Chapter 3

Education, Training, and Retraining

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INTRODUCTION

At various stages in U.S. history, changes in workplace operations and procedures in all sectors of the economy have resulted in changes in education, training, and retraining requirements for those employed or preparing for employment. Changes in instructional requirements for manufacturing-related work have been particularly dramatic. In some instances, they have been so extensive and widespread that they have triggered changes in the structures of institutions and organizations engaged in the delivery of education, training, and retraining services or the emergence of new instructional providers. For example, new production techniques introduced during the Industrial Revolution had much to do with the creation of a system of free public education, since large-scale production and continued industrial expansion required a literate work force capable of functioning on production lines, supervising manufacturing operations, keeping administrative records, and performing other functions. During this period, both industry and the labor movement became involved in the design and implementation of instructional programs to address short-term and special needs they felt could not be met either within a system of general instruction or through the public and private vocational programs that were emerging.[1]

Another era of substantial industrial change occurred in the 1960's, when the aerospace/defense industry underwent tremendous expansion and mechanization as a result of a concern over national defense and a national commitment to manned space exploration. Under provisions of the National Defense Education Act,[2] an example of legislation that led to the establishment of national policy for certain forms of occupational instruction, U.S. educational institutions were charged with coordinating efforts to prepare thousands of individuals for careers in science, engineering, and related fields. Training in these fields was considered necessary in order to develop the expertise and the technological base essential to creating a strong system of national defense and to meeting the challenges of space. Rapid technological change in aerospace/defense and other industries affected by these nationwide efforts required the continued involvement of business and labor in specialized instruction, to ensure that skill levels advanced at the same rate as applications of new machinery. However, when national priorities changed, this cross-sector commitment to linking advances in technology with the upgrading of skills within aerospace/defense and related industries disappeared. Since that time, the development of the human resource for these industries has been approached in more parochial ways by business, labor, educators, and government.

In these and other instances of changing education and training requirements, three factors have impeded the development of a coordinated, flexible system for occupational instruction in the United States. First, the absence of long-range, public and private projections of skill requirements, particularly those that highlight changes in skill levels and in core skill requirements within occupations, has hindered the development and delivery of instructional programs before industrial demand reaches critical proportions. * For example, the Electronic Industries Association reports that within the software technology field, certain highly specialized skills possessed by electrical engineers and computer scientists are interchangeable. Although not captured in more for-

[1]For additional information on the history of education and training in the United States, see *Informational Technology and Its Impact on American Education* (Washington, D. C.: U.S. Congress, Office of Technology Assessment, November 1982), OTA-CIT-187.

[2]National Defense Education Act of 1958 (Public Law 85-864, Sept. 2, 1958); National Defense Education Act Amendments, 1964 (Public Law 88-665).

● There are those who would argue that establishment of a coordinated, flexible system for occupational instruction in which projections of national as well as regional demand are taken into account is not the best approach and that actual rather than projected demand within local labor markets should determine public and private sector human resource development activities.

ma] projections, this interchangeability will affect recruitment strategies and, in turn, supply within both occupational groups. The net result may be that current and projected shortages of computer science graduates may also be seen in electrical engineering and yet may not be reflected in formal occupational projections. * Second, a history of responding to changing industrial skills requirements as crises arise has perpetuated a fragmented approach to education and training. Little or no planning or coordination of efforts takes place among traditional educators, business, labor, government, and others. Third, rapid technological change has placed great strain on educators as they attempt to adapt instruction to the requirements of new technology, while at the same time they address other changes in instructional needs.

The application of programmable automation in manufacturing operations has the potential to trigger widespread changes in education and training requirements. Robots and other forms of programmable equipment and systems may change the organization of the manufacturing process, the character of the production line, the occupational mix, and the human-machine relationship. The utilization of programmable automation, depending on its impact on employment levels within specific occupations, may also necessitate the retraining of individuals for occupations in other sectors.

This section of the technical memorandum examines the changing role of education, training, and retraining in the United States; describes how industry and labor engage in instructional services delivery; presents some current views held by representatives of industry, labor, and the educational community concerning changes in instructional requirements and providers; and outlines selected critical issues for those engaged in instructional design and delivery, in light of possible widespread use of programmable automation. This picture of education, training, and retraining, when viewed in light of present and future trends in the labor market, should facilitate the identification of new opportunities, problems, and issues in education and training policy.**

Changing Role of Education, Training, and Retraining

Formal instruction has always been viewed as an important part of the human development process in the United States. Since the colonial period, a variety of institutions and organizations have been established to deliver education and/or training services to the general public or to special segments of the population. Some of these institutions and organizations consider the provision of instructional services their primary mission; others, such as corporations and labor unions, view education and/or training as one of a number of activities in which they are engaged. The recent OTA study, Informational Technology and Its Impact on *American Education,* found that today, instructional services are available from an even wider variety of sources, including electronic-based services delivered directly to the home.[3]

As U.S. economic and social conditions have changed over the years, the role of education and training in the lives of all citizens has changed as well. Formal instruction was once viewed as a luxury that was unavailable to a large percentage of the population. Then, after a system for public education was established, the role of instruction became the initial preparation of young people to assume responsibilities as productive numbers of society. In the 1980's, instruction has come to

"Alternatively, it could be argued that electrical engineers, given an adequate supply, could be recruited to fill computer science jobs and eliminate projected shortages for that occupational group, but not in ways that could be foreseen by current methods of formal projection. In addition, recruitment for computer science jobs from the ranks of individuals with liberal arts training such as music and foreign languages, a practice that has proven quite successful, is not captured in formal projections of demand for those disciplines.

