DOCUMENT RESUME

ED 327 719 CE 056 803

AUTHOR	Heitner, Keri L.; And Others
TITLE	What Do Workers Have To Say? Skills & Technological Change.
INSTITUTION	Hampden County Employment and Training Consortium, Springfield, MA.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE	Oct 90
CONTRACT	V199A90013-89
NOTE	44p.; A Project CREATE/Machine Action Project. For related documents, see CE 056 736 and CE 056 802.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Auto Mechanics; *Basic Skills; Continuing Education; Education Work Relationship; *Employee Attitudes; Employment Qualifications; *Futures (of Society); Graphic Arts; *Job Skills; Machine Tools; Machinists; Metal Working; Occupational Information; Postsecondary Education; Printing; Refresher Courses; Retraining; Secondary Education; *Skilled Occupations; Skilled Workers; *Technological Advancement; Trade and Industrial Education; Work Environment
IDENTIFIERS	Massachusetts (Hampden County); Massachusetts (Hampshire County)

ABSTRACT

A survey examined workers' perspectives on skills usage and the effects of technological change in the workplace, specifically in three trades: metalworking machining, automotive repair, and graphic arts/printing. Responses to interview questions asked during site visits to shops in Hampden and Hampshire Counties (Massachusetts) were incorporated into the survey design and content. A total of 209 surveys from respondents in participating shops employing under 100 production workers or line personnel were analyzed. Findings showed that a majority of workers across all three trade areas indicated more or much more usage of high technology skills (computer data entry, operation of computer controlled machinery, computer programming) in the year 2000. Workers affirmed that changes in technology will require greater math usage and greater usage and higher levels of reading skills on the job. The majority had attended at least one upgrading course and strongly agreed that they wanted to advance their skills. Most saw usage of problem-solving skills increasing. Recommendations for policy changes focused on the importance of basic skills; importance of technical skills; curriculum restructuring; worker participation in training design; equity and access issues; and development of apprenticeship models. Issues requiring further research were raised. (23 references; 17 tables; 5 graphs) (YLB)

What Do Workers Have To Say?

Skills & Technological Change

by Keri L. Heitner, Robert Forrant, & F. Richard Neveu

Project CREATE/Machine Action Project
Springfield, Massachusetts

October 1990

Research is supported with a grant from the United States Department of Education Office of Adult and Vocational Education - CFDA # 84.199A, Grant #V199A90013-89 Cooperative Demonstration Program

ACKNOWLEDGEMENTS

We would like to thank the Skills Task Force - Joseph Cangro, Frank Mooney, John R. Warner and Kathleen Winkler - for their invaluable contributions to the conceptualization and implementation of this research. We also thank the staffs of Project CREATE and the Machine Action Project - Anna Mangual, Terry Widener, Elyse Cann and Kathleen McGraw - for their critique of numerous drafts of this report.

Several local machine, automotive repair and graphic/printing shops have generously opened their doors to the Skills Task Force, enabling us to conduct site visits, job shadowing, interviews and data collection. A special thank you to Brimfield Precision Instruments, D&S Manufacturing, Standard Manufacturing and Quabbin Industries; Al Marcotte Ford, Brad's Service Station, Houser Buick, Joe Lessier's Motor Clinic and Regency Oldsmobile/Pontiac GMC; Ampad Corporation, Common Wealth Printers, Cookson Graphics, LaJustice Printing Company, and The Pond-Ekberg Company.

This report is dedicated to the skilled workers in the three trades who unselfishly answered our questions and shared their insights into the nature of work and the implications of technological change.

For reprints of this report, contact Robert Forrant at the Machine Action Project, 1176 Main Street, Springfield, MA 01103. Results of data analyses incorporated into this report are available, upon request.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

ABSTRACT

A survey of 209 Hampden and Hampshire County workers employed in three highly skilled trades - metalworking machining, automobile repair, and graphic arts/printing - offers substantial evidence that workers understand how technology has and will continue to change the way their work environment is shaped and the demands it will place on both their physical and mental skills.

The interviews undertaken for this research yielded a consensus of opinion of workers and employers with regard to common cognitive and occupational skills. Math, reading, measurement, problem solving and interpreting (e.g., blueprints, diagrams and charts) are skills that cut across trade areas. Similarly, set up, data entry, machine operation, computer diagnostics and programming will be the skills required of workers in all high technology trades. Competency-based vocational education must be examined in light of the issues raised in this report. Research is needed as to whether students should be trained to acquire the common skills necessary for a high technology career. Perhaps specific occupational training should be limited to the cooperative placement, entry level on the job training, or work-based apprenticeship.

How do we bridge the transition from high school to work? Can schools and businesses work in partnership towards this goal? How do we enable the workers of the future to utilize the skills they have while keeping abreast of rapidly changing technology, particularly when our educational system has fallen behind other industrial nations? The future of America's competetive standing in the global economy may be at stake.

Research is supported with a grant from the United States Department of Education Office of Adult and Vocational Education - CFDA # 84.199A, Grant #V199A90013-89 Cooperative Demonstration Program

I. EXECUTIVE SUMMARY

Dramatic changes are taking place in the economy and labor market. Job skills requirements in a majority of employment fields are being radically altered. It is estimated that workers will need to be retrained every five to seven years to keep pace with the new technology and 'head' skills required to work in this environment. There will be a greater demand than ever before for workers to use math and reading skills, and work in problem-solving teams.

The Hudson Institute in Workforce 2000 analyzed what newly created jobs would look like between 1985 - 2000. A telling statistic was that only 14% of such jobs would require education levels of 3 years of high school or less, while 52% would require one year or more of college. These rapid shifts in analytical skill requirements come at a time when many states, and the nation as a whole, seem unwilling to commit the needed resources in aid to public secondary and higher education. A bad situation will only get worse. According to a Wall Street Journal special report ("WSJ Reports: The Knowledge Gap," February 9, 1990) :

- U.S. 13 year old students ranked last in an international study of math proficiency;
- 58% of Fortune 500 companies complained of having trouble finding entry level workers with basic skills;
- In 1989, out of 3700 people taking an entry level test of 85 questions at Southwestern Bell, only 800 were able to answer 55 questions correctly and pass;
- Some experts estimate that close to 65% of the current workforce can only read at between 5th and 9th grade levels.

As we approach the 21st Century, workers feel and see these changes occurring and are acutely aware of the many new and different skills they must master in order to hold down a job in the workforce of the future. Workers can and should play a key role in training and workplace education design so that their expertise and years of concrete experience can be used to strengthen the skills delivery system.

Key survey results of 209 workers in the machining, graphic arts/printing and automobile repair fields are as follows. (Significant differences between trade areas are reported in the body of the paper.)

MAJOR SURVEY FINDINGS:

- A majority of workers across all three trade areas indicated more or much more usage of high technology skills, e.g., computer data entry, operation of computer controlled machinery, and computer programming, in the year 2000.

- Workers affirmed that changes in technology will require greater math usage on the job in the year 2000.

- A majority of workers across all three trades agreed that changes in technology will require both greater usage and higher levels of reading skills on the job by the year 2000.

- The majority of the surveyed workers in all three trades have attended at least one upgrading course, indicating that workers are interested in skills upgrading. Similarly, the majority of respondents strongly agreed that they wanted to advance their skills.

- Close to 50% of all workers were using problem solving skills on the job and most saw this usage increasing over time.

- A majority of workers agreed or strongly agreed that their employer encouraged them to upgrade their skills.

- Workers are interested in performing a number of functions on the job. A majority agreed or strongly agreed that they wanted more variety in their daily work assignments.

- There is a sharp disjuncture between workers who regularly perform traditional machine set-up functions and those who perform set-up functions on computer-controlled equipment.

- The research findings indicate that the majority of workers are motivated to continue their education. However, it appears that employers are more likely to provide younger workers with the opportunity to obtain training in the usage of new technologies in the workplace, bypassing highly skilled older workers. Thus, older workers who want to be trained to utilize the new technologies must often seek training opportunities on their own.

II. BACKGROUND TO THE RESEARCH

The Machine Action Project (MAP) began in the summer of 1986 in direct response to the rapid decline of metalworking manufacturing in Western Massachusetts. The February, 1986 announcement that the United Technologies Diesel Systems plant (formerly the American Bosch) in Springfield, Massachusetts would be shutting its doors was one in a series of major plant closings and layoffs in the late 1970's and early 1980's. The closing of this important industrial facility was viewed as an ominous harbinger of the fate of manufacturing in Massachusetts. The Greater Springfield area lost close to 15,000 metalworking jobs in a five year period. Since the region historically had been a metalworking center, such sharp decline caused concern for its economic future.

