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ABSTRACT

Profound changes in the economy and the labor market have an effect on the role of employer-sponsored training in preparing and educating the country's work force. On the demand side of the labor market, these changes include the increase in international trade, the changing economic status of the United States relative to its trading partners, the continuing increase in the role of services in all sectors of the economy, and the diffusion of computers and sophisticated communications equipment. Supply-side developments include the increasing average levels of education and the depletion of reserves of labor, either from rural areas, from among women not engaged in paid labor, or from the relatively large cohorts of young people who can be brought into the economy at low levels. In many industries, these developments have brought about profound changes in markets, technologies, work organization, and industry structure, which in turn have reshaped human resource strategies and educational training requirements. As a result of the changes in the economy and the labor market, firm-based education will play a more important role in preparing the country's work force than it has in the past. Firms that can successfully integrate work and learning into the ongoing operation of the business will have an important advantage. (41 references.) (KC)

CHANGES IN THE NATURE AND STRUCTURE OF WORK: IMPLICATIONS FOR EMPLOYER-SPONSORED TRAINING

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CHANGES IN THE NATURE AND STRUCTURE OF WORK: IMPLICATIONS FOR EMPLOYER-SPONSORED TRAINING

INTRODUCTION

Employer-sponsored training was once the unseen stepchild of the system of education and training in this country. But in the last five years, analysts have realized that employers spend tens of billions of dollars annually on training, and although estimates vary wildly, the resources devoted to workplace education certainly exceed those devoted to postsecondary education.[1] Furthermore, a common explanation for the apparent loss of relative competitiveness of the U.S. economy is that the training provided by U.S. employers does not measure up in quantity or quality to training provided by employers in competitor countries. Perhaps the greater traditional emphasis on workplace training, whether it is of the apprenticeship variety in Germany or the internal corporate variety in Japan, has given these countries an advantage in an increasingly competitive and uncertain world economy.

The purpose of this paper is to analyze the effect of the profound changes that are taking place in the economy and labor market on the role of employer-sponsored training in preparing and educating the country's workforce. On the demand side of the labor market, these changes include the increase in international trade, the changing economic position of the United States relative to its trading partners, the continuing increase in the role of services in all sectors of the economy, and the diffusion of computers and sophisticated communications equipment. Although this paper concentrates on the effects of these demand-side changes, supply-side developments may be equally important. These include the increasing average levels of education and the depletion of reserves of labor, either from rural areas, from among women not engaged in paid labor, or from the relatively large cohorts of young people, who can be brought into the economy at low levels. (Interestingly, immigration is an increasingly important source of this type of labor.)

Together, these developments appear to have created conditions that represent a decisive break with the earlier post World War II era. In many industries, these developments have brought about profound changes in markets, technologies, work organization, and industry structure, which in turn have reshaped human resource strategies and educational and training requirements.

In order to lay the groundwork for the analysis, the paper begins with a discussion of the underlying economic changes that are affecting educational and human resource needs. Micro-electronic technology is certainly important; nevertheless, its effect on work and skills is fundamentally shaped by other factors including the rate of technological change and the changing nature of competition and of output markets.

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[1] See, for example, Anthony Carnevale, "The Learning Enterprise," *Training and Development Journal* (January 1986), pp. 18-26; and Nell Eurich, *Corporate Classrooms: The Learning Business, Princeton*, N.J.: The Carnegie Foundation for the Advancement of Teaching, 1985.

The following section describes changes in business and corporate strategies designed to respond to those underlying economic changes. Here I emphasize four developments: an increasing variety and rate of change of products and services that are produced; a greater emphasis by firms to reduce the time it takes to design, produce, and distribute their products; widespread internal reorganization of firms; and changing relationships among firms in supply chains (changing industry structure). In terms of human resource management, these changes are leading to what I refer to as more compact or dense production systems. These are characterized by more complex, interactive, and immediate relationships among employees within firms and between employees and individuals outside the firm--either end-use customers or employees of supplier- or customer-firms. I then discuss the nature of skills required by the development of more compact production systems.

The last section presents a discussion of the implications for firm-based education. I argue that as a result of the changes in the economy and labor market, firm-based education will play a more important role in preparing the country's workforce than it has in the past. Firms that can successfully integrate work and learning into the on-going operation of the business will have an important advantage. This will also encourage interaction and institutional linkages between the education system and the workplace.

This paper is based primarily on case studies of four industries--financial services, textiles, apparel, and business services (primarily accounting and consulting).[2] Unless otherwise stated, the examples that I present are drawn from these studies. In addition, I refer to conclusions and results reported in the growing case study literature on work, technology and skills.

THE UNDERLYING FORCES OF CHANGE IN THE NEW ECONOMY

In this paper I will focus on four fundamental factors that are driving both the changing nature of production and the resulting demands on the skills and education of the country's work force: the growth and diffusion of micro-electronic technology; the accelerating pace of technological and market change; the intensification of both domestic and international competition; and the increasing demands for quality, variety, and service in both retail markets as well as markets for intermediate goods. I shall briefly discuss each of these factors before discussing how they are influencing business and human resource strategies.