● *A number of investigations are now underway in the private sector that could considerably improve the understanding of changing education, training, and retraining requirements *in general* and requirements related to the utilization of programmable automation in manufacturing *in particular. One* such effort is a survey of education and training representatives in 1,000 corporations, conducted by *TrainingMagazine,* designed to identify current instructional needs and in-house program content. A second survey, initiated by the Society of Manufacturing Engineers (SME), has been designed to elicit from a sample of the SME membership, as well as from selected educators, views on instructional requirements that may stem from the application of computer-aided design (CAD) and computer-aided manufacturing (CAM). Knowledge derived from these investigations and others in progress will be incorporated into the final report.

[3] *Informational Technology and Its Impact on American Education,* op. cit.

be seen as a lifelong process that enables individuals of all ages to cope with economic and social change.

Questions concerning who receives instruction, who determines the content, who provides the instruction, what modes of delivery are utilized, how much instruction costs, and who pays for it have received considerable discussion throughout modem U.S. history and have served to shape national education and training policy. Education and training for work and who should provide them have been controversial subjects since the Industrial Revolution.

Participation in Instructional Programs

Due to a variety of forces, including the accelerating rate of technological change and growth in foreign trade, some workers, especially those in manufacturing environments, are finding that their skills are not adequate either to continue to perform their current jobs or, if they are displaced, to secure new jobs. Others may find that they are overskilled for their positions, due to the introduction of computer-based equipment and systems as well as other workplace changes. Changes in skill requirements and skill levels are affecting all manufacturing occupations, from the production line worker to the professional engineer. In response, many individuals are seeking additional training in order to keep pace with technological and economic change, although it is unclear from available data which occupational groups they may represent and whether they are predominantly white- or blue-collar. The relative quality of the instruction, and therefore its usefulness, is also difficult to determine from the available data. The Current Population Survey's Special Survey of Participation in Adult Education revealed that over 21 million persons 17 years old and over, or some 13 percent of the adult U.S. population, participated in adult education programs in 1981. An analysis of enrollments in 37,381 courses revealed that approximately 60 percent had participated for job-related reasons. In 9,260 cases, courses were provided by employers; in another 12,287 cases, employers paid enrollment fees for courses delivered outside the company. Professional and technical workers comprised the largest percentage of those enrolled—some 30 percent (there is no distinction made in the survey as to whether respondents are salaried or hourly employees). About 54 percent of the participants were under 35 years of age; 12 percent were over 55.[4]

Industry and Labor as Instructional Providers

Since the mid-19th century, both business and the labor movement have contributed to or participated in the design and delivery of instructional programs. Formal, in-house instruction is more common in larger business and labor organizations. At present business and labor both sponsor a variety of employee education and training activities, such as secondary-level remedial courses, traditional apprenticeships, and postsecondary degree and nondegree programs.

The American Society for Training and Development estimates that U.S. industry now spends approximately $40 billion annually on education and training programs for employees. The estimate excludes instructor fees or other administrative costs, such as equipment and enrollee travel expenses. Although rather dated, the results of a study of corporate-based training and education conducted by the Conference Board in 1974-75 indicated that in 1973-74, 75 percent of the 610 firms responding provided some in-house courses, 89 percent had tuition aid or refund programs, and 74 percent sponsored the enrollment of selected employees, usually managers and professionals, in courses offered outside the company during working hours. * The Conference Board estimated that in firms with 500 or more employees, with a combined employee base of 32 million, about 3.7 million, or 11 percent, were enrolled in in-house courses during working hours and another 2 percent (or 700,000) were enrolled during nonworking hours. Participation was more common for salaried than for hourly employees. The survey also showed that firms with less than 1,000 employees relied more on hiring trained individuals and on informal, on-the-job training.'

[4]"Participation in Adult Education, May 1981, "*National Center for Education Statistics Early Release,* June 1982.

*Roughly 1.3 million employees in responding companies were taking advantage of tuition assistance programs.

'Seymour Lusterman, *Education in Industry (New* York: The Conference Board, Inc., 1977), pp. 11-12.