The Massachusetts Executive Office of Labor and the Industrial Services Program (ISP) had jointly developed the concept of Cooperative Regional Industrial Laboratories (CRIL's). CRIL's were an effort to focus attention in a specific part of the state on one mature industry that had been hard hit by job loss and plant closings. Through research, community involvement and resource capacity building, the projects would attempt to develop industry-specific programs to stem job loss and help stabilize the regional economy. In Spring 1986 the Hampden County Private Industry Council, Hampden County Employment and Training Consortium, Pioneer Valley Central Labor Council and the leadership of several local unions jointly submitted a proposal to the Commonwealth for a CRIL, with the ISP approving funding in July, 1986.

Since its inception MAP has worked with employers, schools and colleges, training providers and community groups to: improve the quality of training programs offered in machining, graphic arts/printing and automobile electronics repair; develop a more coordinated delivery of those programs to provide individuals with a well-defined pro-gression of training courses, including college credits toward an Associates Degree at the local technical community college; start a training program for women in machining; and more fully involve industry in the way programs are designed and taught. In addition MAP has done extensive research on the Massachusetts metalworking industry and produced several reports on its findings.

The detailed research on the metalworking industry, and the ways we have worked with the entire economic, training and education community, have been shared with people and agencies interested in starting similar programs in Pennsylvania, Wisconsin, North Carolina, New York, Texas and Minnesota. We have also met and discussed our work with economic development specialists from Japan, England, Italy, West Germany and Australia.

MAP was recognized as an innovator in the field of regional economic development when, after a competition with close to 1000 other programs, it won a 1988 Ford Foundation - John F. Kennedy School of Government award as one of the ten most innovative community projects in the country. In 1990 MAP was again recognized with an Innovations Award from the Arthur D. Little Foundation.

MAP has been the recipient of two United States Department of Education Cooperative Demonstration Project grants totaling close to $700,000. One, Project CREATE - Cooperative Resources to Enhance Access to Technology Education - funded this research report and several of the training programs mentioned in it. A grant from the National Center for Research in Vocational Education will allow MAP to expand the research in the coming year.

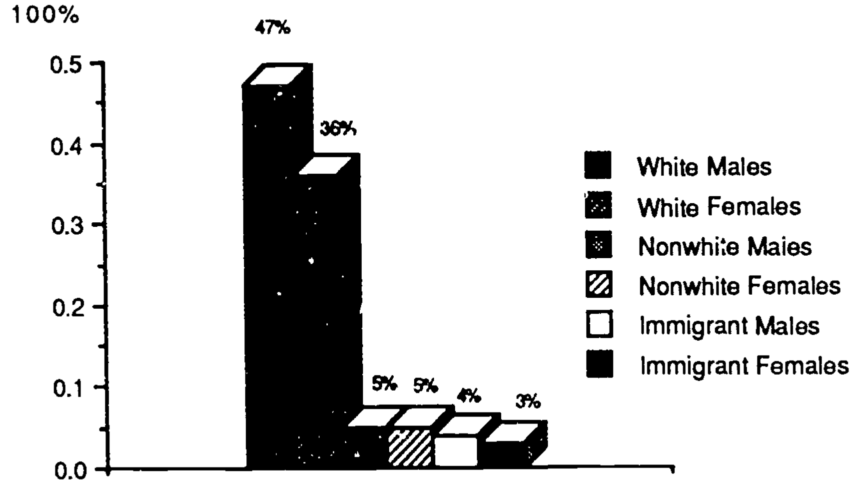
III. LITERATURE REVIEW

Winning the Brain Race (1988), by David Kearns, Xerox Corporation's Chief Executive Officer, and Denis Doyle, Senior Research Fellow at the Hudson Institute, lays out the challenge. "At a time when our pre-eminent role in the world economy is in jeopardy, there are few problems more telling in their urgency. Public education has put this country at a terrible competitive disadvantage." A May, 1989 Massachusetts Institute of Technology report, Made in America, makes a similar point. The authors state, "We think the origins of the problem lie not in the disappearance or weakening of the basic American values and capabilities but in the institutions that educate Americans for work. We have concluded that without major changes in the ways schools and firms train workers over the course of a lifetime, *no amount of macroeconomic fine-tuning or technological innovation will be able to produce significantly improved economic performance and a rising standard of living*" (emphasis added).

According to an article by Suzanne Berger, et al. (Scientific American, June, 1989), "The school system - from Kindergarten through high school - is leaving large numbers of its graduates without basic skills. Unless the nation begins to remedy these inadequacies in education, real progress in improving the U.S.'s productive performance will remain elusive." Furthermore, institutional racism and sexism create barriers which often result in fewer educational and occupational opportunities for men of color and all women. Coupled with inadequacies in the educational system, racial and gender barriers render those traditionally excluded from high technology education and employment underprepared for entry into the workforce.

In light of the above discussion, these efforts take on an even greater urgency when labor market demographic trends are examined. The current workforce is composed of 47% white males; nonwhite males and females make up roughly 10% of the total (Hudson Institute, 1985).

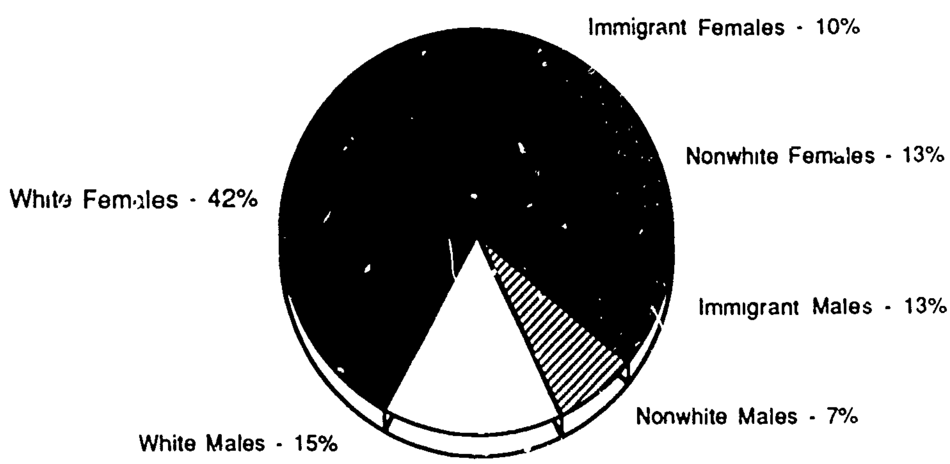
GRAPH 1



Composition of Labor Force - 1985
(Source - Hudson Institute)

Between now and the year 2000 only 35% of new entrants will be men, while 65% will be women; immigrants and people of color will comprise 43% of new entrants.

GRAPH 2



New Entrants to Labor Force
1985 - 2000

Employers, educators, training providers and community-based organizations need to work together to insure access to programs designed to prepare individuals for well-paying jobs. A Massachusetts school dropout stands a 50% chance of never holding a job, according to a study done by Andrew Sum and Paul Harrington of the Northeastern University Center for Labor Market and Population Studies. This statistic reflects the rapid change in job content over the past ten years. Entry level factory positions, requiring little more than a willingness to work hard, are disappearing. In their place are jobs that require math, reading, and problem solving skills - the very skills many youth do not have. Too often, workers are not adequately prepared to meet the education and training challenges that new workplace technologies necessitate.

In virtually every employment field, the widespread use of computers has changed inventory control, data entry, cost estimating, design, inspection, testing and a host of other functions. A 1989 Machine Action Project technology survey of area machine shops indicated that close to 80% of the shops surveyed produce 60 or more distinct parts with batch sizes typically under 200 pieces. Short runs of complex parts require machine tool and worker flexibility. In the high technology automobile repair field, computers are the chief tool used in diagnosing engine, instrumentation and other car problems. In the printing field the age of desk top publishing, customized layouts and rapid turn around of customer requests requires the increased use of computer technologies.

The Machine Action Project's skills research reinforces the notion that metalworking job content is changing and that skill requirements are evolving accordingly. A 1987 MAP survey comparing the skills of 525 workers from companies with fifty or less workers with those having 200 or more workers found that workers in small firms were: three times more likely to operate and set up three or more machine tools; twice as likely to inspect their work from blueprints; twice as likely to assemble parts from blueprints; and twice as likely to sharpen their own tools (Forrant, et al., "Disjuncture in the Hampden County Metalworking Labor Market," Spring, 1987).

