that threatens our very future as a nation and as a people.[214]

In fact, research indicates that the basic skill level of most high school graduates is actually decreasing.

> The average graduate of our schools and colleges today is not as well-educated as the average graduate 25-30 years ago, when a much smaller portion of our population completed high school or college.[215]

The majority of high school students lack basic comprehension skills necessary to perform in college or in business. According to research conducted by the Educational Testing Service, "61% of 17 year olds [fail] to demonstrate the ability to find, understand, summarize and

---

[213]U.S. Department of Labor, Education Level of U.S. Labor Force Continues to Rise, USDL 88-423 [photocopy] August 1988, 1.

[214]The National Commission of Excellence in Education, U.S. Department of Education, A Nation at Risk: The Imperative for Education Reform (Washington, D.C.: Government Printing Office, 1983), 5.

[215]Ibid., 2.

explain relatively complicated information."[216] Similar results were found in mathematics. Nearly 50% of 17 year olds were unable to "compute with decimals, fractions and percents; recognize geometric figures; and solve simple equations."[217] These skills will be necessary for problem solving tasks high school graduates will encounter even in low skill occupations.

In today's society, one comes in contact with computers and other forms of advanced technology in everyday life. However, students poor scientific skills will limit their ability to function in this new high tech environment.

> ...A majority of 17-year olds failed to demonstrate an ability to analyze scientific procedures and data. This suggests that school science is not helping them learn to use what they are being taught to evaluate the appropriateness of procedures or to interpret results. ....While approximately 40% of the Nation's high school students have a moderate understanding of science, only 7% have any degree of sophisticated understanding of the subject.[218]

Without these skills, high school graduates will be unable to fill the growing number of positions for skilled technicians.

Students received similar ratings in other areas evaluated by the service.

---

[216]Arthur N. Applebee, Judith A. Langer and Ina V.S. Mullis, Crossroads in American Education (Princeton, NJ: National Assessment of Educational Progress at Educational Testing Service, 1989), 22

[217]Ibid.

[218]Ibid., 23.

> ...Few [students] included enough information in the writing pieces to communicate their ideas effectively. Additionally, assessment results in other curriculum areas indicate that high school juniors have little sense of historical chronology, have not read much literature, and tend to be unfamiliar with the uses and potential applications of computers.[219]

Clearly, these results do not speak favorably for the future of high school graduates. Nor does it speak favorably for the future of American firms who rely on public education to equip their work force with basic skills.

Deficiencies in basic skills will become magnified in the coming years. Blacks and Hispanics will represent significant portions of labor force and population growth. This will result in an increased presence of their youth in American workplaces. At the same time, their levels of education and skills are significantly below that of the white population. Therefore, the additions to the labor force will be comprised of the segments of the population with the weakest skills.

The proportion of workers "without a high school diploma has declined sharply--from 24% ten years ago to 15% today."[220] Compared to whites, education levels for Hispanics and blacks are still significantly low. In 1988, 40.1% of Hispanics and 22.6% of blacks in the civilian labor force had less than four years of high school. For whites,

---

[219]Ibid., 26.

[220]U.S. Department of Labor, Educational Level of U.S. Labor Force Continues to Rise, 1.

the percentage was 13.8%.[221] The percent of whites, blacks, and Hispanics with four years of high school are 40.1%, 43.1%[222] and 31.4% respectively.[223] The gap between whites and blacks with four years of high school is closing but the same gap remains wide open between Hispanics and whites.

The Educational Testing Service also found evidence of a gap in performance between minorities and whites. However, as the gaps in levels of educational achievement are closing, so are the performance gaps.

> In general, it appears that the performance gaps have narrowed across time, particularly for Black students. Decreases in the disparities in reading and mathematics performance are the most consistent among the subject areas across time, with the gap decreasing gradually, while the gaps in science performance are the least stable.[224]

To date, however, the gaps remain significant from an employer's perspective.[225] Hispanics and blacks will be comprising increasingly larger portions of their work force. Furthermore, low ratings of minority students in science proficiency has significant implications for their

---

[221]Ibid., 2.

[222]Please note, the percent of whites with four years of high school is less than that of blacks because the percentage does not include those who continue their education beyond high school. Realizing that 26.4% of whites and only 15.2% of blacks graduate from college, the 4 year percentage for whites is a more reasonable statistic.

[223]Ibid.

[224]Applebee, Langer, and Mullis, 11.

[225]Ibid., 17.

performance in highly technical work environments. The need for higher skills combined with increases in Hispanic and black work force, points toward larger investments in training by manufacturing employers.

Coping with the Skills Shortage

Employers facing a shortage of high school graduates and a decline in available skills may find females to be an excellent source of needed labor. Along with minorities, women will account for a large portion of labor force growth in the coming years. Additionally, Chapter One emphasized the increasing level of female participation in the labor force. Women accounted for 60% of the job growth between 1960 and 1988. They are expected to account for 64% of the growth during the next decade.[226] While there have traditionally been very few women employed in production occupations, this was due primarily to the physical nature of the work. Technology has replaced many of the physical tasks with mental tasks which could result in new opportunities for women on the shop floor.

Many women posses the skills needed to operate technologically advanced equipment. The skills data presented implies that white women as a whole possess

---

[226]Women Employed Institute, 2.

stronger basic skills than minority populations.[227] Further, there is no indication that the female segment of any population group has lower levels of basic skills than their male counterparts. As a result, employers may now find the female population to be an excellent source of labor.

The lack of basic skills in the external market also creates a strong incentive for manufacturers to retain and upskill their incumbent work force. Historically, a large supply of young, skilled workers were available to provide employees to fill new positions. Today, the number of labor force entrants available for manufacturers is decreasing and, at the same time, their skill level is declining. Employers will be forced to provide basic skills training for most entry-level personnel.

This need for basic skills is not exclusive to new labor force participants, however. Some organizations have already begun training their incumbent work force in basic skills following the advent of new information technology.[228] The Commission on Effective Implementation of Advanced Technology found that job specific training "raised concern about such issues as the general ability of workers to read,

---

[227]See Applebee, Langer, and Mullis Crossroads in American Education; and U.S. Department of Labor, Educational Attainment of Workers March 1988.

[228]See Rosow and Zager, "Continuous Learning: A Strategy for Ongoing Change, 54-93.

write, and communicate."[229] All workers, whether they are incumbents or new hires, must master these basic skills if they are to succeed in technical training.

Evidence indicates that training incumbents in basic skills and in job specific skills may require less employer investment than providing the same training to entry-level personnel.[230] This is accomplished by incorporating basic skills into the technical training. Employees who have the job specific knowledge are better able to absorb and apply the new basic skills as well as the new job specific skills.

> [This] new form of instructional design enables employers to train [incumbent employees lacking basic skills] to handle new technology. Current methods require a long period of general literacy training before students are deemed ready to acquire technical skills. The new method interweaves sharply defined basic-skills training with technical-skills training and thus reaches the objectives faster, at lower cost, and with higher rates of student success.[231]

Utilizing this training design, employers can reduce training time and expense while greatly improving incumbent workers' ability to perform new tasks. This evidence should indicate to management that a "hire and fire" mindset is no longer appropriate given today's economic environment.

To operate in the information age and remain

---

[229]Committee on the Effective Implementation of AMT, 54.

[230]See Rosow and Zager, "Designing Programs to Train "functional Illiterates for New Technology", 172-191; and Ryan, T. A. and William Furlong, "Literacy Programs, The Armed Forces and Penal Institutions," in Toward a Literate Society eds. J. Carroll and J. Chall (New York: McGraw-Hill, 1975).

[231]Rosow and Zager, 172.

competitive in international markets, manufacturers will need to invest in CIMS. They will find it increasingly difficult to produce custom products, hold down costs and maximize productivity without this equipment. However, implementing this equipment will raise additional issues for management to contend with.

The first central concern involves designing production and jobs to optimize investments in information technology. The second consern is finding a work force with the skills needed to perform new knowledge-intensive tasks. From the macro needs analysis presented in the preceding pages, it appears that manufacturing may not find available workers with the appropriate technical and basic skills in either the external work force or their incumbent work force.

Given the vital need for advanced skills, manufacturers will once again need to break with tradition. They will need to invest in extensive training of hourly workers to equip them with the needed skills. This will enable hourly workers to perform effectively in computer-integrated facilities. The emerging economy and advanced technology has generated a need for higher skill levels. As long as these skills are not readily available in the external labor market, employers will be forced to provide the necessary training.

CHAPTER IV

TRAINING FOR COMPUTER-INTEGRATED SYSTEMS

Historically, employers have been willing to invest in development training for professionals and top management or in job specific training for hourly workers. The probability of receiving company sponsored training is higher the greater an employee's education level. Furthermore, investment in training for blue collar workers has always been lower than that for white collar workers.[232] It appears that training has been lower for the less educated and blue collar workers "because of the uncertainty about the probability of lay off or turnover and a firm's ability to retain the returns from [these] investments."[233]

The evidence presented in previous chapters implies that the emerging labor market would force firms implementing CIMS to break from this tradition. However, this has not been the case. Undoubtedly, there are many reasons for this phenomenon but none which justify the lack of training. Through her research, Zuboff came to the following conclusion:

---

[232]Miller, Kathleen, Retraining The American Workforce, (Reading, MA: Addison Wesley Publishing Co., 1989)35.

[233]Panel of Technology and Employment, 141.

> In part, [this lack of training] reflects a profound underestimation of the skill demands associated with a technology that informates. Most managers approached the technological conversion with the belief that the technology would eliminate, not exacerbate, the need for operator understanding.[234]

Additionally, she attributes this lack of training to the desire of management to maintain control of knowledge in the organization and decrease their dependence on skilled labor.

> For many managers at [the] Piney Wood [facility], substantial investment in developing a critical understanding at the data interface symbolized a threat to their authority.[235]

Again, organizations unable to accept the changing management philosophy, and sacrifice a degree of control, will be unable to optimize their investments in information technology.

Conversely, those who accept the challenges presented by this new technology will reap the greatest rewards. Organizations who align their policies on employee education, as well as other human resource areas, to reinforce the new order of work will more successfully innovate change in their operations.[236] The Committee on Successful Implementation of Advanced Manufacturing Technology found a strong link between successful

---

[234]Zuboff, 254.

[235]Ibid.

[236]Walton, Richard E. Innovating to Compete: Lessons for Diffusing and Managing Change in the Workplace, (San Francisco, Jossey-Bass Management Series): 9.

implementation of computerized equipment and the extent of worker training.

> Companies that have successfully implemented AMT are far more likely to have major training programs for their production workers who will have direct responsibility for the control, repair, and use of the equipment.[237]

In the mid-1980's, Caterpillar Inc. implemented CIMS as part of its strategy to create what they termed a "Plant with A Future" (PWAF). Incorporated into this plan was extensive CIMS training for hourly and salaried personnel alike. Caterpillar believed that training was vital to the success of their PWAF strategy. Managements' reaction to the training was evaluated at the end of the program. This evaluation "confirmed that training [had] facilitated the implementation of PWAF and CIMS."[238]

Research conducted by The Work in America Institute provides further evidence of the pay offs from worker retraining. The Institute studied firms in the United States who have invested extensively in training their work force to meet the demands of new high-tech equipment. The leadership in these organizations came to the same conclusion; upskilling was necessary to "optimize investment in new technology."[239] The gains offered by

---

[237]Committee on the Effective Implementation of AMT, 55.

[238]Rosow and Zager, 121-122.

[239]Jill Casner-Lotto, Successful Training Strategies: Twenty-Six Innovative Corporate Models (San Francisco: Jossey-Bass Publishers, 1988), 1.

information technology, the leaders stated, can only be achieved through the "most innovative applications."[240] From their experience, upskilling enabled operators to add value to the process through increased input and innovation, and only then did optimal production gains materialize.

Manufacturers who choose not to upskill their work force will face even graver consequences in the case of CIMS. The Work in America Institute found that adoption of this type of technology places an even higher value on raising skill levels. They attribute this to the following unique characteristics of CIMS:

- Since the technology is complex, draws on many disciplines, and is supplied by multiple vendors, a system requires employees who can integrate the disciplines.
- The jobs of those who run the systems have to be broader in scope than traditional jobs. Training has to match new responsibilities.
- Operating an integrated system consists of programming, setting up, observing , testing, performance and responding to automatic 'error messages' - all far from the usual image of the job.
- To keep down time to a minimum, maintenance workers must be able to react quickly, diagnose accurately, and devise reliable solutions. They need systematic problem solving skills and the ability to understand the flow of information as well as materials.[241]

To meet the demands of this technology, training must be designed very differently from previous company sponsored

---

[240]Ibid.

[241]Rosow and Zager, 7.

programs. Furthermore, the purpose behind these efforts differs significantly from that of traditional training programs. Previously, the goal was to "provide a person with specific skills for performing specific tasks."[242] The training programs addressed here can be characterized as more "educational" because they enhance "a person's general capabilities for living within a society."[243]

The programs provide more than just specific job skills. They include general abilities such as problem solving, team building, reading, writing, math and interpersonal skills. The goal of this new form of training goes beyond preparing employees for one particular job at one particular time. It is broader in scope and focuses on the long term success of the firm and its work force.

The Purpose of Upskilling Programs

For innovative organizations, the decision to upskill production workers is based on business need. They are providing training in general skills (ie. they can be utilized by other firms) because they need a qualified work force to operate a 'World Class Manufacturing System'.[244]

---

[242]Lund and Hanson, 206.

[243]Ibid.

[244]A highly integrated factory operated by information technology-based equipment and new process development techniques derived from modern management theory; such as J.I.T. controls, SPC, and others. Also termed, factory of the future.

Regardless of the nature of technology, a "better educated, better trained work force can produce more output per hour than a less educated and inadequately trained one."[245] Information technology has altered the meaning of the phrase "adequately trained". In that context, to be 'adequately trained' a worker must possess strong general skills and higher cognitive abilities. Nonetheless, labor productivity is still the motivating factor in a firm's decision to upskill its work force.