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[2] These studies were funded by the U.S. Department of Education through the National Center on Education and Employment (NCEE) at Teachers College, Columbia University. Three of the studies are reported in the following NCEE technical papers: Thomas Bailey and Thierry Noyelle, "New Technology and Skill Formation: Issues and Hypotheses," May 1988; Thomas Bailey, "Education and the Transformation of Markets and Technology in the Textile Industry," May 1988. Thomas Bailey, "Technology, Skills, and Education in the Apparel Industry," January 1989. The business services study is still underway.

In the discussion of changes in the nature of work, the influence of micro-electronic technology has perhaps received the most attention. The computer's power lies in its ability to retrieve, process, diffuse, and act on information, and, like other transforming technologies such as the steam and internal combustion engines, computers have the potential to bring about a decisive discontinuity in society and work. But the particular form that the realization of that potential will take is not obvious. The simple deterministic model that conceptualizes technological change as an exogenous force with well-defined implications for the organization of work and for required skills may still hold sway in some popular discussions, but much research on technology and work over the last decade has explicitly rejected this notion. Indeed, Harry Braverman, whose work is at least partly responsible for the controversy about the skill effects of new technology, explicitly argued that the developmental trajectory of new technology was chosen in such a way as to promote management control over the labor force.[3] This argument was further developed in extensive detail for machinists by David Noble.[4] Paul Adler and Bryan Borys review several studies based on what they label as the "social construction" of skill argument. Indeed they argue that rather than try to develop a systematic theory, many of these studies primarily argue that "it is more complicated than it seems."[5] Shoshana Zuboff presents several detailed examples of applications of similar information systems in factories and offices that contrast sharply with each other, based on such factors as the "firm's commitment to participatory management."[6] My own research in the textile and garment industries revealed a wide range of applications of the same technology, sometimes the same machines, with radically different implications for skills and human resource strategies. These differences sometimes have to do with differences in the markets that the firms serve, or the nature of the available labor force. Thus the answer to the question, "what is the effect of micro-electronic technology on skills?" is almost always a resounding "it depends."

But, in addition to the actual nature of the technology, the pace at which it is changing is also a central determinant of the changes in work and skills. Many industries today are characterized by frantic innovation and technological change. Moreover, much of this innovation involves services or processes that are difficult to measure and count.

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[3] Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century*. New York: Monthly Review Press, 1974.

[4] David Noble, *Forces of Production: A Social History of Industrial Automation*. New York: Alfred A. Knopf, 1984.

[5] Paul Adler and Bryan Borys, "Bringing Technology Back in: Automation and the Machinist's Skill," unpublished paper, Department of Industrial Engineering and Engineering Management, Stanford University, November 1987.

[6] Shoshana Zuboff, *In the Age of the Smart Machine: The Future of Work and Power*. New York: Basic Books, 1988.

If we accept that we are in an era of very rapid change, we could then ask whether this is just an era of adjustment to a period of relative stability or whether it is characteristic of a secular shift in the rate of technological and market change and in the level of uncertainty. Are we now in a period of increasingly endemic disequilibrium? If this is true, then according to Schultz's concept of "allocative efficiency" we would expect an increasing demand for workers with higher levels of education.[7] Indeed during the 1980s, the returns to education have grown. In particular, since 1978, while the average real wage of 25- to 34-year-old male college graduates grew by 6 percent, the wage fell by 8 percent for high school graduates and 15 percent for dropouts.[8] Moreover, empirical work presented at this conference suggests that employees in firms and industries that are experiencing faster technological change receive more training on the job.[9]

Of course it is possible that we are experiencing a one-time adjustment to a new type of technology, but some evidence suggests that we are in a period of continuing change. Measures such as counts of patent applications are ambiguous on this question. They reveal a modest growth during the 1980s, although a capacity constraint in the patent office and the increasingly international character of innovation may explain this apparent lack of dramatic growth.[10] Furthermore, many of the changes taking place in work organization concern new applications of computer technology that would not be picked up in available measures. Moreover, given the continuing drop in the cost of hardware and software, it is difficult to believe that the economy is about to settle into a period of stable technology.

A third central influence on the nature of work is the intensification of both domestic and international competition. This trend, which hardly needs to be described here, results both from the internationalization of markets and deregulation. It is exemplified by the increase in the share of U.S. GNP accounted for by imports and exports from 10 percent in 1960 to 22 percent in 1984.[11]

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[7] Theodore W. Schultz, "The Value of the Ability to Deal with Disequilibria," *Journal of Economic Literature* 13 (September 1975), pp. 827-846.

[8] Data from presentation by Richard Freeman at a conference on "Non-College Youth" sponsored by the National Health Policy Forum, at the Marriott Hotel, Washington, D.C., January 27, 1989.