There has been a remarkable increase in the use of new technologies such as Computer Numerical Control (CNC) machine tools, Computer-Assisted Drafting (CAD), coordinate measuring machines for inspection, and Personal Computers (PCs). MAP research into local shop technology usage indicates that the greater Springfield area is a center for the use of these new tools. Two surveys done about a year apart, including a total of 100 of Hampden County's 350 metalworking firms, showed that: close to 80% of firms have CNC machine tools; almost 50% have CAD systems; and 75% use PCs for things like business planning, scheduling and inventory control (Cann, et al., "Markets, Technology Utilization and Worker Skills," forthcoming Fall, 1990). However, the research showed that "this high technology has not come into use smoothly, and that firms still have not worked out all the kinks. The survey indicated that many machine shops suffer from underutilization of their technologies, problematic set-ups, and the inability to repair break-downs." Sixty percent of firms using Computer Numerical Control (CNC) machines felt they were fully utilized. Only 40% of firms indicated that their computer drafting equipment was fully utilized, while 79% of firms said that CNC set-up was a problem (McGraw, "Local Shops and Technology," Western Massachusetts Metalworking Newsletter, July, 1990).

There is both a statewide and local demand for trained automotive mechanics/technicians. Automotive repair is listed on the Massachusetts statewide job demand list and has been selected by the Commonwealth's Department of Employment and Training as one of the "ninety jobs for the nineties." Visits and calls to area automobile dealerships and repair shops have revealed that there are far more openings for trained automotive mechanics than persons with sufficient skills to fill the positions. The automobile has changed from a conglomeration of separate mechanical systems to a complex, electronically dependent machine, necessitating revolutionary changes in automotive service. As automotive technology increases in sophistication, those currently employed automotive mechanics who lack the skills to keep up with technological changes risk becoming underemployed (Boston Globe, September 12, 1988). Many mechanics lack the mathematical and/or linguistic proficiency necessary to acquire the new skills. The need for these skills exists across the country. Lee Miskowski, general manager of Ford Motor Corporation's Parts and Service, estimates that 32,000 new automobile technicians will be needed every year just to maintain the current car-technician ratio. Ford's ASSET training program will produce only 800-900 such technicians a year (Boston Globe, June 25, 1989).

Graphic arts and printing comprise a critical employment sector in Hampden County. MAP has established that there are more than 85 printing operations in Hampden County alone, excluding in-house printing departments and *quick* copying/printing services. Labor market research has revealed a pervasive skilled labor shortage in the printing industry. A typical advertisement for a stripper, prep room trainee, or press operator might yield 20 to 25 applicants but only 1 or 2 with the necessary skills.

Massachusetts ranks 8th in the U.S. in printing activity with 28,929 employees and 1,095 establishments. The printing industry is one of the top three manufacturing sectors in the state. From 1982 - 1988 New England printing employment grew 17% as all other manufacturing employment decreased 7% (New England Printer and Publisher, July, 1989). As in metalworking, the average age of the skilled craftsperson is cause for concern, particularly in the press area. Young workers are not entering the trade in sufficient numbers to replace the existing workforce. Thus, there will be an increased need for skilled workers as the present workforce ages and retires.

Labor market research has shown that technological advances in the three trades have changed both the entry level and career skills required of the current and emerging workforce. Workers and managers should receive the training necessary to maximize the use of new technologies as they are introduced into the work environment. "To use a piece of technology profitably, an organization must do more than operate it - it must design for it; power it; load and unload it (with information as well as physical material); adjust, maintain, and improve it; and adapt it to new uses... Each of these functions is at least as difficult, technically, as operating, and each calls for its own set of skills and knowledge" (Rosow and Zager, Training: The Competitive Edge, 1988). Firms that compete on the basis of quality of product and service are faced with an interesting choice in the face of these rapid changes. They can give workers the knowledge, skills and opportunity to learn or they can attempt to keep control of these newly needed skills in the hands of their managers and professional staff. In Rosow and Zager's words, "*you can smarten-up the workers or dumb-down the work.*"

William Wiggenhorn, Motorola's Corporate Vice-President for Training, has stated, "Ten years ago we hired people to perform tasks and didn't ask them to do a lot of thinking. If a machine broke down, workers raised their hands, and a troubleshooter came to fix it.... Then all the rules of manufacturing changed, and in our drive to change with them, we found we had to rewrite the rules of corporate training and education. We learned that line workers had to actually understand their work and their equipment, that senior management had to exemplify and reinforce new methods and skills if they were going to stick, that change had to be continuous and participative, and that education - not just instruction - was the only way to make all this occur" (Wiggenhorn, "Motorola U: When Training Becomes Education," Harvard Business Review, July-August, 1990).

Smartening-up requires that workers break out of the 20th century mold imposed on them by industrial engineers and factory managers that they be one dimensional and capable of only producing the same part over and over again by rote. The more complex the economy and workplace technology became, the more planners and industrial engineers believed in the necessity of a highly detailed division of labor and a staff of professional managers to run everything. In this context, workers would only be allowed to make the most trivial of decisions about what was happening right in front of them. The philosophy espoused in 1912 by the president of Remington Typewriter, John Calder, still dominates today. "The last thing a good manager would think of doing would be to make his policies of shop management the subject of referendum" (Montgomery, Workers' Control in America, 1979).

Thomas Bailey of the Center on Education and Employment at Columbia University, states that the new work environment calls for "a greater ability to work in a more uncertain and nonroutine environment. In addition to a stronger basic education, this requires knowledge of a wider range of tasks and a better conceptual understanding of the overall production process in which they are involved, of the products and services that their firms produce, and of the market they serve." One implication of the changing nature of work, Bailey's research found, is that "workers who have in the past been trained in vocational education programs increasingly need conceptual and problem solving abilities traditionally expected of students in academic programs" (Bailey, "Changes in the Nature and Structure of Work," National Center on Education and Employment, Technical Paper No. 9, November, 1989).

The acquisition of new technology requires that firms have a specific plan in place to broaden the skills of their workers if the technology is to be used effectively. Market and technology changes are placing increasing demands on employers to rely more on the knowledge and talents of their workers. These changes, in turn, are placing demands on educational and training institutions to work with firms, unions and workers to prepare people accordingly. "The mistake most companies make is to treat new manufacturing equipment simply as *physical* assets. Programmable automation demands a much more interactive decision-making process and tight integration among corporate functions. It also demands attention to nonfinancial, long-term considerations, particularly its impact on the company's *intellectual* assets" (Hayes and Jaikumar, "Manufacturing's Crisis: New Technologies, Obsolete Organizations," Harvard Business Review, September-October, 1988).

Although workers surveyed for this study were not asked specific questions on whether they felt technology would increase or decrease their skill levels over time, the findings may be seen in that context. The descriptions of the upskilling and deskilling arguments presented here sketch them at their most basic. For a more lengthy review of the literature, see a collection of essays edited by Stephen Wood in The Transformation of Work (1989).

In support of upskilling, the argument is that the changed manufacturing and service economy, with its emphasis on quick turn around, on-time deliveries, and top quality, demands the use of computer technologies to integrate a number of previously separated skills and job assignments. Workers must be more highly skilled to do the new work. Planning, inventory control, inspection, and various data entry functions are now rolled into one new job description for workers. This upskilling position conforms to many of the arguments made by Charles Sabel and Michael Piore in The Second Industrial Divide (1984).

Deskilling proponents argue that computer technologies have been introduced as part of an effort to remove the last vestiges of worker skills from the shop floor by placing computer set up and other new skills in the hands of engineers and management personnel. This will create more routine, lower skilled jobs for many, while placing the new expertise in the hands of a tiny segment of the workforce, usually managers and/or engineers (Shaiken, Herzenberg and Kuhn, "The Work Process Under More Flexible Production," Industrial Relations, Volume 25, 1986).

Proponents of the upskilling and deskilling perspectives must answer several questions. When new technologies are introduced into a workplace, who is initially trained to operate them? If workers are displaced what happens to them? Which workers are trained to do the critical programming, set up, and repair and maintenance work on the systems? As the new technologies become more widespread, who gets to contribute their brain power to the work environment, and who gets to just load parts or put tool inserts into chucks at already predetermined settings? In a metalworking machine shop, for instance, set up and repair personnel are usually among the most highly skilled workers in the plant. They have a broad-based knowledge of how traditional machines operate, an ability to determine how machines need to be set up to produce quality parts, and the knowledge to interpret complicated blueprints and machine tool schematic drawings. By looking at who performed these functions before and who performs them after new technologies are introduced, some of these questions may begin to be answered.