It is also important to distinguish efforts to upskill hourly workers from Quality of Work Life (QWL) programs which were popular during the late 1960s and early 1970s. These job-redesign movements were "...of three main types: reorganization of assembly lines, group technology, and job enrichment."[246] Theoretically, each design was suppose to improve productivity, but this was not the central focus. Often times, they were driven by a desire to enrich jobs and increase motivation.

QWL programs were implemented for a variety of reasons, only one of which was the desire to improve productivity and efficiency. In the final analysis, two major problems prevented successful application of QWL techniques.

> Employers saw the reorganization of work as a means of using the groups to undercut trade union influence within the plant, and the trade unions responded by

---

[245]McConnell and Brue, 474.

[246]Gill, 67.

opposing the use of formal work group leaders as potential usurpers of union influence.[247]

Today, upskilling programs are a strategic tool used to build a factory able to compete in the global market place. In such a factory, training becomes a key operating function. A study commissioned by the Economic Development Committee for Electronics at the request of the National Economic Development Council investigated such training programs. The following summaries are examples of companies which developed training programs for operators and craft workers. Each program was designed to raise skill levels in response to a change or realignment of the company's strategic mission.[248]

HOTPOINT The Company was facing increased competition and they believed the only way they could survive was to improve productivity. To do this, they invested in new technology and began extensive training to improve the skills of their maintenance workers. Hotpoint found retraining was vital to the success of their program.

ICL A major product and process change enabled the Company to retrain assembly workers to perform higher skilled positions. The new technology demanded a new occupational level. The idea of retraining operator or craft workers (especially the women) was a radical concept for ICL. However, the program was successful and the workers were able to adapt to the new technology and the new environment.

AUSTIN ROVER An investigation into machine breakdowns concluded that the majority were due to

---

[247]Ibid., 68.

[248]Cecil Fudge, "Retraining for New Technology: Six Success Stories," Personnel Management (February 1986): 42-45.

> electronics faults and a related lack of understanding. A strategy was devised to raise the skill levels of first-line electrician to decrease their dependence on electrician specialists for maintenance and service needs. Similarly, the skill level of electrician specialists were also raised to decrease their dependence on control engineers.
>
> **CLEVELAND BRIDGE AND ENGINEERING** The Company was implementing new equipment with new technology at a greenfield site. They wanted to utilize their current work force to the greatest extent possible. They ran trade union courses in a mobile unit on-site and retraining was a great success for all participants.
>
> **STS** The Company was experiencing an increasing demand for one of its more technologically advanced products. High diagnostic and other advanced skills were required. A retraining program for non-technical and craft workers was designed. The program was successful and these workers acquired the advanced technical skills to meet the needs of their changing product line.

These examples illustrate the success corporations have had in raising the skill level of employees in operator or craft occupations. Each program was driven by economic survival strategies; a need to remain competitive; to raise productivity; or to protect a strong competitive position. Additionally, each involved new advanced technology either in the process or the product produced. Through their analysis, the National Economic Development Office came to the following realization:

> There is under-used talent in most work forces and enormous scope for retraining people to a higher level of skill, regardless of their present position.[249]

These and other strategic training programs are driven

---

[249]Ibid., 42.

solely by the corporate strategy. The improvements in quality of work life are spill over benefits derived from the strategy but not its central focus. In contrast to previous QWL programs, upskilling is part of a survival strategy which also serves the common goals of management and the work force.

In summary, the purpose of upskilling is to carry out and influence the company's strategic plan. Specifically, a plan to enhance a firms competitive position by implementing new equipment and new production/process control techniques. Under these circumstances, the training is only relevant to the extent it serves the strategic mission; to survive in the information age and to be competitive in the global economy.

Components of the Program

In general, efforts to upskill workers are designed to improve technical, basic and general skills. A complete program should also include training to prepare workers for the new work environment. Organizations view this "orientation" or "inaugural" training as a critical first step in transforming its work place to a world-class manufacturing system.[250] The process begins by creating an awareness among employees of the company's new strategy and the role they will play in its realization.

---

[250]Casner-Lotto, 70.

During orientation training, employees are introduced to the new manufacturing philosophy; one that stresses improvements in productivity, quality, efficiency and greater utilization of human resources. Ultimately, the goal of orientation training is to foster employee commitment to the new system and to the new strategy. Many employees will fear the changes occurring in their job and in their work environment. Orientation can be used to set these employees at ease and to facilitate the organizational transformation.[251]

The changes required to create a factory of the future encompass all aspects of the organization including:

> ...comprehensive and integrated change in business philosophy, expectations, responsibilities, structure, employee development, compensation systems, communications, teamwork, trust, the working environment, operating systems, work rules and all industrial relationships.[252]

Employees must understand how the organization's "integrated approach [will] balance emphasis on a trio of objectives: quality, productivity and quality of work life."[253] From this understanding will come recognition of the need for change. In order to provide their full support, hourly workers must believe that operating a world class manufacturing facility will be the only way to sustain a

---

[251]Rosow and Zager, 122.

[252]Nora, Rogers, and Samy, 6.

[253]Ibid., 11.

competitive advantage in the emerging economy. Orientation training is designed to win this support.

A supportive attitude will create a climate conducive to optimal performance. "A positive attitude can produce more results than a negative one."[254] To foster a results-oriented attitude, discussions with employees and policy statements should communicate four points: the employer's expectations; the employee is responsible for results; employer has confidence in employees and wants them to learn; the employer will offer any assistance employees may need in realizing their potential.[255]

Initially, all employees will go through the orientation process prior to other training sessions. As the system becomes fully integrated into daily operations, the material should be incorporated into the regular new employee orientation sessions. Many of the concepts designed into the new manufacturing system will be new to prospective employees, just as they were new to the organization. Again, the objective is to create a supportive attitude and to ease the transition to a world class manufacturing system.

Support for this recommendation can be found in Corning Glass Works' Total Quality initiative (their strategic

---

[254]Jack J. Phillips, The Handbook of Training Evaluation and Measurement Methods (Houston, TX: Gulf Publishing Company, 1983), 43.

[255]Ibid, 45-46.

training program). They define new employee orientation as the first step toward Total Quality. In response to "high early-career turnover"[256] Corning designed a new orientation process to introduce new hires to the Total Quality concept. Success of the program was measured in terms of decreases in turnover, decreases in training time and improved quality of new hire performance. The results were impressive. Corning estimates that it saved $460,000 in four years as a result of the orietation provided to twenty-four new hires.[257]

Technical Training

Next, employers must provide training in the new skills required to operate the new technologically advanced equipment. In the past, employer provided training was generally limited to these types of skills. Management believed that it was in their best interest to only provide employees with specific skills and knowledge required to operate and maintain their equipment. More general forms of training were left to the individual and to educational institutions. Management tends to be much less resistant to engaging in technical training. The returns are obvious and it complies with standard practices.

Many will, however, resist training designed to 'educate' workers in the theoretical principles of the new

---

[256]Casner-Lotto, 66.

[257]Ibid., 69.

integrated manufacturing systems. The content of this instruction should include a basic understanding of information technology and the implications of an integrated system. Also, if employees will be required to learn skills necessary to perform a variety of jobs, theoretical training should provide them with an understanding of the interdependence between these jobs.[258] In particular, the relationship between the output of various jobs and their relationship to the organization as a whole.

The theoretical knowledge will provide a foundation for acquiring more advanced technical skills. After extensive research into successful upskilling programs, the Work in America Institute provided the following recommendation to firms planning to transform their work place:

> To be effective, training in new technology must equip employees and managers with broader knowledge, which enables them to plan for the effective utilization of new technology, integrate it into the work process, maintain it, improve it, and when necessary, replace it and start over.[259]

Their research, coupled with evidence presented in chapter Three, emphasizes the need for a work force with a theoretical and conceptual understanding of CIMS. These principles may be part of a separate training course or incorporated into the curriculum of the technical skills program.

---

[258]Rosow and Zager, 56.

[259]Casner-Lotto, 2.

Training in Basic Skills

Finally, programs must provide instruction in basic skills such as reading, writing, and math. Traditionally, instruction in basic skills has not been included in employer sponsored training programs. Management believed it was the individual's responsibility to acquire these skills.

> And for the individual worker, basic skills are the keys to greater opportunity and a better quality of life. Workers with good basic skills find it easier to acquire more sophisticated skills that leverage better jobs and higher pay.[260]

Employers are reluctant to sponsor such training because they make the employee more attractive to other employers. No one wants to invest in an employee only to have them leave and put the new skills to use in another organization.

However, this attitude may be changing. While new technology has placed strong emphasis on workers proficiency in basic skills, employers are facing a work force severely lacking in these skills. Many prospective employees "do not have the basics essential for acquiring more sophisticated technical skills."[261] This predicament has led a few innovative employers to begin training their work force in

---

[260]Anthony P. Carnevale, Leila J. Gainer, and Anne S. Meltzer, Workplace Basics: The Skills Employers Want (Executive Summary by the American Society for Training and Development and the U.S. Department of Labor and Training Administration, 1988), 5.

[261]Ibid., II.

basic skills. As more and more factories are characterized by highly technical operations and poorly skilled workers, instruction in basic skills will become more widely accepted. For those planning to raise employee skill levels, such training will be a necessity.

Similarly, the large number of minorities and immigrants employed in operator and fabricator positions may require instruction in English. A study conducted by Sherrie Kossoudji concluded that a "lack of English language ability is associate with the underutilization of other preexisting skills."[262] Their success in upskilling programs will be severely limited if they lack strong English language skills. She also found the underutilization was greater among Hispanics than among Asians.[263] Today's business environment, characterized by an increasing need for higher skills and by increasing numbers of Hispanic and immigrant workers, will intensify the underutilization of individuals with weak English language skills.

Employers striving to make the most of their human resources will face a growing number of Hispanics and immigrants who may lack English language skills. This deficiency will hinder their ability to perform to their fullest potential. To secure their long term goals, firms

---

[262]Sherrie A. Kossoudji, "English Language Ability and the Labor Market Opportunities of Hispanic and Asian Immigrant Men," Journal of Labor Economics 6:2 (April 1988): 220.

[263]Ibid., 224.

converting to CIMS will need to provide the opportunity for minority and immigrant workers to improve their English language skills.

In summary, a program to upskill hourly workers is an integral part of any plan to create a world class manufacturing facility. As such, training is designed for the express purpose of achieving this goal. To be successful, the upskilling program must include training in four areas.

1.) Orientation training to introduce workers to the new philosophy and the company's strategic plans.

2.) Basic skills training to provide a foundation for all other training as well as the ability to succeed in a dynamic environment. For many employers this will require instruction in English for minority and immigrant workers.

3.) Theoretical training to provide workers with a conceptual understanding of the system.

4.) Technical training to provide workers with skills and knowledge necessary to perform jobs created by advanced technology.

Retraining Versus a Hire and Fire Strategy

Many organizations may come to realize the benefits from strategically training their work force. The implications for long term success and building a factory of the future are clear. However, some employers may be reluctant to accept the idea of retraining an existing work force rather than hiring new, more highly skilled workers. It appears that the general consensus among American manufactures is that it is more cost-effective to resolve a

skill imbalance by firing current workers who lack needed skills and hiring new workers with the necessary skills.[264] They perceive that it is less costly and less difficult because they do not believe that incumbent workers will be able to "trade their embodied knowledge for a more explicit, 'scientific' inference."[265]

However, experienced workers are quite able to acquire new technical skills. Today, new recruits will require the same, if not more training than an existing work force. Chapter Three provided a needs analysis for the external labor market. This analysis determined that today's entry-level and low-skill work force is severely lacking in basic skills. While in the past it may have been fairly easy to recruit highly skilled workers to perform technical tasks, today these individuals are harder to find. The changing composition of the labor force will force employers to look to the traditionally less skilled populations for needed labor. These recruits will need training in technical, general and basic skills in order to succeed in an integrated factory.

This is not to imply that retraining an existing work force will always be more cost-effective than hiring new workers. Neither option is more cost-effective 100 percent of the time. But management must come to realize that "that

---

[264]Miller, 64.

[265]Zuboff, 72.

the cost of retraining is often much less, and the cost of hiring and firing is much more than generally believed."[266] The experience of Xerox and General Electric provide real life examples where the option to retrain proved more cost-effective than the alternative of hiring a new work force.

The Reprographics Business Group at Xerox was producing products with increasing levels of technological complexity. Their current work force lacked the advanced skills demanded by advanced products and these skills were not readily available in the external market.[267] Xerox carefully analyzed the situation and evaluated all potential solutions. During their analysis they paid careful attention to all the costs associated with each scenario.

Based on their initial analysis, Xerox decided that it would be more cost effective to retrain the existing work force.[268] The cost advantages for this strategy included: decreased severance, relocation and outplacement expenses, and elimination of recruiting costs. Cost analysis conducted upon completion of the program revealed that retraining was in fact the more cost-effective option.[269] They determined that the hire and fire alternative would have been more expensive, not to mention the debilitating

---

[266]Rosow and Zager, 200.

[267]Ibid., 204.

[268]Ibid., 204.

[269]Ibid., 207.

effect it would have had on employee morale.

General Electric came to a similar conclusion when it decided to retrain the employees at its Fort Wayne, Indiana plant.

> General Electric converted an old plant...into a 'postindustrial' facility--whose new products and processes were far more technologically sophisticated than the old--and staffed it with its own displaced workers.[270]

Management had anticipated the need for a large scale retraining program; however, one was not required. The existing work force was able to acquire the new skills much more rapidly than management had expected. "...The amount of retraining needed prior to job assignment proved quite modest."[271] The retraining option proved more cost-effective than the alternative strategy.

Once again, the factors influencing today's business environment, (specifically information technology, changing labor force, and the changing economy) require a new set of rules. They require leadership that is willing and able to set old beliefs and practices aside and face the challenges ahead. They must adhere to a philosophy encompassing new attitudes toward work and workers.