[9] Although this cross-section result does not necessarily mean that faster economic change over time will result in a trend towards demand for higher education levels, it is at least suggestive. Hong Tan, "Private Sector Training in the United States: Who Gets it and Why," Table 2.5, Conference on Employer-Sponsored Training, sponsored by the National Assessment of Vocational Education, U.S. Department of Education, and presented by the Institute on Education and the Economy, Teachers College, Columbia University, in Alexandria, VA, December 1 and 2, 1988.

[10] Zvi Griliches, "Productivity Puzzles and R&D: Another Nonexplanation," *The Journal of Economic Perspectives* 2 (Fall 1988), pp.9-22.

[11] Office of Technology Assessment, *Technology and the American Economic Transition: Choices for the Future* OTA-TET-283. Washington, D.C.: U.S. Government Printing Office, 1988, p. 303.

A fourth trend is the increasing emphasis on quality, variety and service both in consumption and for intermediate goods.[12] In banking, apparel, textiles and business services, there has been a shift from growth based primarily on increased sales of standardized goods or services to attempts to sell more varied and customized products. Markets for basic consumer goods have been saturated, and growth depends more on finer differentiations in quality, style, and service.

I have argued that four factors underlie the changing nature of production--micro-electronics, the pace of technological change, the intensification of competition, and changes in the nature of consumer demand. Industries or firms that differ in these dimensions can also be expected to follow a different human-resource trajectory. For example, given the increasing importance of competition, this focus raises questions about the production of those goods or services that have more tenuous or complicated links with the market such as health and public sector services. In the vast case study literature on skills and technology, these types of sectors have received almost no attention.[13] Clearly they are affected by technology and changing consumption patterns; nevertheless, not only is our knowledge about actual developments more limited, but the motivating factors behind them are more obscure. Thus systematic analyses of sectors or industries that differ according to the central factors identified here are necessary in order to strengthen the generality of the argument.

FIRM RESPONSES TO THE CHANGING ECONOMY

In this section I describe four types of interrelated firm responses to the changing economy that have particularly important implications for human resource strategy, skills, and education. These include an increase in the variety of products, a greater emphasis on continuous innovation and fast response to market shifts, changes in internal firm organization, and changes in the relationships between firms and their suppliers and customers.

Greater Variety of Products

Low cost production has always been associated with economies of scale. Indeed production-process innovation in the United States in the twentieth century has been synonymous with capital-intensive mass production. But the scope for profitable pursuit of this type of strategy obviously depends on strong markets for standardized goods or services. Although there are still many opportunities to produce white underwear or corn flakes, these types of basic commodities account for a shrinking share of the markets. The proliferation

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[12] See Office of Technology Assessment, 1988, Chapter 2 for a discussion of trends in consumption patterns.

[13] There are discussions of health and other not-for-profit sectors in Office of Technology Assessment, 1988; and Thomas Stanback, *Computerization and the Transformation of Employment: Government, Hospitals and Universities*. Boulder, CO: Westview Press, 1987.

of products and services at the consumer level is obvious in many industries. For example, in consumer and business banking, the vast majority of available services simply did not exist ten years ago. In the apparel and textiles industries, the last decade has seen a shift from a two-season year with a substantial segment of apparel hardly affected by fashion, to a multiple-season year (almost continuous change in some lines) with fashion sensitivity penetrating more and more lines of basic apparel such as blue jeans and even tee-shirts. The Office of Technology Assessment's report on the American Economic Transition describes the growth and increasing variety of personal business and communication services.[14] Management consulting, one of the fastest growing industries, by its nature involves an overwhelming element of customization. In industry after industry, a few basic goods or services have given way to dozens of items, and completely customized products are increasing in importance.

Style proliferation is sometimes used as a direct competitive measure. For example, in 1981, faced with a challenge from Yamaha leadership in motorcycle production, Honda responded by touching off a war based on variety. Starting off with 60 models, over the next 18 months the company introduced or replaced 113 models, while Yamaha, which also started with 60 products, could only manage 37 changes in their product line during the same period. Honda succeeded in making motorcycle design and variety a major selling point for its products. Yamaha dealers ended up selling many of their motorcycles below cost.[15]

A Greater Emphasis on Continuous Innovation and Fast Response to Market Shifts

The Honda example also illustrates the increasing importance of reducing the time that it takes to develop, produce, and distribute a product. Improved communications and diffusion of technological information give industry leaders less and less time to reap the benefits of leadership. In addition to its value in getting goods to market faster, reducing product cycle time can also save inventory interest and space costs.

Real-time computer networks have allowed almost instantaneous delivery of many services such as travel reservations or rating of insurance policies. While the computer and its immediate access to information has allowed this to take place in the paper-shuffling industries, time issues are increasingly important in manufacturing. The Japanese made just-in-time inventory systems popular. Using just-in-time and other short-cycle systems, Toyota was able to cut its domestic sales, manufacturing and distribution cycle time from four to six weeks in 1982 to eight days in 1987.[16]

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[14] Office of Technology Assessment, 1988, pp. 132-136.

[15] George Stalk, "Time--The Next Source of Competitive Advantage," *Harvard Business Review* (July-August 1988), pp. 44-45.