According to Bailey the answer to the question "What is the effect of microelectronic technology on work and skills?" is almost always "It depends" (Bailey, 1989). The technology has significantly changed the way a good deal of work is organized and gets done. In "An Introduction to CNC Systems: Background for Learning and Training Research," Martin and Scribner discuss these changes. Machine tool set up on CNC machine tools requires similar skills to traditional set up, but the machinist's knowledge of the job and the behavior of the machines, once his *private knowledge*, now becomes *public*. Critical new skills enter the picture when the computer that runs the machine is programmed; a shop's set up staff will have to have extensive training in programming as well as set up. A totally new perspective must be developed to think in terms of geometric planes, Cartesian Coordinates, and specific, precise programming commands. "The electronic instructions of the computer program do not mimic the manual movements of the machinist but they express these movements as notations about the machine and its tools in a Cartesian Coordinate space. Thus, the essence of CNC machining is not a further elaboration of traditional machining but appears to be a decisive rupture with it" (Martin et al., "An Introduction to CNC Systems: Background for Learning and Training Research," Laboratory for the Cognitive Studies of Work, December, 1988).

Project CREATE was offering skills upgrading training in the three trade areas at the time of survey administration. Currently employed training participants were asked to complete the survey questionnaire.

Data collection took place in Fall/Winter 1989-1990. Respondents were self-selected and were asked to remain anonymous. Responses to demographic questions were optional. Because we did not have control over distribution of the surveys in each shop, there was no way to account for biases in distribution or collection. Surveys were handed out and collected by shop supervisors or course instructors, where applicable. A total of 209 surveys were analyzed for this report.

TABLE 1: RESEARCH PARTICIPANTS

	TOTAL	MACHINE	AUTO	PRINTING
JOB SHADOWS	6	2	2	2
INTERVIEWS				
SUPERVISOR	15	5	5	5
EMPLOYEE	15	5	5	5
NO. RESPONDENTS	209	56	66	87
NO. SHOPS	26	7	11	9

Over 95% of the respondents were male, which is not surprising, considering the historical composition of the three trades. More than 83% of the sample described their race/ethnicity as Caucasian/Non-Hispanic, also consistent with expectations. Although women and men of color are entering into training and educational programs for these occupations, it takes years for the composition of the trades to reflect these demographic changes in the workforce.

Thirty-five percent of the respondents were 29 or younger, while 39.8% were between 30 and 39 years of age. Workers ages 60 and over comprised less than 1% of the sample. This finding differs from MAP's research which indicates that the average age of area machinists and printers is in the fifties. The differences in mean (average) age between the trades was not statistically significant.

TABLE 2: GENDER/RACE/ETHNICITY

	TOTAL	MACHINE	AUTO	PRINTING
RESPONDENTS	**168**	**49**	**48**	**71**
FEMALE	4.8%	6.1%	2.1%	5.6%
MALE	95.2%	93.9%	97.9%	94.4%
RESPONDENTS	**178**	**48**	**51**	**79**
AFRICAN-AMERICAN	8.4%	6.3%	2.0%	13.9%
CAUCASIAN/ NON-HISPANIC	83.1%	91.7%	84.3%	77.2%
CAPE VERDEAN	.56%			1.3%
NATIVE AMERICAN	2.3%	2.1%		3.8%
HISPANIC	5.62%		13.73%	3.8%

TABLE 3: AGE

	TOTAL	MACHINE	AUTO	PRINTING
RESPONDENTS	**103**	**35**	**29**	**39**
<20	4.9%	8.6%	6.9%	
20-29	30.1%	28.6%	37.9%	25.6%
30-39	39.8%	42.9%	31.0%	43.6%
40-49	12.6%	17.1%	10.3%	10.3%
50-59	11.7%		13.8%	20.5%
60+	.97%	2.9%		
MEAN AGE	34.3 yrs.	32.8 yrs.	33.1 yrs.	36.6 yrs.

V. DISCUSSION OF SURVEY RESULTS

The results of statistical analyses are available upon request from the Machine Action Project. Survey responses were analyzed both within and between trades. Descriptive statistics, frequency distributions, and analyses of variance (ANOVA) were performed, where applicable. An alpha level of .05 was used to test statistical significance. The alpha level indicates the probability that the differences between two groups is due to chance. In the analyses, a p level is given. This indicates the alpha level at which the particular finding is significant. P=.01 means that there is a 1% probability that the findings are not due to actual differences between groups, but are coincidental. For example, the three trades differed significantly in usage of interpeting skills, with machinists indicating highest usage, followed by auto mechanics (p=.0000). What this alpha level means is that there is less than one-ten thousandth of one percent probability that the differences between group means is due to chance.

The Survey Results section is divided into several subsections, each focusing on a different aspect of training, skills, or trade characteristics. For clarity, machinists will be used to refer to machine occupations, auto mechanics for automotive repair occupations, and printers for printing/graphic arts occupations. Not every worker responded to all questions, thus the discrepancy in some totals.

A. Workforce characteristics

Responses to questions on work attitudes are presented in Table 4. Questions on whether positions in the trade have matched the workers' skill levels may have been confusing, as the majority of respondents indicated that they were unsure. The majority of respondents agreed or strongly agreed with the balance of statements on work attitudes.

With regard to shop encouragement of worker skills upgrading, machinists and auto mechanics indicated significantly more encouragement than printers (p=.0022), who were somewhat unsure as a group.

TABLE 4: WORK ATTITUDES
(A = AGREE; SA = STRONGLY AGREE)

	MACHINE		AUTOMOTIVE		PRINTING	
	A	SA	A	SA	A	SA
WANT TO REMAIN IN TRADE	38.2%	40.0%	36.7%	31.8%	34.9%	34.9%
SHOP ENCOURAGES UPGRADING	55.4%	26.8%	47.7%	26.2%	37.2%	19.8%
CAN USE ACQUIRED SKILLS	49.1%	30.9%	62.1%	27.3%	56.6%	20.5%
CAN ACQUIRE NEW SKILLS	60.7%	26.8%	57.6%	31.8%	51.8%	23.5%
WANT TO ADVANCE SKILLS	32.7%	65.5%	30.3%	65.2%	37.6%	55.3%
WANT MORE VARIETY	48.2%	39.3%	46.9%	23.4%	29.2%	21.2%
USE SKILLS FROM OTHER JOBS	41.8%	41.8%	31.8%	39.4%	40.7%	31.4%

An overwhelming majority of workers wanted to advance their skills, with 65.5% of machinists and 65.2% of auto mechanics strongly agreeing; 32.7% of machinists and 30.3% of auto mechanics agreed. Eighty-two per cent of machinists and 73.9% of auto technicians agreed or strongly agreed that their employers encouraged skills upgrading. Our data indicate that 87.5% of machinists, 70.3% of automotive technicians and slightly over 50% of the printers surveyed would like more variety in their work. These findings are significant in that they cut against the argument that workers do not want to learn new skills. "There is a pronounced tendency to view basic skills deficiencies as personal failures, to blame individual workers for a lack of will and determination to overcome their weaknesses. The image of the ignorant and illiterate blue-collar worker has been enshrined in American culture....(Daniel Marschall, AFL-CIO Human Resources Development Institute, "Upgrading America's Workforce," May, 1990).

A skilled machinist with 18 years' experience in the trade summed it up best when asked in a MAP interview if the facility's management had a good understanding of the problems confronting it and positive strategies for the future. "Employees are like a goalie in soccer. If a goal gets by the goalie it is because everyone on the field screwed up, not just the goalie. But people blame the goalie."

Printers have spent significantly longer time working at their present job than either machinists or auto mechanics (p=.0005). However, no significant differences exist for years in the trade. Machinists indicated working a significantly longer work week than either auto mechanics or printers. Average hours per week also differed significantly by age, with workers in their 20's and 30's working the most hours (p=.0068).

TABLE 5: AVERAGE TIME SPENT IN THE TRADE				
	ALL TRADES	MACHINE	AUTO	PRINTING
YEARS AT SHOP	8.4	4.7	6.8	11.8
YEARS IN TRADE	12.9	10.5	13.3	14.5
HOURS WORKED PER WEEK	43.9	48.1	43.6	41.0

No significant differences were found between the three trades with regard to starting or present salary. However, an ANOVA using age as the independent variable revealed significant differences in present salary between most age groups, with mean salary increasing with age (p=.0102). The age correlation may be linked to skill levels. Each trade has a career ladder progression of skills learned over time in the trade that would help explain this finding. This may change in the future if high technology skills are concentrated in the hands of a few workers.

TABLE 6: AVERAGE STARTING AND PRESENT SALARIES				
	ALL TRADES	MACHINE	AUTO	PRINTING
FIRST JOB	4.75	4.63	4.76	4.83
PRESENT SALARY	11.55	10.77	12.36	11.56

B. Formal education

The survey examined three distinct areas of education and training: formal occupational education or training; formal education completed (not necessarily in the trade), and upgrading courses within the trade area. Therefore, it is possible for a worker to have completed extensive upgrading training in his/her trade but little formal education. Conversely, a worker may hold a college degree but have little formal training in his/her trade.