Winning Union Support

Prior to implementing any plans to upskill the existing

---

[270]Ibid., 208.

[271]Ibid.

work force, employers of unionized workers should elicit support from the labor organization involved. Union support will enhance the potential success of the plan. The Work in America Institute studied the effect of joint union management action on the transformation of the Packard Electric Facility in Warren, Ohio.

Packard Electric, a division of General Motors, and the IUE came to mutually agreeable terms on how to reduce labor costs while at the same time improving their competitive position in the high-tech precision manufacturing market.

> ...The parties achieved mutual understanding and agreement embodied in a strategic decision: all high labor, low-tech assembly jobs would be moved gradually from Warren to Mexico, while at the same time high-tech, low labor operations would be moved to Warren.[272]

This example illustrates how decisions can be implemented to provide mutual benefits to management and labor. Winning union support must go beyond consensus building. Management must foster a new relationship with labor. This will require a change in their approach to labor relations. They must shift from an adversarial to a collabrative process in order to explore new areas of mutual concern.[273]

Efforts to win the support of organized labor should

---

[272]Ibid., 213.

[273]Camens, Sam "Labor-Managment Participation Teams in the Basic Steel Industry," in Teamwork: Joint Labor-Management Programs in America ed. Jerome M. Rosow (New York: Pergamon Press, Work In America Institute): 113.

emphasis the benefits which workers will receive when the plant is transformed to a high-tech operation. According to the Work in America Institute, the benefits for the worker include:

- enhancing self-confidence and self esteem;
- increasing the meaning, importance, and responsibility level of the work that can be assigned to the employee;
- increasing the individuals potential for advancement and higher compensation; and
- improving the individuals employability within the company as well as in the labor market as a whole.[274]

Management must convince labor that they have an economic stake in the successful transformation of their work place. Training is vital to the organization's future. The success of training will secure the organization's market share and, therefore, provide greater employment security to production workers. Additionally, the largest portion of job growth in the coming years will be for high skill occupations. After the training is completed, employees will possess the skills predicted to be in highest demand by the information economy. In the long run, they will be more marketable to other employers.

In the past, labor has been hesistant to accept new technology in the work place. It was seen as a threat to job security and was met with strong opposition from labor

---

[274]Casner-Lotto, 91.

leaders.[275] In an adversarial system of industrial relations, strong unions were more inclined to accept wage and work rule concessions rather than innovations in the operating process.[276] Management must take a cooperative approach to labor relations to facilitate a transformation in their workplace.

To meet this objective, management must respond to labor's concern for job security and alleiviate their fear of lay offs and shut downs as a result of new technology. Many labor leaders believe that management has a "hidden agenda" when they seek union cooperation.[277] Essentially, they feel managements' goal is to reduce the size of their work force and, ultimately, possess ultimate control over the work place.

However, there is evidence that the most successful union-management participation programs resulted from strong external and economic pressure for change.[278] This implies that the threat of global competition may foster a cooperative appoach to labor-management relations. This type of approach is characterized by open communications, mutual trust, mutual respect, and creative problem

---

[275]Walton, 290.

[276]Walton, 287.

[277]Oswald, Rudolph A., "Joint-Labor Management Programs: A Labor Viewpoint," in Teamwork, 26-40.

[278]Dunlop, John, T. "A Decade of National Experience," Teamwork, 18.

solving.[279]

To facilitate this process, management must truly accept labor's right to exist. They must include them in the decision making process and address their concerns and fears. If management stresses an agenda comprised of market share, competitive status and productivity, at the expense of job security and worker retraining issues, they will loose union support.[280] Generally, the experience of labor-management cooperation indicates that success only comes through shared goals and an acceptance of eachothers interests and roles in the work place.[281]

Successful approaches to labor-management cooperation in the face of global competition and new technology have resulted in innovative contract provisions.[282] The UAW and International Harvetser, for example, created the Job Content Preservation Program. The goal of this program, among other things, was to create a vehicle for mutaully determining the effects of new technology on job content.[283] Similarly, a national committee has been established in the

---

[279]Ibid., 19.

[280]Oswald, "A Labor Viewpoint", 35.

[281]Ibid., 39.

[282]See Siegal and Weinberg, Appendix C "Directory of Major Organizations assisting Labor-Management Cooperative Programs", and

[283]Blueston, Irving "Jiont Action and Collective Bargaining--and Vice Versa,j" Teamwork, 52.

auto industry to train workers to perform new jobs created as a result of innovations in the work place.[284]

Programs designed to increase skill levels and provide the opportunity for future advancement provide significant rewards to production workers. Once the decision to implement CIMS is made, management should make a sincere effort to reach an agreement with the union on the effects of this decision. Specifically, the parties should negotiate a mutually acceptable plan to raise the skill level of incumbent workers and to create an environment conducive to change.

The actual presentation to the union should emphasis that the program is necessary to transform operations to a world class manufacturing system and will increase the job security and employability of the work force. In a unionized facility, the success of an upskilling program is largely dependent on winning the union's support. Winning this support will bring the company one step closer to its ultimate goal.

Program Design

IBM developed an innovative and cost-effective systems approach to developing "readily available, low-cost, yet consistently high-quality education."[285] This approach can

---

[284]Ibid., 53.

[285]Rosow and Zager, 135.

serve as a model for organizations implementing a strategic training plan. "The approach breaks the training process into manageable steps and facilitates decision making and budget planning at each stage."[286] It provides management with greater control and increases the consistency of training outcomes.

The first step is to design curriculum based on business and job specific goals. Business requirements should be emphasized rather than enrichment or general development objectives. These goals will be tailored to specific forms of training (technical, conceptual and basic skills) but the curriculum will always be driven by the corporate mission. Similar to other forms of company sponsored training, the content should reflect corporate policies and practices. For strategic training, content should be carefully designed to incorporate new manufacturing philosophies.

IBM stresses that the next step, instructional design, "is the primary determinant of the quality of training, regardless of delivery methods."[287] The emphasis at this stage is on motivating participants to learn in the most cost-effective manner possible. Instructional designers determine the materials to be used and the structure in which course content will be presented. During this

---

[286]Ibid.

[287]Ibid.

process, they will work "closely with subject-matter experts who fill in the content."[288]

Course content is packaged in conjunction with instructional designers but it is defined based on the strategic mission and on needs analysis. At this stage, experts must determine what information will lead to the desired outcome. The desired outcome refers to pre-set goals defining the knowledge and skills students must have acquired by the end of training. The desired outcome must be compared to data collected through needs analysis. Course content will include only the knowledge and skills required to meet pre-set goals less the knowledge and skills participants already possess.

At this stage, IBM recommends the use of control mechanisms to ensure program quality.

> ...The use of a clearly outlined simple management system to keep course development projects under control and to assure high-quality courses developed on time and within budge.[289]

These controls include validating course content and running pilot classes. While content experts should be responsible for defining course content, it must comply with overall program objectives. With these controls in place, training will lead to the desired performance improvements.

How this material will be delivered to participants is

---

[288]Casner-Lotto, 261.

[289]Ibid., 262.

"the key to achieving cost-effectiveness in education."[290] At this stage, management must determine the most cost-effective manner to provide instruction without sacrificing results. Depending upon the size and financial position of the organization a variety of techniques can be used. All of the following delivery methods are currently in use at IBM.

- traditional classroom
- multimedia classroom
- tutored video classroom
- interactive television classroom
- self-study
- guided learning center
- computer-based training
- interactive videodisc with personal computer[291]

Generally speaking, self-study and computer-based training methods appear to be the most appropriate for the purposes of strategic training programs. Self-study minimizes the expense of having an instructor available at all times. Instead, monitors can be employed to provide assistance when needed and materials can be designed to compensate for the instructors absence. Another benefit is the flexibility inherent in the system. Students are able to progress at their own pace and concentrate on areas where they are most deficient. Materials can include any or all of the following: workbooks, videotapes, audiotapes or slides.

---

[290]Ibid., 263.

[291]Ibid., 263-264.

Simply stated, computer-based training is a technologically advanced form of self-study. Instruction is delivered via a personal computer or a terminal. By adding interactive videodiscs, you can achieve higher levels of motivation. Because it utilizes more technical equipment, this method can be more expensive. The costs and benefits must be weighed to determine if the added expense will lead to improved results. Regardless of which alternative is selected, all offer the benefits of self-paced and on-site learning.

Self-paced, on-site training is significantly less expensive than the alternative modes of delivery. IBM experienced a 25-50% reduction in costs when they transferred 50% of their classroom training to self-study format.[292] While there are substantial set-up costs involved, the elimination of educational centers, travel and living expenses and dependence on instructors leads to significant cost savings.

IBM found these methods also reduced learning time, thereby reducing related expenses. In many instances, self-study programs were completed in half the time that was required for classroom instruction. "...IBM estimates that learning occurs 25% faster with the new delivery methods and is equally effective as traditional classroom education."[293]

---

[292]Ibid., 264-265.

[293]Ibid., 265.

This 25% reduction in training time alone represents a significant cost savings over other delivery methods.

There are also instances where self-study is a more effective means for providing instruction. Often times, it is difficult for persons with weak basic skills to grasp information delivered through classroom or lecture-based models.

> The [collegiate] model aggravates [their] difficulties in learning because it demands the possession of the very skills they are lacking.[294]

Traditionally, these individuals performed poorly in training due to their weak skills in reasoning, analysis and language.[295] Now, using a self study approach, they can perform successfully in training and on the job. For organizations with employees deficient in basic skills, self-study delivery methods may prove to be more effective both in terms of cost and training success.

Self-study should not be the sole means for delivering technical or job-specific training. 'Hands-on' instruction is vital to teaching specific job behaviors. Participants will be guided through the actual tasks they will be expected to perform on the job. This training can be conducted by a supervisor, team leader, or a vendor

---

[294]Rosow and Zager, 180.

[295]Ibid., 178.

representative[296]. Exposure to the work environment enhances learning and motivation because participants see learning points put to practice on the shop floor. Hands-on instruction is a critical part of job specific training.

An Alternative Design for Midlevel Literates

An issue of particular importance to trainers today is the training of persons described as functionally illiterate[297] or midlevel literates[298]. As a result of their deficiency, these individuals perform poorly in the classroom.

> They find it difficult to absorb large amounts of information quickly, when it is presented in complex textbooks or manuals and taught by the collegiate model of assigned readings, lectures and paper-and-pencil tests.[299]

Typically, to improve their success rate, midlevel literates were first placed in programs designed to improve basic skills rapidly. Next, they were assigned to technical training. These programs failed to improve either their basic skills or their success in technical training.[300]

This does not mean that these individuals are unable to

---

[296]See Rosow and Zager, "Manufacturers and Users of New Technology: Partners in Learning." 94-129.

[297]persons possessing a fifth grade reading level.

[298]persons with reading level ranging from 5.0 to 9.9 grade levels, applies to nearly half of young adults.

[299]Ibid., 178.

[300]Ibid., 179.

perform technically advanced tasks. Instead, an alternative approach to training can be applied with great success. The concept of contextual learning enhances the ability of midlevel literates to comprehend new information and knowledge.[301] For the purposes of upskilling, it improves training success for anyone already familiar with operations.

By incorporating basic skills into technical training, this approach greatly increases the training success of midlevel literates and functional illiterates.

> Researchers have (1) enabled functional illiterates to understand and successfully operate new technology, and (2) shortened the overall training time while increasing the trainees' success rate.[302]

Because these individuals are familiar with the "context" of the new technical information they can comprehend and apply it much more rapidly than if they were unfamiliar with the processes involved.[303]

In particular, this approach would be designed for incumbent workers who lack basic skills. These individuals would enter technical training with an understanding of the production process. The objective is to raise "literacy

---

[301]Ryan T. A. and William Furlong, "Literacy Programs, The Armed Forces and Penal Institutions," in Toward a Literate Society, eds. J. Carroll and J. Chall (New York: McGaw-Hill, 1975).

[302]Rosow and Zager, 173.

[303]Ibid., 221.

rapidly in a specific skill domain"[304] at the same time that new technical skills are learned. By presenting the new information in the context of the production process with which participants are familiar, they learn both the basic and technical skills at a much faster pace. This instructional design improves the training success and on the job performance of midlevel literates.

Based on vast research in this area, the Work in America Institutue provides the following design principles for training midlevel literates:

1.) Let students know what they are to learn and why, in such a way that they can understand the purpose of the training or education in their lives.

2.) Develop new knowledge on the basis of knowledge that the students already has on entry to the program.

3.) Develop new lessons on the basis of old lessons, so that the new learning builds on prior knowledge.

4.) Integrate instruction in basic skills--such as reading, writing and arithmetic--into the technical training or academic content area courses, to permit students to better negotiate the requirements for these skills in the program at hand and to permit them to transfer such skills to other, related settings.

5.) Derive objectives from an analysis of the knowledge and skill demands of the situation for which the course is supposed to be providing human resources.

6.) Utilize in the course--to the extent feasible--contexts, tasks, materials, and procedures taken from the setting for which people are being trained and educated.

---

[304]Ibid., 220.

Labor market projections indicate that growth in the labor force will come primarily from populations who have traditionally had weak basic skills. For manufacturers trying to make the most of their human resources, this new approach may offer significant advantages over alternative designs. Success rates can be increased while training time and expenses are minimized.

Measuring Training Success

Evaluating training success is a necessary component of a comprehensive upskilling program. Management must determine if all the pre-set objectives are being met. This process also provides feedback for improvements and modifications in the program. Despite the critical information provided through evaluation, few companies "make strategic efforts to evaluate whether a program has actually produced the intended learning."[305] The role that upskilling plays in transforming an organization to a world-class manufacturing system necessitates a comprehensive evaluation process.