This finding is consistent with other evidence that firms with up to 500 employees depend on informal, on-the-job training for all types of staff, since formal instruction programs are often too expensive for businesses of this size. [b]

Labor unions and labor organizations are also active sponsors and providers of employee education and training. Historically, unions have promoted liberal arts education in addition to more narrowly focused occupational education. Labor unions and labor organizations have been a strong force in shaping the popular view of education as the key to social and economic advancement.[7] Like some companies, unions sponsor 2- and 4-year degree programs at community colleges, colleges and universities, as well as single courses in labor studies. Unions also cosponsor apprenticeship programs with industry, providing specialized training in a skilled trade, craft or occupation at the worksite, and on-the-job instruction.

According to Bureau of Labor Statistics (BLS) figures, at the close of 1979 there were 323,866 persons enrolled in apprenticeship programs. Unpublished BLS estimates of apprenticeship enrollments are *320,000* persons in 1980, 316,000 in 1981, and 287,000 in 1982. While the drop in enrollment reflects reduced public and private funding levels, unions report there is no evidence to suggest that interest in apprenticeship has declined. Reductions in U.S. Employment and Training Administration apprenticeship and preapprenticeship grants to individual labor unions, labor organizations such as the AFL-CIO's Human Resources Development Institute, and community-based organizations such as the National Urban League, have diminished recruitment for and enrollment in apprenticeships. Deteriorating economic conditions within industries providing apprenticeship opportunities may be another factor in declining enrollments.

Manufacturing-Related Instruction

Management and labor have been the major providers of employee instruction beyond initial occupational preparation, since public sponsorship of training and retraining of noneconomically disadvantaged adults has been limited. The extent to which individuals working in manufacturing participate in education, training, and retraining programs offered by industry, labor unions, or other private or public providers is unknown. However, within corporate-based instruction as a whole, fewer courses are designed specifically for production line workers (excluding apprenticeship) than any other occupational group. Training industry representatives suggest that corporate instructional efforts have not previously concentrated on technical training other than in programs provided for engineering or data processing personnel. * This situation may change as U.S. manufacturing firms become familiar with new design and production technologies.

Another reason that technical and skills training do not receive more emphasis in corporate-based instructional programs may be their relative complexity, which requires demonstration of skill as well as knowledge transfer. This implies that technical courses and programs must emphasize hands-on practice and include a performance test to ensure mastery of skills.[8] Technical and skills training also require instructors with an understanding of current manufacturing processes as well as in-depth knowledge of the subject matter. These requirements result in high costs for establishing and maintaining an instructional program. In nonunion facilities, work-related instruction may depend on the advantages companies see in providing continuing education experiences in-house or through tuition reimbursement plans.

Different views exist as to how much emphasis unions place on instruction beyond apprenticeship. Some suggest that such instruction has heretofore not been a great concern of union members who therefore have addressed it in labor-management agreements in only a general way, through tuition reimbursement provisions. How-

[b] Interview with Jerome Pelaquin, Chairman, Technical and Skills Training Special Interest Group, American Society for Training and Development, July 1982.

[7] Paul E. Barton, *Worklife Transitions: The Adult Learning Connection (New* York: McGraw-Hill, 1982), ch. 7.

[8] "Technical training is the term commonly used to describe work-related instruction for individuals who perform technical procedures or who work in environments where technologies have been applied.

[9] Stanley J. Holden, "Business, Industry and Labor: Linkages Between Training and Employment," in *Job Training for Youth*, Robert E. Taylor, Howard Rosen, Frank C. Pratzner (eds.) (Columbus, Ohio: The National Center for Research in Vocational Education, The Ohio State University, 1982), p. 360.

ever, since the late 1960's, layoffs in auto, steel, and other industries have given rise to agreements *featuring* education and training benefits. One indicator of expanded worklife learning may be future emphasis on education and training benefits in labor-management agreements.[9]

[9]Barton, op. cit., pp. 125-126.

TECHNOLOGY AND MANUFACTURING: CHANGES IN INSTRUCTIONAL REQUIREMENTS

Discussions of the impacts of automation on education and training for the American worker are hardly new. The National Commission on Technology, Automation, and Economic Progress (hereafter "Automation Commission"), in its 1966 report, noted shifts in skill requirements occurring during that decade.[10] The report cites rapidly increasing employment levels of the highly skilled, as manifested in a technical work force that had grown from 6.6 percent of the total in 1947 to 12.2 percent of the total in 1964, and significant shifts during the same period from manual to white-collar work. The Commission report notes the trend toward more formal schooling, particularly higher education, as well as the growing education gap between the skilled and the unskilled. The Commission observed:

> The encouragement of an adaptable labor force fostered through education and training is second in importance only to the provision of adequate employment opportunities in the facilitation of adjustment to technological and other change . . . We wish to emphasize at the onset that we regard the goals of education as far transcending economic objectives. These goals go beyond economic progress to the development of individuals as persons and as responsible citizens. A clear division of education into its "economic" and "noneconomic" aspects is impossible . . . From the purely economic point of view, education has three principal effects: 1) it can increase the versatility y and adaptability of people with respect to change; 2) it can open up increasing opportunity to persons who might otherwise have difficulty in finding and holding employment; and 3) it can increase the productivity of workers at any level of skill or ability. Though education is much more than a means of economic progress, it is a decisive factor in the economic advancement of any country.[11]

Commission members acknowledged growth in corporate-based employee instructional programs, and they considered widespread basic skills deficiencies an impediment to future economic growth. Among their recommendations were:

- provision of quality compensatory education to all who need it;
- improvement of "quality and quantity" of primary and secondary education, especially in economicall, depressed areas, in order to achieve equity of access and equity of opportunity;
- universal high school graduation;
- deferral of vocational training until after high school, to ensure that individuals receive a general education to prepare them for subsequent occupational education and to instill an appreciation for education as a continuing process" . . . indispensable for continued adaptability in a changing world . . . ;"
- availability of education, training, and retraining to individuals throughout their lives.