The majority of workers in all three trades obtained their occupational training while attending vocational-technical high school. Many machinists also received training through related high school courses and skills center programs. Many auto mechanics received training through manufacturer-sponsored courses and trade schools. Training for printing also took place through related high school and college courses.

TABLE 7: MOST FREQUENT SOURCES OF FORMAL EDUCATION/TRAINING IN THE WORKERS' TRADE

	MACHINE	AUTO	PRINTING
1 VOC-TECH HIGH SCHOOL	33.3%	32.4%	25.9%
2 RELATED HIGH SCHOOL	20.5%		20.4%
3 RELATED COLLEGE			13.4%
4 SKILLS CENTER	20.5%		
5 MANUFACTURER-SPONSORED		29.4%	
6 TRADE SCHOOL		23.5%	

Respondents were asked to indicate their highest level of formal education completed (see Table 8), as distinct from their source of occupational training. It is notable that 89.1% of the respondents had completed their formal education. Broken down by type of education completed, 48.4 % received a high school or trade school diploma, 27.2% completed some college and 13.7% received an Assocate's Degree or higher.

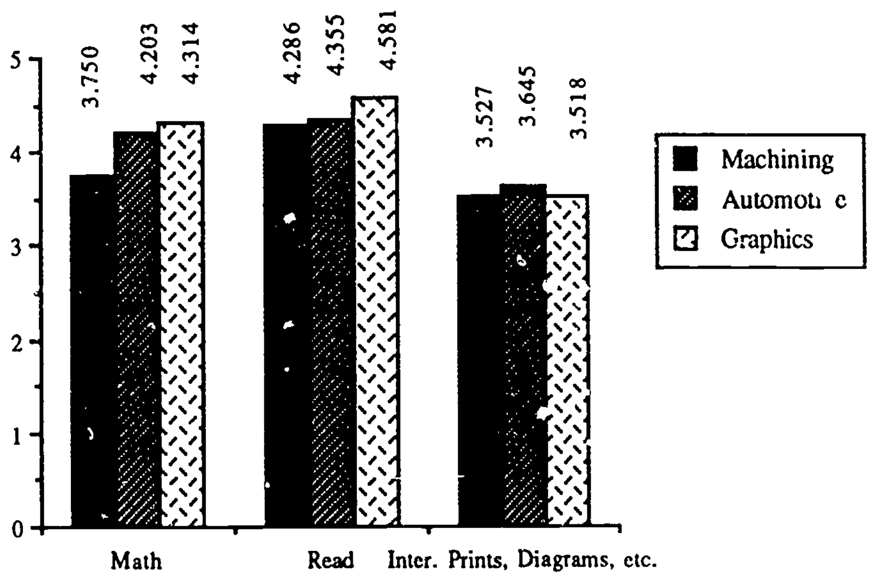
With regard to amount of formal education completed, there were no significant differences between the trades. However, an ANOVA using age as the independent variable revealed that workers in their 30's, 40's and 50's (64.1% of the sample) had completed significantly more formal education (p=.0360) than workers in their teens and twenties (35.0% of the sample). One possible interpretation of this finding is that workers are continuing their education after several years of employment, rather than pursuing additional education immediately after high school. This is consistent with enrollment data provided by the local technical community college.

TABLE 8: HIGHEST LEVEL OF FORMAL EDUCATION COMPLETED	TOTAL	MACHINE	AUTO	PRINTING
< HIGH SCHOOL	4.9%	1.9%	7.7%	5.1%
G.E.D.	6.0%	5.7%	5.8%	6.3%
TRADE SCHOOL	6.5%	7.6%	5.8%	6.3%
HIGH SCHOOL GRAD	41.9%	52.8%	40.4%	35.4%
SOME COLLEGE	27.2%	24.5%	30.8%	26.6%
AA/AS	8.2%	7.6%	7.7%	8.9%
BA/BS	3.3%		1.9%	6.3%
MA/MS	2.2%			5.1%

C. Basic skills

Workers indicated that they felt somewhat well-prepared for their first job with regard to math, reading and interpreting skills. However, machinists felt significantly less well-prepared in terms of math skills than either printers or auto mechanics (p=.0074). This is important in light of our finding that 75.0% of machinists indicated they use math all the time (see Table 9).

GRAPH 3 MEAN SCORE ON PREPARATION FOR FIRST JOB WITH 1 VERY UNPREPARED/ 5 WELL PREPARED



1. Math skills: In machining and printing, math skills are utilized significantly more often than in automotive repair (p=.0000). When asked whether changes in technology will require a higher level of math skills, the majority of responses ranged between yes and unsure. Auto mechanics were significantly more certain than printers in their estimates of higher math requirements (p=.008).

TABLE 9: USAGE OF MATH SKILLS ON THE JOB

	MACHINE	AUTO	PRINTING
ALL THE TIME	75.0%	21.2%	55.2%
FREQUENTLY	14.3%	24.2%	27.6%
OCCASIONALLY	5.4%	39.4%	12.6%
RARELY	3.5%	10.6%	3.5%
NEVER	1.8%	4.6%	1.1%

TABLE 10: CHANGES IN TECHNOLOGY WILL REQUIRE HIGHER LEVEL OF MATH BY YEAR 2000

	MACHINE	AUTO	PRINTING
YES	64.3%	67.2%	45.3%
UNSURE	17.9%	26.6%	32.6%
NO	17.9%	6.3%	22.1%

Although machinists and printers now use math frequently or all the time, workers in all three trades predict that they will be using math more often in the future. When asked about skills usage for the year 2000, 60.7% of machinists, 75.8% of auto mechanics and 50.6% of printers predict more or much more math usage.

2. Reading skills: All three trades differed significantly with regard to reading manuals (p=.0000), with auto mechanics reading manuals most often, followed by machinists. Printers read gauges significantly less often than either machinists or auto mechanics (p=.0000).

read gauges significantly less often than either machinists or auto mechanics (p=.0000). This finding is consistent with the lower reliance on manuals and gauges in printing occupations. Significant differences exist with regard to reading skills in the year 2000 (p=.001), with auto mechanics predicting the greatest increase in usage. Consistent with that finding is the auto mechanics' greater certainty that changes in technology will require a higher level of reading skills in their trade (p=.0061).

TABLE 11: CHANGES IN TECHNOLOGY WILL REQUIRE HIGHER LEVEL OF READING

	MACHINE	AUTO	PRINTING
YES	60.7%	78.1%	51.2%
UNSURE	23.2%	14.1%	29.1%
NO	16.1%	7.8%	19.8%

As indicated, close to two-thirds of machinists and automotive technicians surveyed recognized the critical role math competency will play in the workplace (see Table 10). A majority of workers across all three trades affirmed the notion that higher levels of reading would be critical for job success in the future. The data demonstrate that many workers understand the changes sweeping their trades. Employers should directly involve the workforce and their representatives in training design and recruitment to guarantee their participation. Unions should bargain for inclusion in training program design, implementation, and evaluation.

3. Interpreting skills: The three trades differed significantly in usage of interpretation of blueprints, diagrams or charts (p=.0000) with more than 85% of machinists indicated frequent or constant usage of interpreting skills, while only 53.8% of auto mechanics and 26.4% of printers did so. Auto mechanics predict a significantly higher increase in usage of interpreting skills by the year 2000 (p=.0001).

TABLE 12: USAGE OF INTERPRETING SKILLS ON THE JOB				
	ALL TRADES	MACHINE	AUTO	PRINTING
ALL THE TIME	35.1%	71.4%	30.8%	14.9%
FREQUENTLY	15.9%	14.3%	23.0%	11.5%
OCCASIONALLY	21.1%	3.6%	30.8%	25.3%
RARELY	9.6%	7.1%	7.7%	12.7%
NEVER	18.3%	3.6%	7.7%	35.6%

4. **Problem solving skills:** Problem solving skills were defined in the survey as diagnosis, e.g., figuring out what went wrong with a part or piece, or adjusting machinery to get it to do what you need it to do. In other words, problem solving skills entail the ability to analyze a situation and plan a set of actions to realize a goal or product. Machinists and auto mechanics indicated significantly more usage of problem solving skills than printers (p=.0035), although the vast majority of respondents across the trades indicated frequent or constant usage.