Evaluation is primarily conducted to determine if training is producing the desired outcomes and if any improvements are necessary. In the Handbook of Training Evaluation and Measurement Methods, Jack Phillips describes specific reasons for evaluating employee training programs.

---

[305]Ibid., 11.

Those which apply to strategic training include:

- to determine whether a program is accomplishing its objectives;
- to identify the strengths and weaknesses in the program;
- to identify which participants benefited the most or the least from the program; and
- to determine if the program was appropriate relative to the objectives set for it.[306]

Phillips' developed a results oriented approach to training. This is described as a Human Resources Development (HRD) philosophy which emphasized results and is characterized by the following:

> HRD programs are not usually under taken unless tangible results can be obtained; at least one method to measure the results of an HRD program is included in the program design; each member of the HRD staff should be committed to measuring the results of their efforts; management is involved in the HRD process at all phases; there is an active effort to increase management commitment and support of the HRD effort.[307]

These same characteristics can be found in a program designed to raise the skill levels of workers. Moreover, an upskilling program is a strategic response to a vital business need. This places the central focus on improvements in the production process. The program must add value through measurable performance related results. For this reason, Phillips' results oriented approach is well

---

[306]Phillips, Jack J. The Handbook of Training Evaluation and Measurement Methods, (Houston, TX: Gulf Publishing Company, 1983): 33.

[307]Ibid., 32-33.

suited for our model.

When a results oriented training approach is applied to a upskilling program, it becomes part of an on-going process. As such, it will require a comprehensive and dynamic evaluation procedure. The Kirkpatrick model fits this criteria. Further, it is the most popular and accepted approach to evaluating training success.[308] Using this model, data is collected on four levels: (1) reaction (2) learning (3) behavior and (4) results. Each measures different types of learning but all provide valuable insight into program success.

REACTION: Participants' opinions regarding the program are collected through interviews or a written survey. For the purposes of upskilling, participants' reactions are important in determining how the transformation is progressing. Is training relieving employees' anxiety over the changes which are occurring? Have they accepted the new philosophy? Answers to these types of questions provide valuable insight into the success of the orientation process.

LEARNING: At this level the amount of learning that has occurred is measured. Using paper and pencil tests, learning curves, or job simulations, management determines the principles, facts, techniques and skills that were

---

[308]Ibid., 42.

actually learned.[309] Measures should be "objective and quantifiable indicators of how the participant understood and absorbed the material."[310]

These measures can easily be incorporated into self-study manuals or video materials. A pre-test and post-test can readily determine if employees have met learning objectives. The post-test can also serve as a prerequisite for progression in the program; employees may not proceed to the next phase of training until they pass the post-test.

BEHAVIOR: Next, participants should be observed on the job to determine which behaviors were successfully transferred to the workplace. Subordinates or supervisors can be used to measure the degree to which proper behaviors have been learned.[311] Behavior measurement should contain a long-term component to ensure that bad habits or short cuts do not develop and hinder the effective performance of learned tasks. Proper task performance should be included as a criteria in annual performance evaluations.

RESULTS: Ultimately, success is determined by measurable gains in production-related criteria. Management will measure gains in productivity, decreases in costs, increases in productivity and quantifiable improvements in quality. Phillips also recommends measuring improvements in

---

[309]Ibid., 37.

[310]Ibid., 37.

[311]Ibid., 37.

the following variables as possible sources of cost savings:

- reduction in time to reach a standard proficiency level;
- improvements in scrap rate for new employees;
- improvements in the safety record; and
- reduction in equipment maintenance expenses.[312]

Cost savings from the orientation process could be measured by reductions in absenteeism, new employee turnover, and, where feasible, improved employee morale.[313] Analysis of program results must be very systematic and objective as it will determine the fate of the upskilling program. If the program fails to meet its strategic purpose and add value to the process, it can no longer be justified.

The Work in America Institute also recommends evaluating training on the same four levels; reaction, learning, behavior and results. Through their analysis of IBM's systems approach, they found that IBM measured success at each of these levels. The data was collected in a manner similar to those recommended above. In particular, four sources of data are considered in [IBM's] evaluation process:

(1) post-training surveys to determine reactions of trainees;

(2) knowledge and skills test administered before and after training;

---

[312]Ibid., 195.

[313]Ibid.

(3) interviews with trainees and observations on the job to determine the application of training in the workplace; and

(4) impact on business results.[314]

Through their experiences, IBM considers the greatest challenge to be providing consistent quality and achieving standard results through their decentralized systems approach.[315] However, the above evaluations have assisted in this endeavor. Evaluation occurs throughout training and provides management with the needed controls and checks on program progress. Incorporating this evaluation model into upskilling programs will increase program success by increasing the consistency of training outcomes.

Financial Considerations

The upskilling program described in this chapter is a very systematic and comprehensive program. It requires large financial expenditures and a strong commitment from top management. Determining the cost-effectiveness of such a program requires careful consideration of the implications of these upskilling efforts.

The program described is a strategic response to changes in the economic environment; increasing global competition; decreasing size of manufacturing industries; changing composition of the labor market; and rapid

---

[314]Casner-Lotto, 266.

[315]Ibid., 259.

advances in manufacturing technology. All of these factors have eroded the competitive status of American manufacturers. Those who wish to regain a competitive advantage will invest in new technology, improve process controls and provide their work force with advanced skills.

In these instances, training is not considered an option but rather a necessity. To create a world-class manufacturing facility, industry must provide its work force with new, higher skills. Thus, analyzing the cost-effectiveness of training is conducted to select between alternative methods and not to determine if training will occur.

If training does not occur, individual manufacturers will not be equipped to compete in the global market place. What is to be evaluated is by what means the worker will receive new, higher skills. As noted by IBM's corporate director of education systems, the training program should be evaluated against the option of not upskilling your work force. He believes that in today's economy, the greatest cost to employers will be an "employee not fully trained to do an outstanding job".[316]

However, a cost-analysis should be conducted when selecting between alternative means for raising skill levels. The financial investments in training programs must be weighed against the anticipated results. The method

---

[316]Ibid., 269.

which provides the most cost-effective improvements in production will be selected. If this method fails to produce the desired results, it will be replaced by a new, more effective method.

Alternatives to in-house training include: community supported programs, coordination with community colleges, programs conducted by a trade association and training provided by outside specialists. Also, union contributions have been negotiated by firms experiencing financial hardship. These alternatives can provide employers with needed labor skills at a much lower cost.

Many successful community or government sponsored programs arose out of the last recession. Chapter Two highlighted the success of many manufacturers to rebound from the economic slowdown. These firms increased productivity and competitive status through process changes and new technology. Nonetheless, many were not so lucky. For example, Michigan lost 25% of its manufacturing jobs from 1979 to 1983 as a direct result of foreign competition and advanced technology.[317] Many of the jobs lost have only slowly been replaced. When they were replaced, it was with high-skill jobs. Michigan and other similarly situated states have joined forces with manufacturers to train workers in the skills needed to rebuild their local

---

[317]William E. Schmidt, "Guiding Small Factories Into a Future," New York Times, 17 February 1989, 7.

economy.[318]

The Michigan Modernization Service is offering advise to small employers on how to stay competitive with foreign manufacturers.[319] This includes advise on the use of computer-aided design and manufacturing systems to produce high-skill precision manufactured products as well as assistance in retraining workers.

> The state's first client was H. R. Krueger, a machine tool builder near Detroit that was having a problem keeping highly skilled operators to operate its new computer-based manufacturing equipment. The [Service] worked out an arrangement with a nearby community college, and the company was provided with a steady flow of skilled workers.[320]

Generally, state programs are aimed at retraining workers who have already been displaced as a result of an economic downturn or because new technology has rendered their skills obsolete. These programs enhance workers' marketability to local employers who are unable, or unwilling, to provide the training themselves.

In other instances, Private Industry Councils have been formed between employer associations and state job agencies to coordinate the allocation of state retraining funds.[321]

---

[318]Selyn Feinstein, "States Move to Fill What They See as a Void in Job Training," Wall Street Journal, 10 September 1988, 1(E).

[319]Schmidt, 7.

[320]Ibid.

[321]Norma R. Fritz, "A Good Entry-Level Employee is Hard To Find," Personnel (May 1988): 10,

Under these arrangements, employers receive workers trained specifically for their skill needs. For example, in Rockford, Illinois one such arrangement led to the construction of a training center for advanced technical skills. "The center services industry directly by working with individual companies to design seminars and workshops tailored to their needs."[322]

All of these programs have helped provide employers with the kind of laborers needed in the changing economy. Each system serves the common goals of both business and the community. They rebuild the economic base of communities dependent on manufacturing industries and they provide needed labor skills to employers trying to regain their lost market share.[323]

Long-Term Considerations

Up to this point we have concentrated on concerns associated with installing information technology and creating a world class manufacturing system. However, many of the related issues have long term implications for the organization. Manufacturers must plan accordingly and begin programs to meet the long term needs of a world class manufacturing system.

Economic predictions presented earlier indicate that

---

[322]Training, "More Industry Education Cooperation," (May 1988): 75.

[323]See also, Feinstein, 1(E).

the need for high-skilled labor will continue into the next century. Manufacturing industries will be in heavy competition with service industries for these skills. Unless there are substantial improvements in the public school system, high-skilled workers will be in short supply and employers will be forced to provide basic skills training themselves.

Some Fortune 500 corporations have taken the initiative to reverse this trend and improve the quality of public education.[324] These initiatives vary from financial support to enrich a good school; financial support to improve poor quality schools; programs to reward and motivate exceptional teachers; programs focused on improving curriculum design; and programs to motivate students.

Through these collaborative efforts, business and education can reach their common goal of developing a citizenry equipped with the basic skills needed in an advanced economy,

> ..In the 1980's the needs of the business community and the goals of public education are converging. Each is interested in a liberally educated society, equipped with basic skills and higher-level cognitive abilities. They share the objective of educating people who can and will continue to learn for their own growth and developments, as well as to be able to advance in their workplaces.[325]

---

[324]Committee for Economic Development, American Business and the Public Schools, ed. Marsha Levine and Roberta Trachtman, (New York: Teachers College Press, Columbia University, 1988), Appendix B.

[325]Ibid., xxi.

Organizations "tie their education effort to the central mission, culture and strategy of the business."[326] They realize that specific occupational skills will continually change and will require on going employer sponsored training. However, the need for basic skills will remain strong and such general training can be provided to all citizens through the public education system. Improving public education will relieve business of the responsibility for providing the education required for the "survival of their business, the health of the economy, and the sustenance and maintenance of a free and democratic nation."[327] The intent is to create long-term improvements in the public education system.

There are signs that organized labor has also recognized the need for long-term skills improvement and retraining plans. This issue has increasingly been tied to the larger issue of job security. Raising members job security has become a top priority for organized labor.[328] Related to retraining, contracts may contain stipulations on the effects of technology changes in the workplace. Unions and management have negotiated contract provisions

---

[326]Ibid., 3.

[327]Ibid.

[328]Siegel, Irving H. and Edgar Weinberg, Labor Management Coopertation: The American Experience (Kalamazii, MI: W.E> Upjohhn Institute for Employment Research, 1982): 162. and Louis Uchitelle, "Job Security a Mirage for Unions Despite Wage Concessions of 80's," New York Times, 9 Jan 1989, 1(E).

(redundancy plans) regulating worker displacement and retraining after the introduction of new technology. These provisions may cover any area of employment which is effected by the introduction of new technology, such as transfer, severance pay, and seniority rights.[329] Unions have also bargained for provisions which require the employer to train members to perform the jobs required to operate new equipment.

Labor has also agreed, in certain instances, to aid in funding these programs.[330] This demonstrates even further labor's recognition of retraining as a vital source of job security. An agreement between UAW and Ford Motor Company provides retraining for workers displaced by innovations in the work place. Funds are contributed on a per hour basis for each straight time worked by an employee.[331] The contribution was negotiated as part of the wage and benefit package. As such, the programs are targeted to meet specific employee needs. Typically, they focus on vocational and technical skills.[332] This model of a joint union/employer approach is just one example of how the long-term needs of labor, management and individual employees can

---

[329]Ibid., 161-165.

[330]Ibid.

[331]Geber, Beverly, "The Resurrection of Ford," Training 26:4 (April 1989) 25.

[332]Ibid.

be served on mutually agreeable terms.

A Strategy for On-Going Change

In the long-run, training will become part of an organization's strategy for on going change. Such a strategy will be a result of the following forces:

- The unending search for the competitive edge in a world economy.
- The need for sustained, high-level quality of products and services, requiring a responsive, qualified work force.
- The information age, which changes the flow and speed of transfers of knowledge requires different and changing skills.
- The need for flexibility and interchangeability of skills and knowledge with an adaptable, responsive work force.
- The rapid change in occupations and the need for employees to adapt and learn new occupations within their career employment.
- Better educated, more capable workers , who can participate effectively in decisions affecting their jobs.[333]

As a result, learning must become an everyday occurrence on the shop floor. The changing role of supervisors may create the perfect opportunity for employers to provide continuous learning on the job. In the new workplace, traditional supervisory responsibilities, such as decision making and providing information, will be pushed to the operator level. Their role will undergo a radical transformation. Like their subordinates, supervisors will

---

[333]Rosow and Zager, 55.

be responsible for a broader range of operations. Their "span of responsibility for production operations will increase and responsibility for numbers of workers will decrease."[334] This will lead to more interactive relationship with subordinates and require broad based expertise.

In this scenario, supervisors could step into the role of trainer. They could provide new and incumbent employees with the knowledge and skills they need to progress with the company. As a 'hands on' trainer, the supervisor would be responsible for the continual learning of their subordinates. They should be enabled to provide the basic and specialized skills required to function in their "group". Creating this arrangement will also decrease the organizations dependence on other subject matter experts, typically, the engineering staff.

Employers must also build an infrastructure to support a world class manufacturing system. In addition to learning systems, the transformation will require corresponding changes in decision making, work rules, compensation systems, communication, selection and labor relations. For many organizations, these systems remain in tact despite the radical changes occurring in the workplace. Training and continuous learning only provide employees with the ability to perform.