The Commission also proposed a nationwide system of public education lasting 14 years with direct links between high school curricula and those of community colleges and technical schools designed to prepare individuals for technical and paraprofessional careers.[12]

Education, Training, and Economic Growth

The concerns of the Automation Commission have reemerged in various forms. While the

[10]*Technology and the American Economy: Report of the National Commission on Technology, Automation and Economic Progress, vol. 1,* February 1966.

[11]Ibid.

[12]Ibid, pp. 4s-47.

Automation Commission's report focused on the role of education and training as a complement to technological change in stimulating national economic development, more recent studies focus on education and training and new technology as factors in regional, State, and local economic growth. A 1982 study published by the Northeast-Midwest Institute cites basic skills deficiencies as a critical problem already depressing economic growth rates in the Northeast and Midwest and threatening U.S. participation in international markets. That study recommends a unified policy for training, retraining, and skills upgrading for all workers.[13]

Other observations on the relationship between education, training, and economic growth are being made on the State level, as public and private groups explore the relationship of human resource development and continued economic advancement in their respective geographic areas. A Connecticut Business and Industry Association study has found that an appropriately trained work force is the strongest influence on location decisions of advanced technology companies and is critical to expanding that State's electronic economy. That study recommends: 1) diverting resources within Connecticut education institutions to programs that graduate individuals qualified to enter high technology industries, as well as 2) publicizing existing, in-State continuing education programs for working, corporate-based professionals.[14] Another study, conducted for the New York State Science and Technology Foundation, found that universities could participate in State economic development through cooperative university/industrial education programs, cooperative university/industry research and development programs and improved responsiveness to unique industry needs.[15]

In a series of recent papers on higher education and technological innovation, the New England Board of Higher Education responded to charges of unresponsiveness made by business leaders and others concerned about changes in occupational supply and demand by redefining the problem as a need on the part of educators for:

> . . . hard numbers on the regional supply of trained personnel, and correspondingly, projections of demand based on reasonably firm business plans . . . , a clearly assumed responsibility y for the regular collection of such statistics and for the underwriting of expenses associated with continuing projects of this nature, (and) an organizational structure whose mission is to gain consensus from leaders of the business, education and governmental communities on the regional needs . . . and on the appropriate goals and strategies by which they can be attained. Plans for implementation would, ideally, include a clear demarcation between short- and long-term issues .16

Technological Literacy

It is possible that the United States is entering an era in which the potential for mechanization in the factory and the office will dramatically alter work force skill requirements. This will require employees and individuals preparing to enter the job market to enhance skills and/or to develop new ones. The OTA study, *Informational Technology and Its Impact on American Education,* found that in order to function as citizens in an information-based society that is driven in large part by technological innovation, individuals must have knowledge of the computer as a tool for managing and providing access to massive amounts of information. This need to understand the applications of computer technology has resulted in a modified definition of basic literacy that includes familiarity with the computer. "Technological literacy" is now a common term used to describe a level of understanding of technology in its various forms that goes beyond a familiarity with the computer. Experts suggest that technological literacy will soon be required of all members of the work force, as broader and more extensive applications of information technology are made in offices and plants. Widespread tech-

[13] Pat Choate, *Retooling the American Work Force: Toward a National Training Strategy* (Washington, D. C.: Northeast-Midwest Institute, July 1982).

[14] Ann Wingate and H. Craig Leroy, *High Technology Industries and Future Jobs in Connecticut* (Business and Industry Association, December 1981), p. 10.

[15] *Special Report V: The Higher Education System in New York and Its Potential Role in Economic Development,* prepared for New York State Science and Technology Foundation by Battelle-Columbus Division, April 1982.

[16] "Engineering and Technological Education in New England—Part II: Alternatives for the Eighties," *issues in Planning and Policymaking,* December 1981.

nological literacy may be hard to achieve, however, since about one-fifth of the U.S. population has yet to master the basic skills of reading, writing, and arithmetic.[17]

Industry representatives have expressed growing disillusionment with the lack of employability skills in entry-level workers with educational preparation through the graduate level. They define employability as an individual's understanding of the basic rules of the workplace, including the need to report for work, to arrive on time, to stay with a job for a reasonable period, and to demonstrate competence in the basic skills. This has led many companies to increase their involvement in education on the local and even national levels and to establish more in-house corporate education and training systems.[18] Labor unions and labor organizations have also been vocal in their concerns about basic skills deficiencies in those seeking apprenticeships. One union educational representative has found weak communications and reasoning skills common among trainees today. Many union locals establish close working relationships with school districts to improve basic skills, while national and international labor organizations address these problems by working with national education groups.