[16] Stalk, 1988.

Similar strategies are now being implemented with great fanfare in the United States. In just the last four years, as style changes in apparel have accelerated, leaders in the industry have turned from a virtual obsession with automation to an equally strong preoccupation with reducing production and delivery times, called "Quick Response" in the industry. Most apparel and other soft goods are only being processed for a few hours, yet it often takes up to a year between an order and arrival of goods on the retail shelves. The efforts to implement Quick Response are taking place all up and down the supply chain including sophisticated links between computerized design, manufacturing of fiber, fabric, and apparel, marketing information, and retail level inventories. In some cases these efforts have been able to cut lead times for garments from several months to six to ten weeks. Quick Response is now considered to be the domestic industry's number one weapon (after tariffs and quotas) for fighting import competition.[17] Service firms have also focussed on time. In competing for insurance customers, one company recently argued that it had been able to cut processing time for some services from 20 to 5 days.[18] Concern is increasingly turning to the speed of innovation and of the product development cycle. Much has been made of the ability of Japanese firms to develop projects with significantly shorter lead times than U.S. firms. One survey found that Japanese automobile firms completed design projects in two-thirds the time with one-third the engineering hours of U.S. firms.[19] One line of argument is that the U.S. takes a mass production approach to innovation. Rather than concentrating on incremental changes, U.S. firms have a tendency to focus on potential leaps in technology. This approach has been blamed for the loss of technological leadership in the production of air conditioners and of textile equipment.[20] The alternative is a more incremental approach to innovation with much greater integration into the production process itself.

Changes in Internal Firm Organization

The programmability and communications potential of computers seems to offer the technological basis for flexible, quick-turnaround production. Indeed, attempts to develop flexible and responsive systems all depend heavily on micro-electronics. Nevertheless, case studies that have examined the question find that the productivity and flexibility potential of the technology cannot be achieved without accompanying organizational changes. For example, in the automobile industry, research has not found strong relationships

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[17] Rod Gunston and Peter Harding, "Quick Response: US and UK Experiences," *Textile Outlook International* (March 1987), pp. 43-51.

[18] "Work Teams Can Rev Up Paper Pushers, Too," *Business Week* (November 28, 1988), pp. 64-68.

[19] Kim Clark, Bruce Chew, and Takahiro Fujimoto, "Product Development in the World Auto Industry," *Brookings Papers on Economic Activity* (3: 1987), pp. 729-771.

[20] Stalk, 1988; and Charles Sabel, Gary Herrigel, Richard Kazis, and Richard Deeg, "How to Keep Mature Industries Innovative," *Technology Review* (April, 1987), pp. 27-35.

between new technology and productivity or quality.[21] And many of the most advanced applications of technology in textiles and apparel actually favor continuation of mass production strategies. Larry Hirschorn describes examples from a bank, a medical lab, and an insurance company in which applications of new technology inexorably led to organizational change.[22]

Generally speaking, these reorganizations have involved a movement away from a functionally-oriented organization to one that is more oriented towards products or markets. They also involve the elimination or reduction of in-process inventories. Inventories in effect create buffers between the various steps in the production process. Problems that occur in one area do not immediately flow into other areas. The reduction of inventories can transform the production process. By eliminating inventories, the individual workers and the various steps in the process become much more interdependent. The influence of machine failures and bad quality spreads much more quickly.

Despite these potential problems, this type of reorganization has several advantages. First, direct labor savings and quality increases are often reported. Second, processing times either for manufactured goods or services can be sharply reduced. Third, the groups of workers tend to be more self-directed, thereby cutting down on the need for supervision and supervisors. Fourth, this approach is supposed to draw more initiative out of the workers themselves by getting them involved with improvements in the process.

For example, shirt factories were traditionally divided into large departments that carried out particular functions--preparation of the cuffs or collars, cutting and sewing the button holes, sewing on the buttons, attaching the sleeves to the body of the shirts, and so forth. Orders moved through these factories in sequence. For example, if each of six orders took one week, then it would be over five weeks before some parts of each order came through. Advanced shirt factories are now more likely to be organized into larger numbers of smaller departments that can turn out the entire shirt. As a result, some of each order is finished every day, allowing a more efficient product flow to the customer. In one pilot project using this type of reorganization, direct labor costs were cut by 5 percent, throughput time was reduced from three days to less than half a day, the share of second quality shirts dropped from 2 percent to .2 percent, and space requirements were halved.[23] Thus this reorganization reduced inventories and allowed the factory much more flexibility in filling smaller orders on shorter notice.

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[21] John Krafcik, "High Performance Manufacturing: An International Study of Auto Assembly Practice," working paper, MIT International Motor Vehicle Program, 1988; cited in Thomas B. Kochan, "Adaptability of the U.S. Industrial Relations System," *Science* 240 (April 15, 1988), pp.287-292.

[22] Larry Hirschorn, "The Post-Industrial Economy: Labour, Skills and the New Mode of Production," *The Service Industries Journal* 1 (Spring 1988), pp. 19-38.