---

[334]Lund and Hanson, 108.

> The development of competence is not sufficient, however. Organizations must provide performance opportunities, that is, conditions must exist that required, invite, and nurture these new skills.[335]

The development of a new structure must be derived from the new philosophy. Compensation programs should be based on employee knowledge and skill levels; selection techniques should screen candidates for required basic and social skills (specific skills will be provided); and labor-management relations must become less adversarial and more cooperative.[336] The culture must be transformed to one which fosters communication, responsibility and cooperation. Only then will organizations provide the fullest opportunity for employees to reach their highest levels of performance.

---

[335]Zuboff, 216.

[336]Committee on Effective Implementation of AMT, 12.

CHAPTER V

CASE STUDY: PACKAGING CORPORATION OF AMERICA

Packaging Corporation of America (PCA) is a subsidiary of Tenneco Inc. In their 64 plants world-wide, they produce containerboard, aluminum, plastic and molded fibre containers. PCA's competitive edge is based on high quality products and extensive research and development. PCA operates a state-of-the-art technical center for developing new advanced types of packaging products, such as microwave and plastic containers. Recently, PCA diversified into specialty products to meet the full spectrum of packaging needs.

PCA's mission is to provide top quality, diversified products to world wide markets. This requires close control of process and production management to ensure consistent, high quality products. Additionally, they have moved into new markets which require technologically advanced manufacturing processes. To provide a variety of products in a global market, production change over time (time it takes to set-up new production processes) must be minimized. This allows rapid introduction of new products.

PCA believes the ability to provide top quality, specialty products in the most efficient manner possible is

the only way to sustain a competitive advantage in a global economy. Further, they believe it will be necessary to have a world class manufacturing system running efficiently by 1995 if they are to survive in the changing economy.

Creating a World Class Manufacturing System

PCA began their evolution to a world class manufacturing system in 1985. Senior management realized that in order to maintain their competitive status they had to modernize operations. Senior management also rejected Crosby's philosophy that "Quality is Free"[337], and determined that they needed to invest in the quality of their people and their manufacturing process. There was a high return on investments in quality and PCA was ready to realize this return. The reality of global competition led to the Excellence in Manufacturing (EIM) program.

The pages that follow describe the EIM program, how it was developed, its purpose, goals and component parts. Next, a brief analysis of the gains PCA has received from EIM to date are presented. Lastly, there is evaluation of the program's structure and PCA's implementation strategy. With the exception of the evaluation, all information was gathered through conversations with PCA's Manager of Operations Training, Frank W. Rudolph. Frank Rudolph was closely involved in the implementation of PCA's EIM program

---

[337]Crosby, Philip B. Quality is Free: The Art of Making Quality Certain (New York: McGraw Hill, 1979)

at all 65 facilities. His experiences and knowledge have given rise to the following analysis.

The Excellence in Manufacturing Program

PCA formed a steering committee, made up of senior management, to set program goals. They created a vision of what they believed PCA must "look like" to remain competitive in the future. The steering committee's philosophy was that the Company needed to create a competitive advantage based on the quality and efficiency of the entire production process. This strategy would require large investments in technology and in human resources.

After the steering committee created their vision, training and manufacturing services personnel defined it in terms of applicable concepts. This resulted in a new set of principles and rules for the organization. From here, goals for EIM were clearly defined in terms of the manufacturing process and desired performance gains. Frank Rudolph described six major goals of the program:

1) improve customer service through just-in-time process controls (JIT);

2) improve product quality through statistical process control (SPC);

3) decrease inventories, in process and in the warehouse through JIT controls;

4) decrease operation expenses by increasing productivity;

5) improve throughput and cycle time by enhancing operations; and

6) alleviate bottlenecks by improving production management.

PCA believed these goals would only be achieved by investing in new, advanced technology and by improving the skills of their work force.

The EIM program was defined as PCA's competitive advantage. The new philosophy was that quality, productivity, and cost improvements were all a part of a holistic business strategy. Clearly, EIM was not the latest fad or quick fix. Instead, Mr. Rudolph described it as the end result of a logical, evolutionary, market driven survival strategy. The principle of EIM was that total quality management was a continuous process of improvement in products, process and systems.

An integral part of the process is PCA's work force. Top management decided to make substantial investments in the skills of their hourly work force; a new precedent in training at PCA. This decision came after top management accepted the critical role they play in the manufacturing process. Being closest to the day to day operations, line workers have the greatest effect on the process. Their ideas and innovations could provide significant "inputs" to the system. To maximize employee input, management decided to provide extensive retraining in basic, general and technical skills.

Training for a World Class Manufacturing System

To carry out the new corporate strategy, the EIM training program was formulated. In August of 1987, PCA began to train employees in the new philosophy and its role in the corporate strategy. During the orientation process, upper management (general managers, CEOs) were introduced to the new concept of total quality management. Line supervisors received additional briefing on particular applications of EIM at their facility. Finally, all hourly workers were introduced to their "new responsibilities" as key players in PCA's world class manufacturing system.

The orientation sessions reinforced the new manufacturing philosophy. The following concepts were clearly stated in PCA's EIM training manual.

- all employees would be involved in continuous training;
- PCA needs total employee involvement;
- innovation and change are the driving forces behind the new process;
- PCA will only be successful if it establishes a sustainable competitive advantage;
- PCA must continually improve its manufacturing process, products, and support systems in order to stay competitive; and
- the central focus of all efforts will be satisfaction of true customer needs.

The curriculum of EIM training was also outlined in the training manual. It included an introduction to the concept

of world class manufacturing and its underlying principles. Next, participants were introduced to the new production control techniques that would be incorporated into daily operations. These included statistical process control, bottleneck analysis, measures of utilization, a productivity profile and the concept of single minute exchange of die. This training was designed to prepare organization members for the transformation to a world class system. The EIM program was described as a strategy for survival in the emerging global economy.

The following EIM training outcomes or objectives were shared with all participants at the start of training. The desired outcomes, as presented in the EIM training manual, were as follows:

1.) ensure a baseline understanding of EIM strategy, goals, and objectives;

2.) standardize concepts and definitions; create a consistent language;

3.) crystallize distinctions between EIM and traditional thinking; and

4.) train key personnel in tools of EIM.

Introducing Advanced Manufacturing Technology

The second stage in the transformation was the introduction of advanced technology. This required people and process adjustments. To determine precisely what these adjustments would be, the training team began an indepth analysis of the system and the technology. The team was

composed of representatives from all levels of the organization.

Curriculum was developed by top management representatives utilizing the input of three groups of employees: for process improvements, members of the engineering staff; for production improvements, select supervisors and production managers; for improvements in daily operations, select line personnel.

The process began with an analysis of the systems component parts, how they functioned and their interrelationships. Next, the concepts of EIM were incorporated into the process. For example, utilizing SPC would require the performance of tasks not otherwise required. The technology in conjunction with process and production control changes would alter the nature of work at PCA. Therefore, the analysis had to evaluate the effect that both would have on the workplace. From this analysis a complete picture of a world class factory was devised.

During the process, jobs were designed and tasks were defined. At this time, PCA determined that all workers needed a clear understanding of the entire manufacturing system and the interrelationships within it. They felt that a multiskilled work force was needed to operationalize the EIM concept. PCA would create a multiskilled work force in order to realize all the performance gains possible in the new plant. Ultimately, horizontal, or job enlargement,

training would lead to a facility where all employees could perform all jobs.

Next, training goals were defined for each job category. These "excellence requirements" were defined for all tasks performed. For example, excellence requirements for the task of setting the trim press are clearly outlined in the student guide for this module of training. As stated in the performance checklist in the last section of the guide, the excellence requirements include: demonstrating the proper safety procedures used to remove the old tool; correctly installing the new tool; and correctly setting the stroke length and positioning. This example illustrates the job specific nature of EIM training. The curriculum was based solely on job specific tasks and output requirements. The training goals, excellence requirements, represented the level of performance required to achieve the desired gains in production.

Needs Analysis

Next, PCA determined the type of skills needed to meet excellence requirements and, in turn, succeed in training. In addition to specific technical skills, PCA needed employees with the ability to perform in a world class manufacturing facility. According to Mr. Rudolph, this requires individuals who can work in an environment of change and innovation, who want more responsibility and are willing to work as part of a team. PCA looked both

internally and externally for these people.

Outside the plant, PCA found a labor force severely lacking in basic skills. Inside the plant, they found a work force with experience in their old manufacturing process but again, lacking in basic skills. Given this realization, programs were designed to incorporate basic and technical skills. PCA chose to improve the skills of its existing work force and only go to the external labor market to fill vacancies resulting from attrition and the like.

The Technical Training Series

The series includes both horizontal and vertical training. Both are presented in a self-study format which includes workbooks, videos, and pen and pencil tests. The vertical series provides the "tools" for successful performance in the new EIM environment. These tools include team building, communication, feedback and problem solving skills. Vertical training is provided to the extent these skills are needed for effective job performance. The concepts are taught in the context of specific, job related applications.

More simply, an operator will learn problem solving skills necessary to perform their specific tasks. By virtue of the position, this will entail considerably less instruction than would be required to teach a maintenance mechanic problem solving skills. Continuing this example, operators will learn problem solving techniques through the

simulation of events which may occur in the course of a typical day. During the simulation, employees are instructed in effective ways of resolving the simulated problem. It is also explained how the technique can be applied to a variety of problems encountered on the job.

The horizontal or job specific training was developed into a series of modules. Each type of operation (e.g. mills, converting facilities, thermoforming) has its own set of modules for instruction on its particular system. Modules are constructed as career paths for operations personnel. There are separate modules for each job category, such as packer, operator, setup, and maintenance.

Within job categories, employees progress through three phases before completing that level of training. For example, in one system, packers would progress through the "beginner" stage by passing Modules I and II; progress though the "individual performer" stage by passing module III; finally, qualifying as "master performer" upon completing the fourth module. Only after becoming a master at one level may an employee move to training in the next level or job category. To continue the same example, one must be a "master" packer before he or she can begin the first module for the "beginner" operator program.

Each module is highly structured and utilizes similar design and delivery methods. The first module had to be passed by all incumbent employees. It served as an

introduction to the plant's entire manufacturing process. New employees are put on a 90 day probation period. During this period they too must pass the first module or their employment will be terminated. Successful completion of Module I leads to success in subsequent training. Each module begins with a pre-test. This measures each participant's current knowledge level. The program is self-paced and includes reading assignments, videos, and question and answer sections. While each workbook is written on an eighth grade level, Mr. Rudolph explained that the advanced concepts, terms and math problems included do raise the required skill level. For employees lacking the needed skills, tutors are provided. Tutors have assisted those with weak english language skills as well as those with weak math or reading skills. On average, trainees spend roughly eight hours over a two to three day period on the self study portion of the program.

After the self-study portion is complete, they receive on-the-job training. Here, they apply the concepts and techniques included in the manual and on the videos. Similar to the theoretical training, the practical portion is very structured. Trainees are given a specified amount of practice time and are carefully monitored by crew and team leaders. This training exposes participants to all the variables they will encounter on the job. From their experiences employees return to the theoretical training

with practical questions and new insight into the process.

The crew and team leaders are usually supervisors and top performing line workers. Top performers went through the new program first. This served two purposes. First, top performers were able to learn the new system prior to its official introduction. To become trainers or, as Mr. Rudolph put it, shop floor "consultants", they needed a thorough understanding of the system to optimize the benefits on the shop floor. Their early participation allowed trainers to develop this level of understanding. Second, their training was a pilot study of training effectiveness and served as a measure of the program's validity.

After on the job instruction and self-study learning is complete, trainees must pass a post-training exam. This is a pen and pencil test anchored to job and performance criteria. Again, the test is legally defensible because of its high correlation with job performance. Mr. Rudolph described the test is used as a self-evaluation tool. Employees are able to review the training manual and take the test as often as necessary. They can take all the time they need to learn EIM's theoretical and conceptual concepts.

Unlike the job performance test, 100% accuracy is not required. The objective is to improve actual performance, therefore written tests do not usually have a minimum

passing score. Employees review material and find correct answers to questions which were missed. According to Mr. Rudolph, top management believes this leniency reinforces the performance focus of the program. It places the emphasis on actual performance.

Finally, to complete a module, trainees must pass the "ultimate" test; they must perform all required tasks with 100% accuracy. The crew and team leaders evaluate participants' on-the-job performance. If a trainee does not pass the evaluation they must continue training. The on-the-job evaluation should identify the weakness on which participants must focus during their next phase of training.

To pass a module of technical training employees must be able to meet the excellence requirements defined for that particular job category. Trainees can receive extra help if needed but they must be able to perform according to pre-set standards. They must demonstrate that they possess the skills and knowledge needed to operate and maintain the equipment.

Measuring Program Success

The EIM program is evaluated strictly on production results. The ultimate goal is to optimize the investments made in technology and in human resources. Because the training was defined as a strategic necessity, success is dependent upon its ability to further the corporate strategy. More specifically, the program must lead to

measurable improvements in the production process and to performance gains.

These criteria are tied directly to the goals of the EIM program. This includes decreasing waste; decreasing inventory levels; decreasing operation expenses; and improving throughput and cycle times. To the extent that training facilitates progress toward EIM goals it is an effective program and a sound investment in PCA's future. The training is driven solely by the need to create a competitive edge based on PCA's manufacturing process. Therefore, improvements in the process are the sole criteria for success.

Mr. Rudolph describes PCA's evaluation method as an analysis of cause and effect relationships. For example, the goal is to reduce cycle time[338] to 30 days by a specified date. Reduction in cycle time maximizes the value added at each stage in the production cycle. By analyzing the process in incremental steps, delays in production where no value is added should be eliminated. This will lead to desired gains in production by reducing in process and warehouse inventories. Measuring these decreases provides quantitative feedback on the success of training.