Although many elementary and secondary schools, both public and private, are placing renewed emphasis on basic skills development, and many adult education programs offer remedial courses in math, reading, and writing, these programs reach only some of the individuals who need this type of instruction. In addition, public school systems are hampered in modifying and strengthening curricula as a result of lower levels of Federal funding and reduced State and local tax revenues in many areas. These conditions complicate the process of developing strong basic skills and technological literacy among those preparing for entry into, and those already in, the work force.

[17] "Ahead: A Nation of Illiterates?" *U.S. News and WorldReport,* May 17, 1982; National Center for Education Statistics.

[18] James Campbell, "Employers Expect the Best, " reprinted from *Vocational Education Journal of the American Vocational Association,* vol. 55, No. 8, October 1981.

NEW TYPES OF INSTRUCTIONAL PROGRAMS

As a result of research performed to date, OTA has identified several instructional programs to prepare individuals to function in computer-automated manufacturing environments. It is too early to say whether or not the establishment of these programs constitutes the beginning of a trend, or to make qualitative evaluations, but the existence of these programs does indicate that some business, labor, and government representatives are aware of a skills gap in manufacturing firms where programmable automation has already been applied. It is important to note, however, that these programs are scattered; by no means do they constitute a coordinated attempt by the public and private sectors to address the problem of a potential widespread skills gap. At this stage in the investigation, it appears that the evolution of these and similar programs is occurring in traditional, uneven fashion, and that the capacities of educational institutions and other instructional providers would fall severely short of the potential demand for skills development and upgrading that may be associated with the widespread adoption of programmable automation.

Secondary-Level Programs

Since the establishment of a public education system, local school districts have attempted to develop secondary-level programs that achieve two distinct ends: 1) the preparation of some individuals for direct entry into the work force immediately after graduation; and 2) the preparation of others planning to enter college who require a strong foundation of knowledge on which to base more advanced instruction. Since lifelong learning is likely to become necessary for all members of the labor force, these objectives are becoming blurred. For example, in some high schools serving areas where programmable automation is now being produced or used in manufacturing, there are indications that students not

going on to college are receiving more attention than in the past, and that career exploration for high technology careers is recognized as important for all students, regardless of their postgraduation plans.

The State of Michigan, due to its economic dependence on auto and truck manufacturing, has been hit hard by massive layoffs over the past few years. With high unemployment among manufacturing workers in the region, some local high schools in southeastern Michigan have been looking for new career opportunities for which they can begin to prepare their students.

Several Michigan school systems, including Oakland County, have added introductory robotics courses to their curricula. These courses give students an opportunity to learn first-hand about robotics technology and to explore career opportunities within this manufacturing-related field. Students learn to operate simple, tabletop, electric robots, which are provided to the school systems by local robot manufacturers, or build their own robots. In some cases, courses include site visits to local auto manufacturing plants to observe robot applications in welding and painting. There are no prerequisites for juniors and seniors who wish to enroll. It is important to note that these courses do not purport to develop entry-level job skills in students, but are offered simply as an opportunity to develop some measure of career awareness in high technology. Also, there are no formal placement services provided and at present no links to more advanced robotics technology instruction.

An experiment is underway in Oakland County, where segments of a successful summer high school robotics course have been incorporated into the curricula of several regional vocational-technical centers. Courses offered through these centers are open to high school students as well as adults who wish to explore interests and career options in the field of robotics.

Retraining for Skilled and Semiskilled Occupations

Unions and others concerned about the potential social impacts of the use of programmable automation have been active in promoting the need for retraining programs for skilled and semiskilled occupations. They regard education and training as tools for strengthening the job security of and alternative job opportunities for their members. Through collective bargaining and other means, unions are looking for ways to influence who is trained and what is taught in retraining programs. In particular, unions are looking at ways to have more control over in-plant training to upgrade skills and to modify standard tuition refund programs to provide members with more opportunities to participate in education and training programs outside the workplace .19 This position is in keeping with provisions included in selected agreements of the 1960's, when earlier forms of manufacturing automation were applied in steel, electronics, and aerospace firms.[20]

The United Auto Workers (UAW) and the International Association of Machinists (IAM) are among the most active unions in promoting technology-related education, training, and retraining opportunities for their respective memberships. Within 1982 agreements UAW reached with Ford Motor Co., General Motors, and International Harvester, there are provisions for training and retraining programs for current employees as well as those laid off. In addition, each contract calls for the establishment of a joint union-management employee development and training committee through which special instructional assistance will be provided to members who are displaced by new technologies, new techniques of production and " . . . shifts in customer preference. " Employees—both skilled and semiskilled —are covered under other provisions of the agreements. They are eligible to participate in upgrade training designed to sharpen job skills and to provide updates on the state of the art of technology being utilized in their plants.[21 22 23]

[19] "Retraining: The Need for Flexibility," in *Silicon, Satellites and Robots: The Impacts of Technological Change on the Workplace* (Washington, D. C.: Department for Professional Employees AFL-CIO, 1979), pp. 44-45!