[23] Kurt Salmon Associates, *Quick Response Implementation*. New York: Kurt Salmon Associates, 1988, p. 13.

Internal reorganizations in the auto and other manufacturing industries have perhaps attracted the most attention, but changes within the service industries have been just as profound. For example, in 1987, the insurance company AAL in Wisconsin transformed a traditional functional organization in which life insurance cases were handled by one department, health insurance by another, and billing and policy loans by a third. Now groups of 20 or 30 workers are assigned to work with field agents from a given region. The teams are able to carry out all of the 167 tasks formerly performed by the three functional departments.[24]

There are no comprehensive numbers on how widespread this change is. Surveys indicate that between 25 and 35 percent of all U.S. firms and over 50 percent of firms employing at least 1000 workers have experimented with quality circles or other forms of employee involvement or participation techniques.[25] But this would be a vast underestimate, even for manufacturing, since there are many types of decentralizations and reorganizations that would not necessarily be identified as "teamwork" experiments. This is true of the changes reported by Hirschorn in several industries (discussed earlier) or the changes described by Zuboff in pulp mills and insurance companies.

The actual impact of this type of reorganization has yet to be determined. Teamwork experiments have a one-year attrition rate of 20 percent.[26] And some union representatives in the auto industry, where the team concept has been tried in many factories, argue that teams in that industry are little more than sophisticated techniques for speeding up work and weakening the union.[27] One direct attempt to measure productivity gains attributable to the use of teams in the auto industry actually turned up some negative results.[28] Nevertheless, focussing on explicit teamwork experiments is much too narrow. Teams are not likely to work without other changes in the organizations that make them more flexible and responsive to their markets. The current strategies for this in general involve market-oriented organization with both expanded roles for the individual workers and much greater integration and interaction among them.

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[24] "Work Teams Can Rev Up Paper Pushers, Too," 1988.

[25] W. Alper, B.N. Pfau, D. Sirota, *The 1985 National Survey of Employee Attitudes.* New York: Business Week and Sirota and Alper Associates, 1985; and Goodmeasure Inc., *The Changing American Workplace: Work Alternatives in the '80s.* New York: American Management Association, 1985. These sources are cited in Thomas Kochan, 1988.

[26] R. Drago, "Quality Circle Survival: An Exploratory Analysis," working paper, Department of Economics, University of Wisconsin, 1987; cited in Kochan, 1988.

[27] Mike Parker and Jane Slaughter, *Choosing Sides: Unions and the Team Concept.* Boston: A Labor Notes Book, South End Press, 1988.

[28] Harry Katz, Thomas Kochan, and Jeffrey Keefe, "Industrial Relations and Productivity in the U.S. Automobile Industry," *Brookings Papers on Economic Activity* (3:1987), pp. 685-715.

Changes in Industrial Organization and Relationships Between Suppliers and Customers

The needs of flexibility, quality, and speed have profound implications for the relationships among firms in the overall supply line for a product. If a producer is to be able to turn out a variety of goods quickly, without large inventories of supplies, that producer's suppliers must also be able to deliver high quality inputs just as quickly, whether they are manufactured items or services. One response to this problem has been vertical integration. This allows maximum control over all steps in the supply line.

But a central problem with vertical integration, at least where substantial fixed or specialized capital, either human or physical, is involved, is that it makes flexibility much more difficult. Since every product does not necessarily require the same mix of inputs, changing products or processes will almost always involve the idling or the inefficient use of some of that capital. The need for flexibility therefore promotes a movement away from integration towards greater use of subcontracting, purchased inputs and services, and temporary relationships with workers or individuals providing services to the firm.[29]

Thus the dual trends towards the need for greater control over delivery schedules and input quality on the one hand, and greater flexibility on the other, both promote and discourage vertical integration and permanent and long term relationships to employees. A common solution to this complex of problems involves the development of networks or partnerships among firms in the supply chain. One alternative is for a large firm to spin off departments to serve as independent contractors--this is sometimes referred to as quasi-disintegration. Another is for smaller firms in the supply chain, rather than maintaining arms-length, market-mediated relationships to customer and supplier firms, to work out partnership arrangements in which they share information on demand and innovations and coordinate their production.[30] As long as each firm can develop this type of relationship with at least a few other firms, it can enjoy the advantages of a coordinated and responsive supply pipeline while concentrating on its function within that process. Moreover, it is not stuck with the problems of capacity utilization and balance that plague larger, more diverse organizations.

The apparel/textile complex offers a particularly dramatic example of this development. Some analysts have attributed the success of some sectors of these industries in Japan and Italy to their successful

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[29] Katherine Abraham, "Restructuring the Employment Relationship: The Growth of Market-Mediated Work Arrangements," unpublished, Brookings Institution, 1988.