A decrease in cycle time can also provide significant gains in cash flow. Reducing time by just a few days can

---

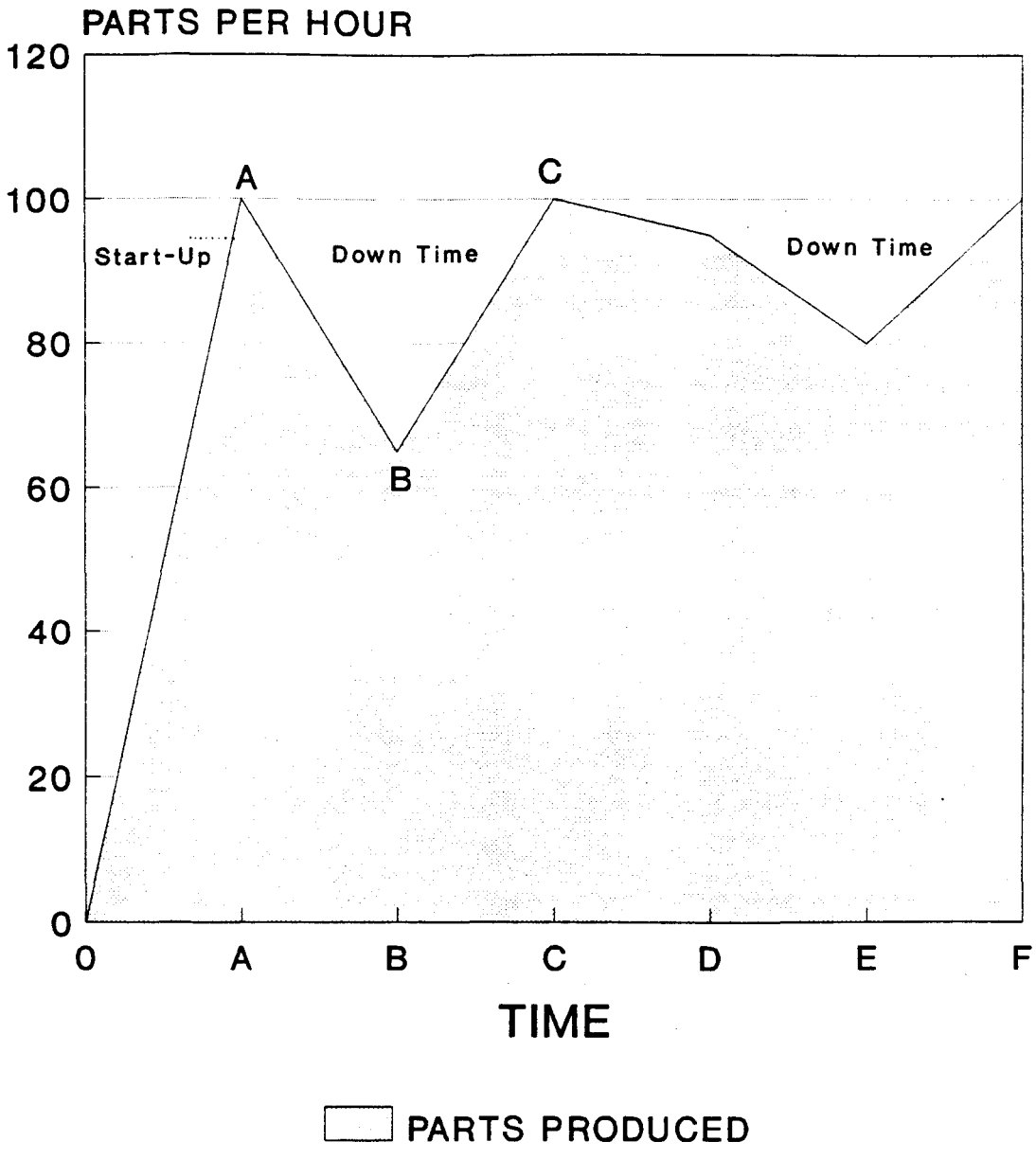
[338]Beginning with its arrival at the plant, the time it takes material to reach a customer in the form of a finished product.

result in higher levels of available cash. When raw materials are purchased and arrive at the plant, cash flows out of PCA and to the supplier, thereby reducing the companies available cash. During production PCA has no way of recouping the decrease in available cash. Not until production is complete and the product is shipped will cash flow again become positive. When the customer receives their order they provide payment for the goods and cash flows from the customer to PCA.

One of the goals of reducing cycle time is to minimize the time between PCA's payment to the supply and the customers payment to PCA. In this way, PCA increases its level of available cash. Increased cash flow is another benefit derived from reduced cycle time. This quantifiable measure of training success is measured by PCA to evaluate the effectiveness of the EIM program.

At PCA, training is viewed as the means to regain lost opportunity. The productivity profile in Graph 1 illustrates this concept. On the rate of production axis, 100 parts per hour is considered "capacity" and is the optimal level of production. However, due to variables in the 'real world' this optimal level is not always reached. The time span from 0 to point A represents start up time. Time spent on set-up and starting the system represents lost opportunity because less than the optimal number of parts are being produced. Horizontal training to decrease set up

Graph 1
PRODUCTIVITY PROFILE



capacity equals 100 parts per hour

time, time elapsed between 0 and point A, recaptures this opportunity and enhances production. Decreases in start up time provide a quantifiable measure of the success of "set up" training.

Similarly, time from point A to point B represents lost opportunity. During the course of operations, problems will arise and production will fall below 100 parts per hour. Minimizing downtime, represented by the non-shaded area between points A and C, is another training goal. It can be reduced through effective vertical training in problem solving skills and horizontal training in maintenance skills. If successful, training will reduce the time between A and C and recapture opportunities lost to equipment downtime. Measuring the reductions in downtime provides further evidence of program success.

Training expenses are carefully measured and evaluated against savings which result from production improvements. Mr. Rudolph estimated training costs to be $1,000 for each employee to complete the standard two year program. To date, this cost is minimal compared to the savings resulting from improvements in production. In 1988, these improvements resulted in a 24 million dollar savings. All of this savings was attributed to the EIM program. These measurable results included:

- decreased throughput time;
- decreased in-process and warehouse inventories;

- decreased cycle time;
- decreased down time; and
- alleviation of bottlenecks

PCA's EIM program has led to substantial improvements in their manufacturing system. Training is still in its infancy and is continually improving. PCA expects the positive results to increase as the program is perfected. Top management views the program as a success and is committed to further its advancement and development. Before looking at PCA's long-term concerns, the following will provide a brief review of the strengths and weaknesses in their implementation strategy.

Program Evaluation

Union Involvement

Unions were not involved in either the decision to implement EIM or the effects of its implementation. PCA merely presented the finished product for their review. Generally speaking, the union's response was favorable. They felt it was a positive program and would benefit the work force by increasing their level of job security; both within PCA and in the external labor market.

However, given management's recognition of very low morale among hourly workers, this approach did little to alleviate this problem. In fact, it can be argued that such an approach may have added to management's negative image. One of the guiding principles behind EIM is employee

involvement, yet employees were excluded from its development. Further, their union representatives were not consulted on the effects of PCA's decision to modernize operations or their decision to upskill the current work force.

While there may be no legal obligation to consult labor on these issues, it is contrary to the goals of EIM to exclude them. In the EIM environment, labor and management must operate under a cooperative system. It appears that labor has accepted managements goals as well as their role of managing operations. To maintain labor's support, PCA should indicate to labor that they accept labor's goal for job security and accept their role as representatives of the work force. A cooperative appoach to labor-management relations can provide a vehicle for greater employee input. If PCA truly wants greater employee involvement they must transform their adversarial relationship with labor to one characterised by cooperation, trust and mutual respect.

Despite the obvious benefits, some employees may still feel cynical about a program designed to increase their participation that was created and developed without their knowledge, let alone input. Workers already harboring resentment toward management may only see the benefits from EIM which will accrue to management. Their negative attitude will distort their view of most management initiatives. They may, as other unions have, believe that

management has a "hidden agenda" to increase profitability without raising wages or that management will eventually cut the size of the work force as a result of the new operating systems.

Involving the union in the process could have been a first step toward new, positive relations with production workers. Regardless of the union's acquiescence to EIM, excluding them from the development process represents a lost opportunity to enhance relations. These enhanced relations could have translated into additional cost savings as a result of reduced turnover, absenteeism and potentially greater savings from waste, downtime and other variables within the employees' control. If management truly wants employee involvement they must accept and respond to employees' concerns and goals.

Program Structure

EIM is structured very similar to IBM's system approach which combines orietation training, job-specific training and conceptual training of the new technology. The program is job related and results oriented. Also, it provides training in technical, general and basic skills. Under PCA's format, training in basic skills is kept to a minimum. Only the basics for an employee's current job level is provided. While this is adequate, a more sound footing in math, reading etc. is recommended by many trainers to enhance the programs long term success (Chapter Three).

Workers with high levels of basic skills are better able to adapt to continuous change and progress with advancing technology.

Training is delivered through a self-study format. This allows flexible, cost-effective, decentralized training. Given the variety of operations employed by PCA, any other format would be prohibitively expensive. Providing subject matter experts, instructors and educational centers for each type of operation would have been too great a burden. Developing workbooks and videos, while start-up is expensive and time consuming, is far more cost-effective than alternative delivery methods.

PCA's structure goes one step further than the training approach outlined in chapter four. EIM provides a career path for hourly personnel. Career development is rarely provided to operator or semi-skilled personnel. To the extent these workers desire advancement and enhanced responsibilities, this program does provide significant benefits to hourly workers. The EIM model provides training to all employees with the capacity and desire to learn. It also provides a structured path on which hourly employees can progress to higher occupational levels through employer sponsored training.

Evaluation Methods

Orientation training is the introduction to EIM and world class manufacturing. Upon employment, all new hires

are also introduced to these concepts through orientation training. PCA has not attempted to evaluate participant reaction to ascertain orientation effectiveness. Again, given the low morale, this would be recommended to determine if employees understand what is occurring in their workplace, if they want these new responsibilities, and if they will provide the type of input and involvement PCA is expecting to receive from its work force. Otherwise, PCA may be equipping its work force with skills and abilities they have no intention of using in the long term.

The effectiveness of orientation training can only be evaluated by surveying participants. Informal discussions will not elicit feedback from everyone and consequently, will not provide complete information on participants' reactions. A confidential, written evaluation form can be administered quickly and easily at the end of each orientation session. Administering the survey and analyzing the responses takes very little time but provides management with valuable participant feedback.

The program effectively incorporates the other recommended levels of evaluation: learning, behavior and results. Pre- and post-tests provide feedback on whether trainees have learned the desired concepts and techniques. Formal on-the-job observation ensures proper task performance and that desired job behaviors have been acquired. Finally, results evaluation provides desired

feedback on production gains and process improvements resulting from EIM.

A final note, the leniency provided participants taking the post-training written test provides an additional benefit not already mentioned. The flexibility provides a cushion for individuals with literacy problems or weak english language skills. While participants have the opportunity of using a tutor, this may not completely eliminate their difficulties in comprehending the self-study materials. Their deficiency may inhibit their ability to comprehend the complex conceptual concepts while they are still capable of effective on the job performance.

Overall, EIM is a good example of an effective strategic training plan. The sole purpose of EIM is to further PCA's goal of providing high quality packaging products. According to PCA, global competition and advanced technology demand a work force with higher levels of general and job specific skills. EIM was designed to provide PCA's work force with these skills.

Since the plan is still in early stages of development it can not yet be proclaimed a complete success. Also, there are many long-term considerations that PCA has yet to address. New recruiting techniques should be developed to select candidates most likely to succeed in training and consequently, on-the-job. Reward systems should be designed to compensate individuals for their increased skill levels

and for team participation. Also, a more cooperative relationship with labor should be developed to foster the success of EIM and to maximize employee involvement.

Plans for the Future

To date, PCA has no formal plans for structural changes in their organization. However, they have goals they hope to attain in the next seven to ten years. Most importantly, they hope to see changes in the role of their supervisors to correspond with the changes occurring in line responsibilities. Ideally, line personnel will operate as members of self regulating teams. All line employees will have reached the top level of training, that is 'individual team contributor' status. This means they have complete knowledge of the system and teams can work with very little supervision.

At this point supervisors would no longer manage production. Their role will have shifted to, in PCA's terminology, managing continuous improvement. They will manage production inputs which consists of materials and human resources. They will secure the quality of workers by providing them with the training and education needed for optimal performance. They will also provide them with feedback on production outputs. This will provide teams with knowledge on finished products and customer satisfaction. This feedback is a valuable input to the production process.

Also responding to long term goals, PCA recently appointed a Senior Vice President of Manufacturing. Since he was only recently appointed, his specific objectives have yet to be determined. In general, he has been enlisted to solve PCA's 'people problems'. He will work individually with each plant to resolve morale and related concerns. Ultimately, PCA hopes to replace the hostilities of the past with a cooperative, mutually respectful relationship between labor and management. They also hope to measure the benefits from improved relations in the form of reduced turnover and improved morale at all 64 plants.

The new vice president will explore ways to boost productivity by implementing new reward systems, less rigid work rules and by improving management-labor relations. He will investigate the possible introduction of a gainsharing plan to reward individuals and teams for productivity improvements. Also, PCA hopes that less rigid work rules and increased employee involvement will enhance the long term success of the EIM program.

Lastly, and perhaps most importantly, the new vice president will take the necessary steps to improve PCA's relationship with its unions. Historically, PCA's bargaining approach has stressed the goals of minimizing wage increases and maximizing management's control. They now hope to transform this relationship to more of a partnership. The new relationship will be characterized by

cooperation and mutual understanding.

While PCA has done little to improve this situation, they have apparently realized the critical role union cooperation will play in their future. Their future is based on a successful transformation to a world class manufacturing system. The more employee support and involvement PCA receives, the more secure their future will be.