[20] See *Recent Collective Bargaining and Technological Change* (Washington, D. C.: U.S. Department of Labor, Bureau of Labor Statistics, March 1964), BLS Report No. 266.

[21] "Programs Set Up for Training and Retraining," *UAW-GM Report*, March 1982, p. 11.

[22] "Training, Retraining Plan to Cover Ford Workers," *UAW-Ford Report*, February 1982, p. 7.

[23] *UAW-International Harvester: Highlights of the New Agreement-1982-1984* (Detroit, Mich.: UAW Agricultural Implement Department, April 1982).

The Ford agreement called for the establishment of a National Development and Training Center, where staff on loan from the union and the company will promote training, retraining, and other skills development opportunities for current and displaced workers. * Two projects were launched by the Center in August 1982: a National Vocational Retraining Assistance Plan, which provides prepaid financial assistance of up to $1,000 per year to workers on layoff who wish to undertake self-directed, formal education or retraining; and Targeted Vocational Retraining Projects, highly specialized retraining activities designed to develop skills for use in new or existing occupations in which there are documented worker shortages. The Vocational Retraining Projects would be limited to geographic areas where established educational institutions and vocational training programs are not already providing such instructional opportunities. The Center also hopes to stimulate similar, publicly funded efforts in areas of the country where Ford workers are on layoff and might be eligible to participate.[24]

IAM initiated in the 1950's an annual electronics industry conference, known since 1968 as the Electronics and New Technology Conference, during which national staff and representatives of IAM union locals discuss issues that arise from the use of manufacturing technologies. In 1960, IAM began the practice of preparing a manual of model contract language that included provisions for use in dealing with in-plant technological change. 1AM model contract language on training benefits calls for instruction during working hours at company expense and at prevailing wage rates. It also states that senior employees should have first claim on training opportunities and suggests that management should be required to train employees for jobs not necessarily associated with new technology, in cases where " . . . either the new technology requires substantially fewer workers or present employees are not capable of successful retraining. "2[5] At an IAM-sponsored Scientists and Engineers Conference, held in the union's Placid Harbor Training Center in June 1982, members expressed concern that training and retraining provisions in contracts address instructional procedures as well as content.

Retraining the Displaced

A comprehensive review of documentation representing *over* 20 years of plant-closing experience revealed that retraining programs are of greater benefit to displaced workers who are younger, have slightly more formal education, and have achieved some level of financial security. Even among displaced individuals who possessed these characteristics, only about 15 percent participated in retraining, due to inadequate financial assistance during the training period.[26] These findings suggest that some new approaches to retraining the displaced should be developed that increase the utility of instruction and its availability to workers of all ages, with varying amounts of formal education and different degrees of financial security.

Although the public perception is that industry is one of the chief sources of sponsorship for retraining of displaced workers, in the past it has sponsored few retraining efforts. In some cases, the communities surrounding plants lacked alternative career opportunities for which instruction could be provided; in others, workers expected to be called back to their old jobs and resisted taking advantage of instructional and placement opportunities; in still other cases, economic conditions that led a company to close a plant made the cost of retraining prohibitive. Although retraining activities authorized under the Comprehensive Employment and Training Act (CETA) and the Trade Readjustment Assistance Act (TRA)

● The Center, temporarily located at Ford World Headquarters in Dearborn, Mich., will move to its permanent headquarters at Henry Ford Community College (Dearborn) in 1983.

"'National Vocational Retraining Assistance Plan and Other Projects for Certain Employees on Layoff," *UAW-Ford Employee Development and Training Program Bulletin,* Aug. 20, 1982.

[25] Leslie E. Nulty, "Case Studies of IAM Local Experiences With the Introduction of New Technologies," in *Labor and Technology: Union Responses to Changing Environments* (University Park, Pa.: Department of Labor Studies, Pennsylvania State University, 1982), pp. 115-139.

[26] J. P. Gordus, Paul Jarley, and Louis A. Ferman, *Plant Closings and Economic Dislocation* (Kalamazoo, Mich.: W. E. Upjohn Institute for Employment Research, 1981).

have been criticized, these Federal programs represent the majority of resources that have been utilized to prepare displaced workers for new careers. *