[30] Alexis Jacquemin, *The New Industrial Organization: Market Forces and Strategic Behavior*, Cambridge, MA: MIT Press, 1988, pp. 150-151. Of course it is possible to develop close relationships with contractors without actually setting them up. For a discussion of this development see Russell Johnston and Paul Lawrence, "Beyond Vertical Integration--The Rise of the Value Adding Partnership," *Harvard Business Review* (July-August 1988), pp. 94-101.

use of producer networks.[31] In the United States, in the last three or four years, large apparel and textile employers have tried to develop closer relationships to suppliers and customers. These relationships now include computerized links to facilitate ordering and minimize inventory. In general, whether through backward or forward integration or through the development of subcontracting partnerships, the traditional vertical structure of the textile/apparel complex is blurring. Large department store chains are becoming more deeply involved with apparel and soft goods production, while garment producers themselves--such as Benetton--have moved into direct retailing. But whatever the particular institutional form, there is now much more interaction among firms (or departments and divisions in the case of integrated operations) up and down the supply chain. One important implication is that more employees within each firm or division will interact with employees in other firms or divisions. The problem of vertical integration versus network in the structure of the industry has its analogy in the relationships between employers and employees. Given the increasing uncertainty and change, firms want to maintain flexibility and are therefore reluctant to make long-term commitments to individuals. Many firms have turned increasingly to temporary or contract workers. Katherine Abraham refers to the relationship to temporary workers as "market-mediated" relationships. But just as the relationship between subcontractors and contractors is much closer than an arms-length market relationship would imply, temporary workers, especially those higher up in the employment hierarchy, could have close and long-lasting interactions with the firms that hire them.

I have emphasized four trends: greater flexibility, a greater emphasis on continuous innovation and fast response to market shifts, more market- and product-oriented internal firm organization, and closer interactions among firms in the supply chain. A central effect of these trends is to create a much denser and more tightly packed production system. Lead times, buffer inventories, and other types of slack and margins for error and relaxation are, at least in principle, all being squeezed out of the production system. Firms and workers within the supply chain are now involved in a more integrated network and are therefore much more interdependent. This interdependence and its attendant technological and organizational developments can potentially have a strong influence on skill needs and human resource strategies, including training provided by the firm. In the next section I take up these potential changes.

SKILLS

Changes in firm-based training will be influenced by changes in the types of skills needed in the workplace. Therefore an analysis of the evolution of firm-based training must take account of the on-going controversy concerning the nature of the changes in skills that is taking place in the economy.

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[31] Ronald Dore, *Flexible Rigidities: Industrial Policy and Structural Adjustment in the Japanese Economy, 1970-1980*. Stanford: Stanford University Press, 1986; and Michael Piore and Charles Sable, *The Second Industrial Divide*. New York: Basic Books, 1984.

The traditional de-skilling debate has implications for the analysis of employer-based training for two reasons. The de-skilling proponents argue not only that lower level jobs are less demanding, but that there is a growing gap between entry-level positions and higher-level jobs. Of course, if there is a general degradation of skills, then there needs to be less training of all types, both employer-sponsored and school-based. Moreover, the argument that there is a growing gap between lower- and higher-level positions would also imply a reduction of the need or usefulness of employer-based training. Employer-based training is probably most effective in helping workers to move up the steps of a reasonably-articulated job ladder. Large gaps in the ladder would be better bridged simply by hiring recruits with higher levels of initial education or experience. But neither occupational forecasts nor evidence from case studies suggests that there is a general lowering of skill levels, a proliferation of low-skilled jobs, or a sharp decline in middle-level jobs.

Changes in skill requirements can come about either through changes in the occupational structure that increase or decrease occupations of particular skill levels or through changes in the skill requirements within occupations.[32] This section briefly reviews the occupational data, then discusses how the structural changes in the economy, especially the spread of more compact production systems, change the nature of skills within occupational categories.[33]

Occupational forecasts suggest that some occupations that are generally considered to require very little skill will add large numbers of jobs to the economy over the next decade. Indeed, the four occupations that are expected to add the most jobs are retail salespersons, waiters and waitresses, registered nurses, and janitors and cleaners. Cashiers, truck drivers, and food counter workers also make the top ten. Nevertheless, a more comprehensive look at these data fail to support this perception. Between 1979 and 1986, the number of executive, managerial, technical and related support, precision production, craft, and repair workers grew by 18 percent, while all other occupations grew by only 7 percent. If one assumes that the distribution of education across occupations will not change, then the occupational projections developed by the Bureau of Labor Statistics suggest that while 45 percent of the employed workers now have at least some college education, about 55 percent of the net new jobs generated between now and the year 2000 will require some college education.[34] This is simply another way of saying that those jobs that are now filled by workers with

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[32] The research literature in this area is extensive. Useful reviews can be found in the following sources: Paul Adler and Bryan Borys, 1987; Barbara Baran and Carol Parsons, "Technology and Skill: A Literature Review," unpublished paper prepared for the Carnegie Forum on Education and the Economy, Berkeley Roundtable on the International Economy, 1986; Patricia Flynn, *Facilitating Technological Change: The Human Resource Challenge*. Cambridge, MA: Ballinger Publishing Company, 1988; and Kenneth Spenner, "Upgrading and Downgrading of Occupations," *Review of Educational Research* 55 (Summer 1985), pp. 125-154.