Based on initial results, PCA's implementation of the EIM program has been a success. New technology has provided PCA with the equipment to produce high tech, diversified products and to reduce new product development and introduction times. Training has provided employees with the ability to perform new tasks created by this equipment. Also, training is teaching employees how to perform in the new EIM environment.

Despite these improvements, more changes are required to secure the long-term success of the EIM program. Without corresponding structural changes and improved employee morale, these new skills may not be put to use on the shop floor. In turn, the anticipated, long-term production gains may never be achieved. The program has only provided PCA with the ability to become a world class manufacturer. EIM must run the test of time to determine if this transformation will actually occur.

CONCLUSION

American manufacturers are facing significant new challenges from both inside and outside of the United States. The relative importance of manufacturing to the economic expansion of the United States is declining. At the same time, their once unchallenged preeminence in industry and technological innovations is being overtaken by competitors through out the world. Due to the recent entrance of LICs in world markets, manufacturers are finding it increasingly difficult to compete in standardized, high-volume production industries. Similarly, manufacturers in the United States are facing increased competition from IACs in flexible, high-skill industries. These forces are radically changing the role of American manufacturing in both the United States and the global economy.

This thesis describes how innovative firms have met the challenges presented by the changing environment. To remain competitive in the global economy, these leaders are transforming their factories into world class manufacturing systems. As a means to this end, they have taken the following steps: invested in advanced technology, reorganized their production processes, adopted new production principles, and made significant investments in the skills of their work force.

Computer-based production equipment places new demands on the work force and on organizational leadership. The studies presented in this thesis indicate that leaders must transform their work place to provide an environment which will maximize the output of both advanced technology and their work force. Manufactueres who have made these investments have regained or improved their position in the market place.

Investments in their work force have included extensive training in the performance of new, more advanced tasks. To optimize investments in computer-integrated manufacturing systems and to perform more advanced tasks, workers must be equipped with the following skills: visualization, understanding of process phenomena, conceptualization, statistics, attentiveness, individual responsibility, communication skills, flexibility and self reliance. Evidence presented in this thesis indicates that increasing worker skill levels provides a greater benefit to management (in the form of improved operations and profitability) than does the alternative of hiring new workers.

Additionally, government studies indicate that the supply of workers with the needed skills does not meet the current demand. They also indicate that the shortage of skilled labor will increase as we approach the twenty-first century. American manufacturers must recognize the conflicting pressures being exerted by advanced technology

and the changing composition of the work force.

To meet these challanges, successful training programs have incorporated basic skills training in math and reading; general training in team building, problem solving and communication; and technical training in the specific tasks to be performed on the job. The objective of these programs has been to equip workers with skills necessary to receive optimal performance gains from both new computer-integrated systems and from the application of new production principles.

Where an organized work force is present, union support should be solicited immediately following the decision to create a world class manufacturing system. Their involvement has been vital to the the success of many programs. Employers who are truly interested in creating a work force which is individually responsible for production output, is self-reliant and flexible, must foster the growth of industrial relations systems based on mutual collaberation. The studies presented indicate that such an approach reinforces the goals of the new system and the new operating philosophy.

An upskilling program plays a vital role in an organization's strategic plan. It must be carefully designed to serve the corporate mission. Consequently, the success of upskill training will be determined by measurable performance gains. This includes decreases in waste, cycle

time, throughput time, down time, inventories, as well as increases in quality, and, ultimately, increases in profitability. These programs are driven solely by a strategic need to remain competitive. As such, training is only effective to the extent it serves a strategic, rather than developmental, purpose.

After organizations successfully implement new technology and upskilling programs, they must begin to focus on long-term concerns. Through time, organizations will progressively integrate additional plant functions into the new system. Also, global competition will continually place demands for new products and new processes. These forces will create a need for continuous training and adaption. These demands can be met by developing a strategy for on-going change.

Such a strategy will include programs for continuous work force training. Organizations may change the role of their supervisory staff to provide for the training needs of their work force. Additionally, multiskilled workers and semi-autonomous work groups can be used to provide training for new hires. In this way, each plant can independently provide for its own needs and the company as a whole is not dependent on outside content-experts; nor is it dependent upon a large staff of professional educators.

Also, long-term strategies must address the need for new human resources practices. This will include new reward

systems to compensate workers for behaviors which further the goals of a world class manufacturing system; new selection techniques which will screen candidates most likely to succeed in training and on the job; new performance criteria to link wage increases to 'world class behaviors'; and new approaches to labor-management relations which will further the attainment of mutually beneficial goals.

These objectives can be met through new management philosophies. Traditional practices based on scientific management will no longer be appropriate. In fact, they will undermine progress toward a world class system. Management must be willing and able to accept the challenges presented by the external environment. They must also accept the new role for production workers in controlling certain aspects of production.

All tolled, strategies to upskill production workers and to provide for on-going change will create significant challenges for both management and labor. Packaging Corporation of America is one company which is successfully meeting these challenges. Their EIM program is designed to create a world class manufacturing system. PCA believes this system will enable the firm to sustain a competitive advantage in the global economy. As part of this program, they have made significant investments in the technical, general and basic skill levels of their work force. Through

these investments they hope to maximize not only their production output but also the output of their human resources.

To date, PCA has successfully trained their workers in a variety of new skills. The success of training is based solely on measurable production gains. In 1988 alone, they realized a $25 million dollar savings from improved operations. While PCA's program is not perfect, it provides strong evidence of the potential gains to be received from upskilling production workers. According to PCA and other innovative firms, such a program is the only way to bridge the gap between advanced technology and a work force lacking in basic and technical skills.

Bridging this gap can bring many other firms one step closer to becoming a world class manufacturer. It will provide them with the flexibility and the skills necessary to exploit the full potential of information-based technology. To compete in the emerging economy, firms must utilize all the capabilities of their human resources and their advanced equipment. Only those companies who are able to fully utilize computer-integrated systems and their human resources will survive into the twenty-first century.

BIBLIOGRAPHY

Adler, Paul S. "New Technologies, New Skills." California Managment Review 29:1 (Fall 1986): 9-20.

_____ "Managing Flexible Automation." California Managment Review 30:3 (Spring 1988): 34-56.

Albin, Peter S. "Job Design within Changing Patterns of Technological Development." In American Jobs and the Changing Technological Base. ed. Eileen L. Collins and Lucretia Dewey Tanner. NewYork: Ballinger Publishing Co, 1985.

Applebee, Arthur N., Judith A. Langer and Ina V.S. Mullis, Crossroads in American Education. Princeton, NJ: National Assesment of Educational Progress at the Educational Testing Service, 1989.

Bacas, Harry. "Desperately Seeking Workers." Nations Business 76 (February 1988): 16-23.

Bartel, Anne P. and Frank R. Lichtenberg. "The Comparative Advantage of Educated Workers in Implementing New Technology." The Review of Economics and Statistics 69:1 (Februrary 1987): 1-11.

Bernstein, Aaron. "Where the Jobs Are is Where the Skills Aren't." Business Week, 19 September 1988, 104-108.

Blumberg, Melvin and Donald Gerwin. "Coping with Advanced Manufacturing Technology." Journal of Occupational Behaviour 5 (1984): 113-130.

Bove, Robert. "Retraining the Older Workers." Training and Development Journal 41 (March 1987): 77-78.

Brannigan, Martha. "A Shortage of Youth Brings Wide Changes toLabor Market." Wall Street Journal, 2 September 1986, 1- 2(E).

Burck, Charles G. "Toward Two Societies?" Fortune, 10 October 1988, 48-49.

Bushe, Gervase R. "Cultural Contradictons of Statistical Process Control in American Manufacturing Organizations." Journal of Management 14:1 (1988): 19-31.

Carneale, Anthony P., Leila J. Gainer, and Anne S. Meltzer. Workplace Basics: The Skills Employers Want. by the American Society of Training and Development and the U.S. Department of Labor and Training Administration. 1988.

Carroll, John B., and Jeanne S. Chall. Toward A Literate Society. The Report of the Committee on Reading of the National Academy of Education. New York: McGraw Hill Book Co., 1975.

Casner-Lotto, Jill. Successful Training Strategies: Twenty-Six Innovative Corporate Models San Francisco: Josey-Bass Publishers, 1988.

Cattan, Peter. "The Growing Presence of Hispanics in the U.S. Workforce." Monthly Labor Review 111:8 (August 1988): 9-14.

Chiswick, Barry P. "Hispanic Men: Divergent Paths in U.S. Labor Market," Monthly Labor Review 111:11 (November 1988): 33.

Collins, Eileen L. and Lucretia Dewey Tanner, ed. American Jobs and The Changing Industrial Base. Cambridge, Mass: Ballinger Publishing Company, 1984.

Collins,Joseph E. "New Technologies Vital to Economic Growth." Data Managment 25 (October 1987): 7-8.

Committee for Economic Development, American Business and the Public Schools. ed. Marsha Levine and Roberta Trachtman. New York: Teachers College Press, Columbia University, 1988.

Committee on the Effective Implementation of Advanced Manufacturing Technology, Manufacturing Studies Board, Commission on Engineering and Technical Systems, Human Resource Practices for Implenting Advanced Manufacturing Technology. Washington D.C.: National Academy Press, 1986.

Conference Board, Employing Older Americans: Opportunities and Constraints. Report number 916, ed. Helen Axel, U.S.A.: The Conference Board, 1988.

Conference Board, Manufacturing: New Concepts and New Technology to Meet New Competition. ed. James K. Brown, U.S.A.: The Conference Board, 1984.

Conference Board, Total Quality Performance. Report number 909, ed. Lawrence Scheim and Melissa A. Berman, U.S.A.: The Conference Board, 1988.

Coopers & Lybrand, Made in America: A Survey of Manufacturing's Future. U.S.A.: Coopers & Lybrand, 1987.

_____ Made in America II: A Survey of Manufacturing's Future. U.S.A.: Coopers & Lybrand, 1989.

Courter, Eileen. "Employee Training Key Need for Auto Suppliers." American Metal Market, 10 June 1985,19.

Crosby, Philip B. Quality is Free: The Art of Making Quality Certain New York: McGraw-Hill, 1979.

Davis, Donald D. and Associates. Managing Technological Innovation: Organizational Strategies for Implementing Advanced Technologies San Francisco: Jossey-Bass Publishers, 1986.

Dean, Edwin, Harry Boissevain and James Thomas. "Productivity and Labor Cost Trends in Manufacturing, 12 Countries." Monthly Labor Review 109:3 (March 1986): 3-10.

Denny, Micheal and Melvyn Fuss. "The Effects of Factor Prices and Technological Change on the Occupational Demand for Labor: Evidence From Canadian Telecommunications." The Journal of Human Resources 17: 161-176.

Dunlop, John T. Industrial Relations Systems. New York: Henry Holt & Company, 1958.

Ehrlich, Elizabeth. "America's Schools Still Aren't Making the Grade." Business Week, 19 September 1988, 129-136.

_____ "Business is Becoming a Substitute Teacher." Business Week, 19 September 1988, 134-135.

_____ "For American Business, A New World of Workers." Business Week, 19 September 1988. 112-120.

Ebel, Karl-H. "The Impact of Industrial Robots on the World of Work." International Labour Review 125:1 (Jan-Feb 1986): 39-51.

Economic Report of the President. Transmitted to the Congress January 1989. Washington D.C.: United States Printing Office, 1989.

Farmsworth Riche, Martha. "America's New Workers." American Demographics 10:2 (February 1988): 35.

Feinstein, Selwyn. "States Move to Fill What They See as a Void in Job Training." Wall Street Journal, 10 September 1988, 1(E).

_____ "Economic Shifts Will Bring Broad Changes in the Way We Work." Wall Street Journal, 31 May 1988, 1(E).

Feuer, Dale. "Keeping Current at Motorola." Training 22 (Sept 1988): 20-25.

Finney, Martha I. "The ASPA Labor Survey," Personnel Administrator 34:2 (February 1989): 36-42.

Fitz-ens, Jac. "Proving the Value of Training." Personnel 65:3 (March 1988): 17-23.

Francis, Arthur. New Technology at Work. New York: University Press, 1986.

Freedberg, Louis. "Push is on for Overhaul of Vocational Training." New York Times, 11 January 1989, 23.

Fritz, Norma R. "A Good Entry-level Employee is Hard To Find." Personnel 65:5 (May 1988): 10.

Fudge, Cecil. "Retraining for New Technology: Six Success Stories." Personnel Management 18:2 (February 1986): 42-45.

Fullerton, Howard N. Jr., "Labor Force Projections: 1986-2000." Monthly Labor Review 110:9 (September 1987) 19-29.

Galagan, Patricia A. "Joining Forces: Business and Education Take on Competitiveness." Training and Development Journal 47:4 (July 1988): 27-29.

Garland, Susan B. "Why the Underlass Can't Get Out From Under." Business Week, 19 September 1988, 122-124.

Geber, Beverly, "The Resurrection of Ford," Training 26:4 (April 1989): 23-32.

Gil, Avishai. "Some Labour Implications of Technological Change in Rail and Air Transport." International Labour Review125:1 (Jan-Feb 1986): 1-17.

Gill, Colin. Work, Unemployment and New Technology. Cambridge: Polity Press, 1985.

Goldhar, Joel D. and Mariann Jelinek. "Plan for Economies of Scope." Harvard Business Review 61:6 (Nov-Dec 1983): 141-148.

Hall, Robert W. Attaining Manufacturing Excellence. Homewood, IL: Dow Jones-Irwin, 1987.

Hallett, Jeffrey J. "America at Work: The U.S. Workforce 1988-2015." Electric Perspectives 12:2 (Summer 1988): 30-44.

Haugen, Steven. "The Employment Expansion in Retail Trade 1973-1985." Monthly Labor Review 109:8 (August 1986): 9-15.

Hayes, Robert H. "Managing As If Tomorrow Mattered." Harvard Business Review 60:3 (May-June 1982): 70-76.