Two recent examples of retraining efforts funded under CETA illustrate the potential for retraining some of the displaced for new, technology-related occupations. The first, a pilot project made possible through a $300,000 Department of Labor discretionary grant to UAW, is designed to retrain 400 displaced auto workers for occupations in demand within the aerospace/defense industry. The first phase of the project, an assessment of the potential for skills transfer from jobs performed within the auto industry to the new positions within aerospace/defense, has already been completed. Other products of the grant include two retraining programs, which will be developed by combining components of existing retraining packages.[27] Although the project does not train individuals solely for technology-related positions, a UAW spokesperson indicated that many of the new aerospace jobs involve working with automated equipment and therefore related skills requirements will be addressed in the retraining packages to be developed. Implementation of the training process now awaits Federal funding or sponsorship by the aerospace/defense industry. A second CETA-funded project, initiated by the Warren County, Mich., prime sponsor, is a *40*-week robotic technician program, which qualifies 18 displaced auto workers, machinists, and others who completed the course to assume new careers within the auto industry, in local robotics firms, or in other companies using robots.**

*The recently enacted Job Training Partnership Act, which replaces CETA, authorizes the expenditure of Federal funds for employment and training of dislocated workers. CETA will operate during fiscal year 1983 at a $2.8 billion funding level, while programs authorized under the Training Partnership Act are established *(Employment and Training Reporter, Nov. 19, 1982).*

[27] "Assessment of the Reemployment Opportunities for Unemployed Automobile Workers in the Aerospace/Defense Industry," proposal prepared for the U.S. Department of Labor by the United Auto Workers, 1982.

● **As stipulated in Public Law 95-524, CETA amendments of 1978, a prime sponsor may be" . . . a State; a unit of general local government which has a population of 100,000 or more . . . ; a consortium of units of general local government . . . ; . . . program grantees serving rural areas having a high level of unemployment . . . ; and any unit of general local government previously designated as a prime sponsor under the provisions of this Act . . . , regardless of population decline. "

Instruction for Technician= Level Occupations

Although technicians emerged as an occupational group within the field of engineering in the 1920's, the availability and application of technology in manufacturing has increased the demand for and the popularity of this occupation. Technicians who are trained in the use of computer-aided drafting systems are now in great demand within aerospace and other industries.[28] Technician instruction is typically a 2-year associate degree program, although other, more concentrated approaches to program delivery are becoming more common, such as the one initiated in Warren County, Mich. The electromechanical technician curriculum, which combines two formerly distinct engineering specialties, is viewed by some educators and industry representatives as an excellent foundation for careers that require knowledge of programmable automation.

Community colleges in various areas of the country are currently offering electromechanical technician programs, sometimes called robotics technician programs by the institutions in order to capitalize on general public awareness of this form of programmable automation. The State of Georgia began offering an electromechanical curriculum in its community colleges in 1982. Several community colleges in Michigan have offered electromechanical programs for the past few years. In general, curricula are designed to prepare enrollees to perform installation, maintenance, repair, and programing functions. At present, however, no standardized performance criteria exist for electromechanical technicians, so the content and emphasis of these programs vary considerably.

Engineering Education

The utilization of programmable automation has had an observable effect on initial and continuing education for engineers. CAD, which enables faster design and analysis, is now common in the aerospace and auto industries. Selected engineering schools are working with industry to

[28] "The Engineering of a Revolution: Computer Now Designer's Tool," *The Atlanta Constitution,* Oct. 24, 1982.

add CAD instruction to their curricula. Boeing Commercial Airplane Co. in Seattle, Wash., has established at the request of local universities (e.g., Washington State) CAD laboratories adjacent to engineering school campuses. These labs provide students with opportunities to work with Boeing aircraft data bases when they are not being utilized by Boeing personnel. The program is voluntary, but students receive university credit for participating.

On the national level, a 1981 grant from the National Science Foundation's Directorate for Science and Engineering Education (now the Office for Science and Engineering Education) established the College CAD/CAM Consortium as a nonprofit group dedicated to the development of CAD/CAM curriculum and the improvement of CAD/CAM instruction. Twelve engineering schools, including Carnegie-Mellon University and Rensselaer Polytechnic Institute, were founding members.[29]

[29] *The College CAD/CM Consortium: An Overview* (Charlottesville, Va.: University of Virginia, School of Engineering and Applied Science, January 1981).

SURVEY OF CURRENT VIEWS OF EDUCATION, TRAINING, AND RETRAINING REQUIREMENTS

There has been little or no information gathered on how representatives of the key groups involved in or affected by the manufacturing automation process—producers of the equipment and systems; users of the equipment and systems; and various groups in the work force—view the potential retooling of the operations with which they are associated. In addition, no national readings have been taken of current views held by these groups on education, training, and retraining requirements associated with the use of programmable automation. In order to supplement available information of this type, and in so doing get a better sense of the climate in which automation is occurring, OTA commissioned structured telephone interviews with a sample of representatives of firms within the electric and electronics equipment, industrial machinery, and transportation equipment industries (industries in which firms are especially likely to use programmable automation). OTA also contacted producers of programmable automation equipment and systems, as well as educators and others familiar with the instructional design process. A total of 506 interviews were completed in July and August 1982. * In this section of the technical memorandum, a summary of selected survey findings is presented. A description of the survey methodology and sample size are included in appendix A.

*The term users refers to firms applying programmable automation; the term *producers* refers to firms producing programmable automation; and the term *others* refers to educators and others involved with education and training.