TABLE 13: USAGE OF PROBLEM SOLVING SKILLS ON THE JOB				
	ALL TRADES	MACHINE	AUTO	PRINTING
ALL THE TIME	45.2%	50.0%	49.2%	39.1%
FREQUENTLY	34.1%	37.5%	41.5%	26.4%
OCCASIONALLY	13.5%	7.1%	7.7%	21.8%
RARELY	3.8%	3.6%	0%	6.9%
NEVER	3.4%	1.8%	1.6%	5.8%

D. Skills upgrading

Machinists and auto mechanics were significantly more likely than printers to agree that their employer encouraged them to upgrade their skills (p=.008). However, there were no significant differences between the trades with regard to acquisition of new skills or having the opportunity to use these skills on the job (see Table 4). An ANOVA, using age as the independent variable, showed that the ability to acquire new skills on the job decreased with age (p=.0047).

TABLE 15: MOST FREQUENT SOURCES OF SKILLS UPGRADING	MACHINE	AUTO	PRINTING
1 VOC-TECH HIGH SCHOOL	30.3%		
2 TECHNICAL SCHOOL	21.2%	16.0%	
3 MANUFACTURER-SPONSORED		64.0%	
4 TECHNICAL COLLEGE			32.2%
5 PROJECT CREATE COURSE		44..0%	29.0%

E. Vocational/Occupational Skills

1. Traditional skills: Machine set up, measurement, blueprint and chart interpretation, and gauge usage are considered traditional skills. Workers indicated occasional to frequent and constant usage of traditional skills on the job. Over 60% of the respondents performed set ups frequently or all the time, with machinists performing them significantly more often than auto mechanics or printers (p=.0000). There were significant differences between all three trades with regard to blueprint interpretation, with machinists leading in usage, followed by auto mechanics (p=.0000). Setting up complicated machine tools, presses, and automotive diagnostic and repair equipment requires that workers use a multiplicity of skills. They must be able to read prints, charts, and diagrams in order to guarantee that the equipment will produce a quality product. The ability to perform successful set ups is usually acquired over time through on the job training under the tutelage of a senior worker.

TABLE 16: PERFORMANCE OF TRADITIONAL SET UP	ALL TRADES	MACHINE	AUTO	PRINTING
ALL THE TIME	36.7%	69.6%	23.1%	25.6%
FREQUENTLY	23.7%	16.1%	30.8%	23.3%
OCCASIONALLY	17.9%	8.9%	26.1%	17.4%
RARELY	10.1%	1.8%	16.9%	10.4%
NEVER	11.6%	3.6%	3.1%	23.3%

2. High-tech skills: Respondents indicated much less usage of high-tech than traditional skills. Although traditional skills are performed with regularity, more than two-thirds of the workers in the study do not perform high-tech functions on a regular basis.

Of respondents in all three trades:

87% rarely or never do computer programming.

86% rarely or never do computer set up or typesetting.

75% rarely or never do computer data entry.

72% rarely or never do computer diagnostics.

67% rarely or never operate CNC machines.

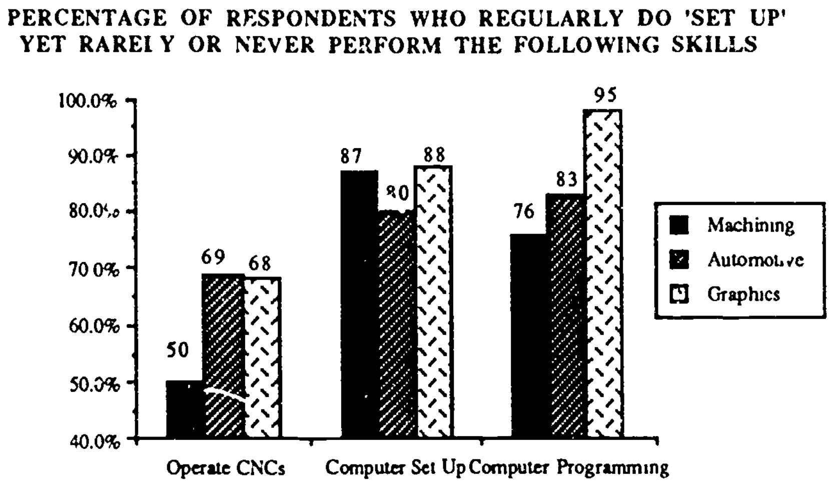
Machinists and auto mechanics differed significantly from printers with regard to computer data entry (p=.0479), although mean scores for all three trades indicated very little usage. Mean responses for machinists and auto mechanics indicated rare usage of computer data entry; the mean for printers indicated no usage at all.

Auto mechanics used computer diagnostics significantly more often than either machinists or printers (p=.0000); auto mechanics indicated occasional to frequent usage, whereas machinists and printers rarely or never used this skill. This reflects recent changes in the automotive repair trade, which has been utilizing computer diagnostics with increasing regularity. Although all of the trades indicated rare to no usage of computer programming, the difference between machinists and printers approached significance (p=.0514), with machinists indicating greater usage.

Machinists operated CNC equipment significantly more often than in the other trades (p=.0046); however, machinists indicated only occasional usage. An ANOVA using age as the independent variable showed that, across trades, workers in their 20's and 30's reported significantly more usage of CNC equipment than workers in other age groups (p=.0208).

A sharp disjuncture exists between the performance of traditional machine set up and high-tech skills. Over 61% of the respondents across all three trades now do traditional set up regularly (frequently or all the time). **However, the overwhelming majority of those who regularly do traditional machine set up rarely or never use the high tech skills emerging in their trades.**

GRAPH 4



These results confirm an observation made by Laura Martin that "Our interviews with machinists and engineers in a variety of industrial and educational settings across the country disclose that, in a number of cases, employers are departing from traditional upgrading practices to train young workers or *non-machinists* (emphasis added) to operate or train others to operate these machines. This means that skills of experienced machinists may not be available in the new informatic work environments. The consequences of further diminishing the traditionally skilled workforce through such practices have not been thought out" (Martin, 1988). MAP research into machine shop technology practices showed that 77.5 % of shops rely on engineers, managers and outside consultants to program CNC machinery, and 82.5% used the same groups to repair the machine tools (Cann, 1990).

The findings also lend support to the argument that many new technologies are *in fact, if not in specific intent,* deskilling large groups of blue collar workers by shifting highly skilled work to engineers, managers, and outside personnel, thus removing a measure of skill and power from the shop floor (Shaiken, Work Transformed, 1984). Since this is happening in small shops the argument that small shops may offer the best opportunity for new technology skills upgrading needs to be closely examined (Kelley, "New Process Technology, Job Design, and Work Organization: A Contingency Model, American Sociological Review, Vol. 55, April, 1990).

F. Major changes in the trades

Respondents were asked to indicate the most significant change in their trade in the last five years. Responses ranged from salaries, amount of work, Occupational Safety and Health Administration regulations, environmental concerns, management issues, etc., to indications of a technological revolution in the making. Nonetheless, the majority of respondents stated changes in technology, although the specifics differ by trade.

TABLE 17: MOST OFTEN MENTIONED SIGNIFICANT CHANGE IN LAST FIVE YEARS

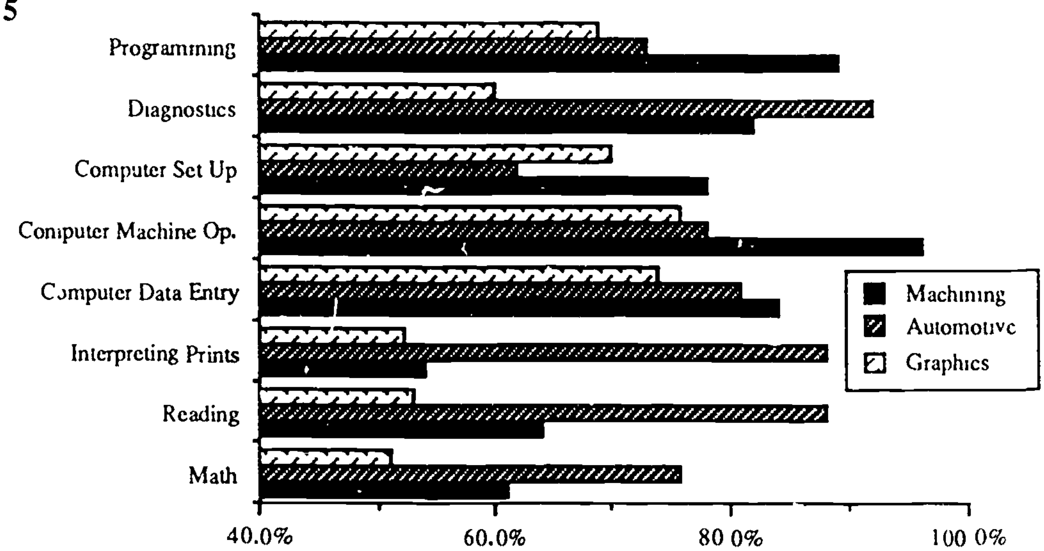
	MACHINE	AUTO	PRINTING
1 CNC MACHINERY	45.0%		
2 COMPUTERS		46.7%	28.3%
3 TECH ADVANCES	20.0%		24.5%
4 GROWTH OF ELECTRONICS		20.0%	

G. Skills for the year 2000

The majority of respondents across all three trades expect *more or much more usage of all skills, both traditional and high technology, in the year 2000.* Results of an ANOVA showed significant differences between trades with regard to high-tech skills usage by the year 2000. **Machinists** predict: more operation of CNC machinery than auto mechanics and printers (p=.0012); more usage of computer set up than auto mechanics (p=.0266); and more usage of computer programming than auto mechanics and printers (p=.0180). **Auto mechanics** predict significantly more usage of computer diagnostics than either machinists or printers (p=.0001).