_____ and Ramchandran Jaikumar. "Manufacturing's Crisis: New Technolgies, Obsolete Organizations." Harvard Business Review 66:5 (Sept-Oct 1988): 77-85.

Hayghe, Howard. "Rise in Mothers Labor Force Activity Includes Those with Infants." Monthly Labor Review 109:2 (February 1986): 43-45.

Henry, Lawrence, "High-Tech Training For The High-Tech Factory," Training 26:8 (August 1989): 41-43.

Herz, Diane E. "Employment Characteristics of Older Women, 1987." Monthly Labor Review 111:9 (September 1988): 3.

Hoerr, John. "Management Discovers the Human Side of Automation." Business Week, 19 September 1988, 70-76.

Holpp. Lawrence and Richard S. Wellins, "The Role of HRD in World- Class Manufacturing, Training 26:3 (March 1989): 52-55.

Hopkins, Kevin R. and William B. Johnston Opportunities 2000: Creative Affrimative Action Strategies for a Changing Workforce, for the U.S. Department of Labor, Indianpolis, Ind. Hudson Institute, 1988.

Howe, Wayne J. and William Parks II. "Labor Market completes Sixth Year of Expansion." Monthly Labor Review 112:2 (February 1989): 3-14.

Jaffe, Irving. "The NIC's Climb Up the Industrial Ladder: Challenge and Opportunity for the Developed Countries." OECD Observer 147 (Aug-Sept 1987): 10-12.

Jaikumar, Ramchandran. "Post-Industrial Manufacturing." Harvard Business Review 66:6 (Nov-Dec 1988): 69-76.

Johnston, WIlliam B. and Arnold H. Packer. Workforce 2000: Work and Workers for the 21st Century. Indianapolis, Ind: Hudson Institute, 1987.

Jones, Robert T. "Looking Ahead: Trends in the Workforce and Job Training." Mangement Review 77 (May 1988): 46-48.

Kaplan, Robert S. "Must CIM be Justified by Faith Alone?" Harvard Business Review 64:2 (March-April 1986): 87-95.

Kossoudji, Sherrie A. "English Language Ability and the Labor Market Opportunities of Hispanic and East Asian Immigrant Men." Journal of Labor Economics 6:2 (April 1988): 205-228.

Kutscher, Ronald E. "Overview and Implications of the Projections to 2000." Monthly Labor Review 110:9 (September 1987): 3-9.

Lee, Chris, "Training Magazine's Industry Report 1987," Training 24:10 (October 1987): 33-35.

_____, "Where the Training Dollars Go", Training 24:10 (October 1987): 51-65.

Lefebvre, Louis A. and Elizabeth Lefebve. "The Innovative Business Firm in Canada: An Empirical Study of CAD/CAM Firms." International Labor Review 127:4 (1988): 497-513.

Lokiec, Mitchell. Labor and Technology in the Post-War Era. Columbia, SC: The State Printing Company, 1973.

Lund, Robert T. and John S. Hanson. Keeping America at Work: Strategies for Employing the New Technologies New York: John Wiley and Sons, 1986.

Mark, Jerome A. "Technological Change and Employment: Some Results From BLS Research." Monthly Labor Review 110 (April 1987): 26-29.

Markey, James P. "The Labor Market Problems of Today's High school Dropouts." Monthly Labor Review 111 (June 1988): 36-43.

Mather, Hal. Competitive Manufacturing. Englewood Cliffs, NJ: Prentice Hall, 1988.

McClenahen, Johns S. and Threse R. Welter. "Training Americans for Work: Industry's Monumental Challenge." Industry Week, 19 September 1988, 52-60.

McConnell, Campbell R. and Stanley L. Brue, Contemporary Labor Economics, 2nd Ed. New York: McGraw-Hill Book Company, 1980.

McDougall Young, Anne. "Fewer Students in Workforce as School Age Population Declines." Monthly Labor Review 107:7 (July 1984): 34-39.

Mellow, Craig "Motown's Manpower Renewal." Across the Board 24:6 (June 1987): 31-39.

Miller, Kathleen. Retraining the American Workforce. Reading, MA: Addison Wesley Publishing Co., 1989.

Nardone, Thomas. "Decline in Youth Population Doesn't Lead to Lower Jobless Rates." Monthly Labor Review 110:6 (June 1987): 37-40.

National Association of Manufacturers, NAM Small Manufacturers Operating Survey. Washington D.C.: The National Association of Manufacturers, 1989.

Nime, Manabu. "The Social Impact of Micro-electronics in Japan." International Labor Review 125:4 (July-Aug 1986): 473-507.

Nelson, Richard R. and Edmund S. Phelps, "Investment in Humans, Technological Diffusion and Economic Growth." The American Economic Review 56:2 (May 1966): 69-72.

Nora, John, C. Raymond Rogers, and Robert Stramy. Transforming the Workplace. Princeton, NJ: Princeton Research Press, 1986.

Norwood, Janet L. "Competition and Competence." Monthly Labor Review 111:6 (June 1988): 2.

Nussbaum, Bruce. "Needed: Human Capital." Business Week, 19 September 1988, 100-103.

Panel on Secondary School Education for The Changing Workplace High School and the Changing Workplace: The Employers View. Washington D.C.: National Academey Press, 1984.

Panel on Technology and Employment. Committee on Science, Engineering and Public Policy. Technology and Employment: Innovation and Growth in the U.S. Economy. Washington D.C. National Academy Press. 1987.

Patterson, Gregory A. "Auto Assemble Lines Enter a New Era." Wall Street Journal, 28 December 1988, A2(E).

Pennar, Karen. "It's Time to Put Our Money Where Our Future Is." Business Week, 19 September 1988, 140-141.

Personick, Valarie A. "Industry Output and Employment Through The End of the Century." Monthly Labor Review 110:9 (September 1987): 30-45.

Phillips, Jack J. The Handbook of Training Evaluation and Measurement Methods. Houston, TX: Gulf Publishing Company, 1983.

Porter, Glenn, ed. Encyclopedia of Econonic History. Vol 1. NewYork:Charles Scribner's Sons, 1980.

Porter, Michael E. Competitive Advantage. New York: Collier MacMillan Publishers, The Free Press, 1985.

Ramirez, Anthony. "Making Better Use of Older Workers." Fortune, 30 January 1989, 179-187.

Reutersward, Anders. "Educationg and Training Tomorrow's WorkForce." The OECD Observer 149 (Dec 1987-Jan 1988): 22-24.

Richman, Louis S. "Tomorrow's Jobs: Plentiful, But..." Fortune, 11 April 1988, 42-47.

Rohan, Thomas M. "Blue-Collar Skills: A Vanishing Resource." Industry 6 June 1988, 41-46.

Rosow, Jerome M. and Robert Zager, Training--The Competitive Edge. San Francisco: Jossey-Bass Publishers, 1988.

Ryan, T. A. and William Furlong. "Literacy Programs, the Armed Forces, and Penal Institutions", in Toward a Literate Society. eds. J. Carroll and J. Chall. New York: McGraw-Hill, 1975.

Sargent, Jon. "Labor Shortage: Menace or Mirage." Occupational Outlook Quarterly 32:4 (Winter 1988): 27-33.

Rohan, Thomas M. "Blue-Collar Skills: A Vanishing Resource." Industry 6 June 1988, 41-46.

Rosow, Jerome M. and Robert Zager, Training--The Competitive Edge. San Francisco: Jossey-Bass Publishers, 1988.

Ryan, T. A. and William Furlong. "Literacy Programs, the Armed Forces, and Penal Institutions", in Toward a Literate Society. eds. J. Carroll and J. Chall. New York: McGraw-Hill, 1975.

Sargent, Jon. "Labor Shortage: Menace or Mirage." Occupational Outlook Quarterly 32:4 (Winter 1988): 27-33.

Saunders, Norman C. "Economic Projections to the Year 2000." Monthly Labor Review 110:9 (September 1987): 10-18.

Schmidt, William E. "Guiding Small Factories into a Future." New York Times, 17 February 1989, 7.

Schultz, Theordore W. "The Increasing Economic Value of Human Time." American Journal of Agricultural Economics. 54 (December 1972): 843-850.

Shaiken, Harley. Work Transformed: Automation and Labor in the Computer Age. New York: Holt, Rinehart and Winston, 1985.

Shank, Susan. "Women in the Labor Market: The Link Grows Stronger." Monthly Labor Review 111:3 (March 1988): 3-9.

Shapiro, Rober J. and Maureen Walsh. "The Great Jobs Mismatch." U.S. News and World Report, 7 September 1987, 42-43.

Siegel, Irving H. and Edgar Weinberg. Labor and Management Cooperation. Kalamazoo, MI: W. E. UpJohn Institute for Employment Research, 1982.

Silvestri, G.T. and J. M. Lukasiewicz. "A look at Occupational Employment Trends." Monthly Labor Review 110:9 (Septmeber 1987): 46-63.

Spencer's Research Reports. Retirement Experience 1979-1988: Employee Decisons Confound Federal Laws. Chicago: Charles D. Spencer & Associates, Inc., 1989.

Spenner, Kenneth I. "The Upgrading and Downgradig of Occupatons: Issues, Evidence and Implications for Educaton." Review of Educational Research 55:2 (Summer 1985): 125-154.

Starkweather, Kendall N. "The Technology Education Thrust." The Technology Teacher 46 (Sept-Oct 1986): 3-8.

Stevens, Catherine. "High Grades for NEC's Growth." Financial World, 13 November 1985, 85-86.

Susser, Peter. "Modern Office Technology and Employee Relations." Employment Relations Today 15 (Spring 1988): 9-18.

Taylor, Fredrick Winslow. Shop Management introduction by Henry R. Towne. New York: Harper & Brothers, 1911.

Touche Ross. 1989 Small Business Survey Results. U.S.A.: Touche Ross, 1989.

Training "More Industry and Education Cooperation." 25 (May 1988): 75-76.

Uchitelle, Louis. "Job Security a Mirage for Unions Despite Wage Concessions of 80's." New York Times, 9 January 1989, 1.

U.S. Department of Commerce, Bureau of the Census. 1980 Census of Population, Volume One: Characteristics of the Population, Chapter C, General Social and Economic Characteristics. Washington D.C.: Government Printing Office, 1983.

_____ Educational Attainment in the U.S: March 1987 and 1986. Population Report, Series P-20, No. 428. Washington D.C: Government Printing Office, 1988.

_____ Survey of Current Business. ed. Carol S. Carson. 69:1, Washington D.C.: Government Printing Office, January 1989.

_____ Population Profile of the United States 1984/85 Current Population Reports, Series P-23, Number 150, Issued April 1987.

_____ Statistical Abstract of the United States: 1988, 108th Ed. Washington D.C.: Government Printing Office, 1987.

U.S. Department of Commerce, Bureau of Economic Analysis. "U.S. International Transactions, Fourth Quarter and Year 1988." Survey of Current Business 69:3 (March 1989).

U.S. Department of Education, National Center for Educational Statistics. Projections of Educational Statistics 1992-1993. Washington D.C.: Government Printing Office, 1988.

U.S. Department of Labor, Bureau of Labor Statistics. Educational Level of U.S. Labor Force Continues to Rise, USDL 88-423, August, 1988.

_____ International Comparisons of Hourly Compensation Costs for Production Workers, 1988 Report 766 March 1989.

_____ "International Comparisons of Manufacturing Productivity and Labor Cost Trends 1987." News USDL: 88-326. July 1988.

_____ "Tomorrow's Jobs," in Occupational Outlook Handbook. Bulletin 2300. (Washington D.C., Government Printing Office, April 1988), 8-13.

_____ "Projections 2000." Occupational Outlook Quarterly 31:1 (Fall 1987).

_____ Students, Graduates, and Dropouts, October 1980-82. Bulletin 2192, Washington D.C.: Government Printing Office, 1983.

_____ Technology and Its Impact on Labor in Four Industries. Bulletin 2242. Washington D.C.: Government Printing Office, 1986

_____ "Proportion of Youth with Jobs." News USDL 88-422, August 1988.

_____ "Current Labor Statistics: Employment Data." Monthly Labor Review 112:2 (Februrary 1989): 67- 73.

Walton, Richard E. and Robert B. McKersie. A Behavioral Theory of Labor Negotiations. New York: McGraw-Hill Book Co., 1965.

Watanabe, Susmu. "Labour-Saving Versus Work-Amplifying Effects of Micro-Electronics." International Labour Review 125:3 (May-June 1986): 243-259.

Welch, Finis. "Education in Producton." Journal of Political Economy 78:1 (January 1970): 35-59.

Wheelwright, S.C. and R.H. Hayes. "Competing Through Manufacturing." Harvard Business Review 63:1 (Jan-Feb 1985): 99-109.

Women Employed Institute. Occupational Segregation. Chicago: The Women Employed Institute, 1988.

Work In America Institute. Teamwork: Joint Labor-Managment Programs in America. ed. Jerome M. Rosow. New York: Pergamon Press, 1986.

Wozniak, Gregory, "The Adoption of Interrelated Innovations: A Human Capital Approach." The Review of Economics and Statistics 66 (Februrary 1984): 70-79.

Zemke, Ron, "Workplace Illiteracy: Shall We Overcome?" Training 26:6 (June 1989): 33-38.

Zuboff, Shashana, In the Age of the Smart Machine: The Future of Work and Power. New York: Basic Books, Inc., 1988.

APPROVAL SHEET

The thesis submitted by Diane Bounds has been read and approved by the following committee:

Dr. Arthur G. Dobbeleare, Director
Associate Professor, Institute of Industrial Relations,
Loyola University of Chicago.

Dr. Lemont Stallworth
Associate Professor, Institute of Industrial Relations,
Loyola University of Chicago.

The final copies have been examined by the Director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master's of Science in Industrial Relations.

11/8/89 Arthur G Dobbeleare
Date Signature of Director