Education and Training: Users and Producers

The survey found that 40 percent of the representative manufacturing plants contacted utilized some form of programmable automation, and of this number, only 22 percent sponsored or conducted education and training for new technology. Among plants currently not offering education and training of this type, only 18 percent indicated any plans to implement programs in the future. Low benefits relative to costs was by far most commonly cited by user firm representatives as a barrier to the establishment of instructional programs for new technology. The low levels of current and anticipated direct involvement in education and training for new technology is particularly notable in light of the nearly unanimous view expressed by users, producers, and others that the users should bear the costs for new technology instruction. This seems to indicate that while users may be willing to pay for instruction delivered by vendors, educational institutions, and others, few are planning to establish their own, in-house programs. Another possible interpretation of the low levels of in-house instruction among users might be that changes brought about through the utilization of programmable automa-

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tion thus far have not been sufficient to warrant the establishment of formal instructional systems.

Instruction Available Through Producers

In contrast to the low proportion of users who sponsored and conducted education and training for new technology, a very high proportion of producers (93 percent) provide such instruction for their customers. Manufacturers within the industry groups polled appeared to depend on producers for design and delivery of new technology-related instruction. Results indicate that vendors or producers of programmable automation equipment were more heavily used for instruction than were training industry/management consultants, traditional educational institutions, proprietary schools, unions, and government-sponsored instructional programs such as CETA.

The nature and scope of instruction currently offered by producers, however, seems to be quite limited. Over 80 percent provide only single courses, and few provide series of courses. Furthermore, only about one-third of the producers felt that vendors or manufacturers of computer-automated equipment and systems were currently ready to provide the necessary education and training. One can speculate that the producers who work closely with new technology understand the education and training implications of implementing their technology, but are currently only providing part of what they consider is required. Producers may be providing limited services for a variety of other reasons, including cost factors, customer demand, and their views of the responsibilities of other institutions (particularly users) in providing additional training.

Occupational Coverage and Content Coverage

Both users and producers reported generally broad occupational coverage in the instructional programs on new technology that they provided, although there was considerable variation in the extent to which occupations were covered. The majority of both users and producers sponsored or conducted programs for various types of shop-floor staff (e.g., assemblers, handlers, loaders, equipment operators), repair and maintenance staff, engineers, programmers, and supervisors or managers. Apparently, the impact of programmable automation on a wide array of occupations is recognized by industry.

Broad occupational coverage was not accompanied by breadth in instructional content. The primary content of current education and training programs appears to reflect traditional topics addressed in technical training; e.g., machine operation, safety procedures, and maintenance. Current instructional programs focus least on the basic skills—reading, writing, and arithmetic—and basic physical science. The survey results suggest that manufacturers assume that these needs should be met in ways other than in instructional programs they devise.

Government Role in New Technology Instruction

Survey results show a lack of receptivity to government involvement in instruction for new technology by both users and producers. As noted earlier, government-sponsored instructional systems such as CETA were generally considered not ready to provide such training and were not expected to become ready within 10 years. When asked about possible sources of funding for education and training for new technology, only about half of the respondents in both groups indicated that Federal or State and local government funding was desirable, while funding from all other sources, particularly private sector user industries and foundations, was endorsed by at least three quarters of the respondents. In contrast, a great majority of the others (the group that included educators and Federal and State officials) endorsed government as a funding source. *

● It is not clear whether these responses reflect popular political views, attitudes toward government intervention in general, or actual preferences for private control of instruction for high technology. In any case, it is unlikely that respondents had in mind all forms of Federal, State, or local support (e.g., funding of colleges, universities, and research efforts), although it is not possible to determine this from the present data. Nevertheless, the consistency of responses in the user and producer groups may provide some guidance for determining the nature of the government role in instruction for computer-automated manufacturing. It is likely that indirect or less visible forms of government intervention would be more acceptable to industry than more direct forms of intervention, such as the provision of education and training services (e.g., CETA programs) or direct subsidies to industry for worker retraining.

SELECTED CRITICAL ISSUES FOR INSTRUCTIONAL PROGRAMING

Current views of representatives from industry, labor, the educational community and government are consistent with other indicators discussed earlier in this technical memorandum in suggesting that training and retraining requirements for programmable automation are, at this point, poorly defined. Even within specific geographic areas, programs initiated to address changing instructional requirements do not in the aggregate represent a coordinated approach to defining instructional needs associated with new industrial processes. While it is too soon to know how widespread applications of programmable automation will be, there is little evidence that any sector—including private industry-is seriously considering the long-range implications of possible widespread use on occupational skills requirements and current instructional capacities.

There are a number of pressing issues facing those who operate instructional systems, in the event that widespread utilization of programmable automation occurs. Among them are:

1. **how and by whom the need for technological literacy will be addressed,**
2. **types of short-range and long-term counseling and instructional systems,**
3. **initiation of appropriate curriculum design processes, and**
4. **funding sources for curriculum design and implementation.**