[33] Harry Braverman, 1974.

[34] This estimate was derived with the following procedure: all employed workers in the 1987 public-use sample for the Current Population Survey were categorized into 19 occupational groups. These in turn were divided into two subgroups--those with at least some college, and those with no more than a high school

some college education are projected to grow faster than those jobs currently filled by workers with no more than a high school degree.

Changes within Occupations

But the de-skilling argument also suggests that technology can be used to reduce skill requirements of given occupations. Indeed, the power and tenacity of the hypothesis comes from the many examples that seem to indicate that computers and new technology do indeed simplify many tasks. Due to sophisticated cash registers and scanners, fast-food workers and supermarket cashiers presumably no longer need to be able to recognize numbers. Word processors allow workers to turn out error-free text using the "hunt and peck" system, and machinists can be reduced to machine tenders when numerically-controlled technologies can take over the operation of the cutting process.

In this case, the available broad-based data from the Dictionary of Occupational Titles (DOT) are highly suspect.[35] Moreover, they fail to support the de-skilling perspective. Kenneth Spenner's review of the research based on the DOT reveals, if anything, a slight overall tendency towards upgrading despite the bias that these data have against change.[36]

Although the image of the technologically-induced transformation of the skilled machinist into a semi-skilled machine tender has proved to be influential, some case studies have found reasons why employers would not want to put their new technology in the hands of lower-skilled workers. This is not necessarily because the technology itself requires more skill, although certainly in some cases it does, but rather because of broader changes in the environment including increases in uncertainty and more rapid change. Firms that expect to make only a narrow range of products with the same equipment for several years could make do with low-skilled workers who had little conceptual understanding of what they were doing, even if the machines were highly sophisticated. The problem involves the interaction of the technology with the changing environment in which the firms operate. Thus the manager of technical personnel in a large apparel plant, in complaining about the repair personnel, told me, "these workers can't do a damn thing that they haven't done before, and my equipment is changing too fast to allow me to show them how to do everything."

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degree. Assuming that the educational distribution within each occupation did not change, the projected number of workers within each category was calculated based on the Bureau of Labor Statistics' occupational projections for the year 2000. These projections are reported in George T. Silvestri and John M. Lukasiewicz, "A Look at Occupational Employment Trends to the Year 2000," *Monthly Labor Review* 110 (September 1987), pp. 46-63.

[35] The Dictionary of Occupational Titles is a data set that is designed to track the changing characteristics of thousands of individual occupations. Unfortunately, methodological problems in the surveys used to collect the information make any results about changing characteristics derived from this data set unreliable. (See A. Miller, D. Treiman, P. Cain, and P. Roos, *Work, Jobs and Occupations: A Critical Review of the Dictionary of Occupational Titles*. Washington, D.C.: National Academy Press, 1980.

[36] Spenner, 1985.

The Need for Skilled and Adaptable Lower-Level Workers

There is a growing body of research that supports the argument that the combination of new and changing technology, and the increasing emphasis on flexibility, quality, and service and the spread of what I have referred to as more compact production systems create needs for many lower- and middle-level workers who have broader skills and who are more adaptable.[27] Moreover, these call forth not simply a need for a new portfolio of skills, but a different orientation on the part of firms towards education and training and the management of human resources in general. More specifically, I would argue that for firms that move towards increasingly compact production systems, three general principles will become more important in their human resource management strategy for workers at the middle and lower levels of the job structure. Furthermore, it may be more useful to look at micro-electronic technology as facilitating these developments rather than in some sense causing them.

Increasing the responsibility and scope of action of lower- and middle-level workers. As a result of increased production variety, and the pace of product as well as technological change, it is much more difficult, and less efficient, to plan out every contingency that an employee must face. Furthermore, the increases in time pressure and the reduction in buffer inventories make it more difficult for employees to refer problems to specialized departments or to await instruction or permission from superiors. Increased responsibility and scope of action might also facilitate incremental innovation and process improvements by lower-level workers. The particular skills needed to do this are extremely difficult to define but an ability to understand the broader system in which the employee is involved and a more abstract understanding of the technologies with which he or she is working would be important.

Facilitating greater and more complex interactions among employees within the firm, and between workers in the firm and individuals from customer- and supplier-firms. A fundamental characteristic of compact production systems is the reduction or elimination of the separations between individuals within firms and between firms at different places in the supply chain. The separations traditionally have been created by long lead times, slow communications, bureaucratic procedures, and buffer inventories. This will first create greater direct interdependence among individual workers--the actions of any individual will have a much more immediate effect on others. Some of the reorganization that is taking place now within firms also creates greater personal interaction among workers. In the more complex

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[27] See for example, Paul Adler, "Managing Flexible Automation," unpublished paper, Department of Industrial Engineering, Stanford University, April 1987; Thomas Bailey, 1988; Olivier Bertrand and Thierry Noyelle, *Human Resources and Corporate Strategy: Technological Changes in Banks and Insurance Companies*. Paris: Organization for Economic Co-operation and Development, 1988; Hirschorn, 1987; Manufacturing Studies Board, *Human Resource Practices for Implementing Advanced Manufacturing Technology*, Washington, D.C.: National Academy Press, 1986; Office of Technology Assessment, 1988, Chapter 11; Rosenfeld, 1988, Chapter 5.

subcontracting relationships that are beginning to develop, there is also the potential for greater interaction among individuals in the various firms at lower levels of the job structure.