PERCENTAGE OF RESPONDENTS INDICATING MORE OR MUCH MORE USAGE OF SKILLS BY YEAR 2000

GRAPH 5



VI. POLICY IMPLICATIONS OF MAJOR FINDINGS

A. Importance of Basic Skills

The data indicate that workers realize requirements for basic literacy and math skills will increase in the coming decade; the abiliity to read and comprehend highly technical information and training manuals will be essential. Workers must be able to use several technical manuals that explain how complex systems work, and then find the correct diagnostic tests to apply in order to quickly and correctly repair the machinery. They need to be able to handle large amounts of information by sorting and grouping technical material effectively.

For example, automobile on-board electronic controls in new cars are almost always computer-driven. As one automobile technician pointed out during the initial interview process, some cars have up to *seven computers* controlling such functions as braking, engine operation, steering, and emissions.

Machinists and printers will be in a similar position when it comes to working on new computer controlled machine tools. Particularly in the areas of set up and repair, workers must be able to analyze technical information and from it construct *a plan of action* to get the machine tool to perform correctly. Math skills are needed in the programming of computer controlled machinery. Workers will have to learn how to think in terms of geometric planes and Cartesian Coordinates. Specific and precise programming commands will have to be given, with wrong entries potentially costing thousands of dollars in scrap, rework, and damaged equipment.

Math will be used regularly as firms move to install more sophisticated inspection programs. Workers will be required to perform a whole range of charting and other statistical functions at their machines. They must be able to make sense out of the data and come up with corrective measures when necessary, troubleshooting and problem solving on a regular basis.

Recommendations:

1. Schools should establish programs that concretely demonstrate to students the relationship between math and reading skills and positive job outcomes. Such efforts must begin as early as possible, but no later that the middle school years to be effective. Employers and workers should visit classrooms to discuss how their current employees use these skills. Math and reading programs must incorporate various workplace situations so that clear links are established between these skills and later success in life.

2. Time should be spent in shop areas working on problem solving projects. Students should be taught how to use resource manuals and charts and statistics to come up with solutions to workplace problems. The Gloucester, Massachusetts high school has built a problem-solving quality control curriculum in which students examine industry donated machined parts that failed quality control checks. The exercise requires students to work in teams with blueprints and drawings of the parts in order to determine why the parts failed. *They must act as detectives trying to find the defect*. The work is challenging and fun and develops the analytical thinking and problem solving skills of everyone involved.

B. Importance of Technical Skills

The increased usage of electronics, computers, digital-based equipment/ components and fiber optics in the workplace makes technology training essential. As one automotive supervisor stated, "You can forget this business entirely if you can't understand computers. Electronics and computers are the most important skills of the future as it applies to the automotive field." Incorporation of computer usage skills in the automotive technology training curriculum is mandatory to equip trainees with the skills they need to work on 21st century automobiles. The need for such expertise was pointed out by a repair manager: *"If we have to work on an air bag system, and the air bag later inadvertently inflates when the customer hits a bump at 60 miles an hour, the effects could be disastrous, both for the customer as well as my shop. We have to take responsibility for what we work on."*

The impact of computer technologies in the machining field requires a similar approach. Machinists are cutting and forming metals at tolerances less than the diameter of a human hair. Metal cutting is extremely exacting work. *Once you begin taking stock off a piece of steel you cannot glue the metal back on if you make a mistake!* Computers are proliferating even in the smallest job shop. In printing plants and machine shops, computers control machine operations, inspect work, track inventory and the progress of parts through the shop, and are used more and more in the design of prototypes. Desk-top publishing is revolutionizing layout. Our research evidence suggests that machinists and printers need computer literacy skills. The underutilization of the technology reported by shop owners will only change when more people in the shop know how to program, set up, and repair the equipment.

Recommendations:

1. Vocational-technical high schools must acquire the high technology equipment they need to train students for the emerging needs of the workplace. Their instructional staff must be trained on the equipment so that they can effectively work with students. The private sector must play a major role here. Firms that have acquired high technology equipment should make it available for training during off shift hours. Companies should allow staff to spend time in the vocational schools helping instructors acquire and teach these new skills. The schools can then be used at night as state-of-the-art worker training centers. There are a number of successful models like this in Massachusetts. The machining program at Smith Vocational High School in Northampton is one of the most exciting examples of just such an industry-school partnership.

2. The need for technical training which incorporates skill specific training as well as computer use, basic electronics, and machine/computer integration appears to be essential for entering the trade areas examined in this research.

3. Instructors must be able to keep up with changes in their trade areas. This can take the form of encouraging instructors to regularly spend time in private industry where technology is being used. One possiblity is an exchange program in which a shop teacher and a skilled tradesperson can change places, with the students, instructors and shops benefitting. Another

2. Team teaching should be utilized. Too often teachers in related subject areas know little about the in-shop relationships and applications. In many instances the course content bears little relationship to the world of work and the hands-on activities taking place in the various shops.

3. Curricula must be expanded to include units on quality control, computer applications and technical mathematics. Working in collaboration with the machine shop advisory board and private industry, Westfield (Massachusetts) Vocational High School received a grant to develop curriculum for a course in Statistical Process Control. Students are required to take this course in their senior year.

4. Teaching must be less project- and more process-oriented. Observations of several classrooms reveal that instructors typically respond to student questions by providing an answer rather than the framework for the students to solve the problem on their own. This does little to prepare individuals for the workplace. Students should be encouraged to work together when problems arise so they can develop the interpersonal skills needed to solve problems on the job. These skills will also help them in their daily lives.

D. Worker Participation in Training Design

The research suggests that workers have a keen awareness of the ways in which technology has and will impact on the nature of work and how it is performed. Who better to be involved in curriculum design at the high school and community college level and in publically and privately funded training centers?

Recommendations:

1. Workers, in conjunction with unions and training providers, should develop a skills assessment survey instrument for dislocated workers to take prior to entering training. The knowledge that is derived concerning the particular skills that people have will be helpful in structuring programs based specifically on *what dislocated workers know,* not what it is assumed *they do not know!*

2. Vocational-technical high schools, community colleges and other training centers should invite workers and their unions to join various shop advisory boards. As the research demonstrates, workers are interested in upgrading their skills and staying current with new technologies. Their participation in program design will insure that the people closest to the work

are involved in what will be taught and how. At the same time, worker participation will help to encourage other workers to take advantage of upgrading courses.

E. Equity/Access Issues

Employers interviewed stated their willingness to hire women, people of color and linguistic minorities if they possessed the requisite skills to compete for an entry level position. But they believed that women were not attracted to non-traditional fields due to the general working conditions (greasy/ dirty) and physical demands of the trades. There are many women at work in the graphics and printing field, but few operate the large presses. The field of automotive repair, with the gradual transition to computer diagnostics as opposed to *wrench turning,* may attract more women in the future. Individuals with an armed services background indicated that women were integrated into repair facilities in the military services and worked on an equal basis with men. The success of the MAP-sponsored Women in Machining program demonstrates that women can be attracted to the trade and find good jobs in it, provided that support services are made available throughout training, placement and employment (Heather Warner, Access, Equity and Opportunity: The Women in Machining Program, Machine Action Project, Fall 1989).

While prospective workers' impressions of the trade are important, equally important are the attitudes of employers. Programs must involve employers at every stage of development including curriculum design, recruitment and instruction, and utilization of shops for tours.

Those persons traditionally excluded from high technology fields have often been the recipients of inadequate or limited educational opportunities. Since a majority of all new jobs created will require more technical, reading, math, and problem solving skills the education and training establishment must do a better job preparing everyone in these areas. For linguistic minorities the challenge is even greater. A severe lack of training and technical manuals in Spanish, for instance, makes it extremely difficult for high school students, trainees, or employed but under-skilled workers to acquire newly needed skills. The lack of bilingual shop instructors and classroom teachers is another serious problem.

The assumption that a person must first learn English before he/she can begin to learn technical skills acts as a serious impediment to effective training. Many immigrants arrive here with high levels of basic and occupational skills. Limited in English, they are often placed in an English as a Second Language (ESL) classroom for several weeks before they ever get their hands on the tools of their trade. Training providers incorrectly assume that lack of English proficiency implies lack of other skills. At the same time, English is often taught devoid of any vocabulary, reading, or discussion related to the workers' experiences.

As enrollments in vocational schools and training programs decline and the pool of prospective workers shifts demographically, schools, training institutions and employers must reach out to include women, immigrants and people of color. In order to effectively recruit these populations community outreach is essential.

Finally, schools and career counselors need to do a better job exposing young women, linguistic minorities and people of color to well-paying career fields. Regardless of their gender, race or primary language, students and adult trainees must be offered a range of choices reflecting all that the school or training center has to offer.

Recommendations:

1. Training providers, schools and colleges must make every effort to recruit people of color, women and linguistic minorities into vocational teaching. These instructors will be positive role models. Currently employed tradespeople from these populations should be recruited to regularly spend time working with students and trainees.

2. Student support groups and mentoring programs should be established in all training programs. These are key elements in MAP's successful Women in Machining program.

3. Schools and training institutions must incorporate English as a Second Language training components that use relevant vocabulary from several trades and technology fields.

4. Representatives of community-based organizations must be directly involved in the recruitment, development and evaluation of all vocational training programs.

For specific recommendations with regard to the Latino community, one resource is "Training Hispanics: Implications for the JTPA System", National Commission for Employment Policy, January, 1990.

F. Development of Apprenticeship Models

The private sector and labor unions must play leadership roles in fostering effective school to work transition programs. Life-long learning based on an apprenticeship model can provide a structure for youth and adults to continue supervised training while holding down a job. Apprenticeship combines the best of book and theoretical learning with hands-on applications, creating a training ladder that ties significant pay increases directly to increased skills levels. Models can link course completion to the earning of college credits toward a degree in a related technical field. MAP has developed similar agreements in machining and graphic arts/ printing.

Two exciting models are the *Apprenticeship: A Partnership Project* of the Fairfax County, Virginia Public Schools and the *Jobs for the Future, Inc.* program based in Somerville, Massachusetts. The Fairfax County Project has produced a variety of materials, including video, that explain apprenticeship and encourage participation in programs to women, minorities and limited English speakers in the construction trades.

Jobs for the Future (JFF) is aimed at improving the transition from high school to high-skilled employment. Parents and guardians are heavily involved in program design and implementation. JFF is currently developing materials on mentoring; credentialing of work-based learning; setting performance standards for academic and occupational competencies; and developing curricula in applied math and science, critical thinking, and team work.

Recommendations:

1. These and other models must be supported and expanded and materials detailing best practices must be disseminated to training and educational institutions.

2. The design of the current apprenticeship model and its relationship to rapidly changing technologies should be reviewed. The apprenticeship road is a long one. It is conceivable that apprentices could see their skills become obsolete before they finish the required related instruction and hands on experience.

3. Employers must be convinced that they should tie pay increases directly to increased worker skills in order for an apprenticeship model to provide them with highly trained workers. Generally speaking, U.S. employers are reluctant to enter into such agreements. MAP's work over the past three years indicates that workers want to learn and improve their skills but also want

to see the acquistition of new skills reflected in their pay check. Short of this, the tremendous potential workplace learning has to offer will remain just that.

VII. FUTURE RESEARCH POSSIBILITIES

A number of issues requiring further research have been raised. The ways in which workers best learn to operate new technologies need to be explored in greate detail. Much research is presently underway, such as at the Laboratory for the Cogniti dy of Work at the Graduate School of the City University of New York (CUNY). Indu lysts agree that a majority of the workforce will have to be continually trained to stay current with technological advances in the workplace. A greater understanding of how these skills can best be acquired and retained is essential.

A related subject is how the newly acquired skills are utilized in the workplace. Anecdotal information gathered during this research indicates that quite often employed workers are sent to a course and then never given the opportunity to use the newly learned technical skills on the job. The training is often quickly forgotten. *This is expensive.* A comparison should be done between training programs requiring employer participation (i.e., employer orientation to the courses their workers attend and input into incorporation of these new skills) and programs that do not.

Another issue concerns who gets training in new technologies as they are introduced into the workplace. It appears that age may be a critical determining factor. In union shop environments this may cause protracted contract fights as unions try to protect worker seniority in the face of technological change. In small shops it may create tensions on the shop floor as senior, highly skilled workers see their traditional set up skills *diminished* by a box with some fancy dials and numbers. Either situation causes problems that will stand in the way of the effective utilization of new equipment.

Additionally, unions and union members often actively resist cross-training, as it may jeopardize their future when layoffs occur. However, cross-training and broad-based skill acquisition can benefit the worker as much or more than the employer. A worker with a breadth and depth of skills will go farthest in the emerging workforce. Further research into how to structure joint worker-management training committees, and how to involve the workforce in all aspects of technology acquisition at the earliest possible moment - not when the truck is backing the equipment up to the loading dock - is needed.

Vocational-technical high schools have recently moved towards *competency-based* education, with emphasis placed on the acquisition of specific occupational skills for the individual trades. The research findings presented here, along with current research in technological education, engender the question of whether competency-based vocational education is the appropriate model for training the workforce of the future.

The interviews undertaken yielded a consensus of opinion of workers and employers with regard to common cognitive and occupational skills. Math, reading, measurement, problem solving and interpreting (e.g., blueprints, diagrams and charts) are skills that cut across trade areas. Set up, data entry, machine operation, computer diagnostics and programming are present and/or future skills required of workers in these high technology trades. Competency-based vocational education must be examined in light of the issues raised in this report. Should students be trained, instead, to acquire the common skills necessary for a high technology career? Perhaps specific occupational training should be limited to the cooperative placement, entry level on the job training, or work-based apprenticeship.

How do we bridge the transition from high school to work? Can schools and businesses work in partnership towards this goal? How do we enable the workers of the future to utilize the skills they have while keeping abreast of rapidly changing technology, particularly when our educational system has fallen behind other industrial nations? Team work, problem solving, cross-training, greater usage of math and reading on the job, all require a reintegration of conception and execution at the workplace. Frederick Winslow Taylor's early 20th century concepts of scientific management had as their underpinning the forced separation of doing and planning. Early proponents of numerical control technology touted it as a way to replace skilled labor (David Noble, Forces of Production: A Social History of Industrial Automation, 1984).

According to John Hoerr, "Increasingly employees must be able to recognize and deal with breakdowns of all sorts - machine failures, computer glitches, and even a breakdown in communications between workers (John Hoerr, "With Job Training A Little Dab Won't Do Ya," Business Week, September 24, 1990). Technology is no panacea, just as Taylor's mind-hand separation will fail in the new workplace environment. We can and must do better.

Martin, Laura, and Scribner, Sylvia. *An Introduction to CNC Systems: Background for Learning and Training Research*. New York: Laboratory for the Cognitive Studies of Work, December 1988.

McGraw, Kathleen. "Local Shops and Technology." *Western Mass. Metalworking Newsletter*, Vol. 3, No. 4, July-August, 1990.

Montgomery, David. *Workers' Control in America: Studies in the History of Work, Technology, and Labor Struggles*. New York: Cambridge University Press, 1979.

National Commission for Employment Policy. *Training Hispanics: Implications for the JTPA System*. Washington, D.C.: Report No. 27, January, 1990.

Noble, David. *Forces of Production: A Social History of Industrial Automation*. New York: Oxford University Press, 1984.

Rosow, James, and Zager, Robert. *Training: The Competitive Edge*. San Francisco: Josey-Bass Publishers, 1988.

Shaiken, Harley. *Work Transformed: Automation and Labor in the Computer Age*. New York: Holt, Rinehart, and Winston, 1984.

Shaiken, Harley, Herzenberg, Stephen, and Sarah Kuhn. "The Work Process Under More Flexible Production." *Industrial Relations*, Volume 25, 1986.

Warner, Heather. *Women in Machining: Access, Equity and Opportunity*. Machine Action Project Report, September, 1989.

Wiggenhorn, William. "Motorola U: When Training Becomes an Education." *Harvard Business Review*, Volume 68, No. 4, 1990.

Wood, Stephen (Ed.). *The Transformation of Work: Skill, Flexibility, and the Labour Process*. London: Unwin and Hyman, 1989.

END

U.S. Dept. of Education

Office of Educational
Research and Improvement (OERI)

ERIC

Date Filmed
July 17, 1991