Integrating formal and informal education into the operations of the firm to allow the on-going adaptation to new products, technologies, and market conditions. Continuing changes in technology, products, market characteristics, firm organization, and production processes will require more frequent retraining and updating of knowledge. Schools are now called upon to try to develop better methods to better prepare students to be able to continue to learn throughout their lives. Although this makes some sense, continuous learning is more an institutional than a pedagogic problem. Even if we could design educational programs that would make adults more efficient learners, concrete mechanisms must be developed to provide the instruction. Informal training has always been an integral part of workplace education, but informal training is primarily useful for passing on skills and knowledge from one group of employees to another. More explicit and organized means are needed for more rapidly diffusing new knowledge and skills.

In this paper I have emphasized that these changes in human resource strategy are needed as a response to the nature and rate of change of technology and the structure of competition and output markets. These all influence the demand side of the labor market. Nevertheless, supply side issues also play an important role. As the general level of education rises, as reserves of rural labor dry up, and as the relative size of the young population drops, firms find it increasingly difficult to attract recruits for tedious, low-paid positions for traditional production processes. Thus many apparel and textile manufacturers facing intense international competition and therefore having little flexibility to raise wages, cannot hire up to capacity. The changes in human resource strategy discussed here may not only be important to boost productivity, but by improving the environment in which workers are employed and making their jobs more interesting, these changes may strengthen the labor supply for many low-level jobs.

IMPLICATIONS FOR FIRM-SPONSORED EDUCATION

Changing skill demands influence both the role of the formal educational system as well as the role of education or training that takes place at the workplace or is paid for by the firm. As this paper is concerned primarily with firm-sponsored education, I will only briefly outline some basic implications for the formal education system.

The Role of the Outside Education System

Employers generally state that they want workers who can read and write, who know basic arithmetic, and who have appropriate social skills. Although these skills have become most important, there is little controversy that schools should teach basic academic competencies.

The combination of new technology and accompanying changes and uncertainty in the economy create the need for more workers in lower-level jobs who have a stronger conceptual and abstract understanding not only of the new technology, but also of the production system within which they are working. Nevertheless, we do not know much about the magnitude of the current deficiency in this area. Moreover, despite growing research in the area among psychologists and educators,[28] it is not clear whether schools are the best places to provide an ability to operate at a more conceptual level, and if they are, how they can do it.

The shift to a more integrated and interactive production system suggests that schools should do a better job in teaching students how to cooperate and to work together. While this is not controversial at a superficial level, it is less obvious how to reform an educational system to achieve this. There is an active research program accompanied by demonstration projects in cooperative learning,[29] but this remains very much at the fringes of the education system. Moreover, the problem goes beyond the abstract ability to cooperate. A higher level of interaction increases both the potential scope of problems resulting from discrimination and the importance of basic socialization. And this creates additional barriers for high school dropouts especially in cities whose ties to the labor force are in any case weak. This at least increases the need for social support services to augment educational programs.

Firm-Sponsored Training

In general, the types of training provided by the firm can be grouped into six categories. Much of this training would be more efficiently carried out in the school system, but increasing demands for certain types of skills and competencies have forced many firms to try to compensate for the deficiencies of the outside education system. In the following section, I will describe each of the six categories and then discuss how each is affected by the changing structure of the work, in particular the growth of more compact production systems.

Basic reading and arithmetic. There is certainly no controversy that basic skills should be taught in school. But given the high dropout rates and high levels of illiteracy, some employers, whose needs for a more literate workforce have grown, have had to arrange for remediation for many of their employees. For example, textile and apparel firms that in the past were satisfied with a semi-literate workforce have turned to outside educational institutions such as high schools, community-based organizations, or community colleges rather than providing remediation internally. Literacy remediation is also provided in some cases in

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[28] See for example, Lauren Resnick, *Education and Learning to Think*. Washington, D.C.: National Academy Press, 1987.

[29] See Robert Slavin, et al., *Learning to Cooperate, Cooperating to Learn*. New York: Plenum Press, 1985.

conjunction with skills-upgrading programs in which employers have found that illiteracy has prevented students from learning the necessary technical skills.

Social skills and teamwork. In this case as well, employers expect that their workers will learn in their families, communities, and schools how to behave in group settings and how to work and interact with other people. But even when recruits arrive prepared in this sense, some supplemental training is often necessary, especially for employees who deal directly with customers. I have argued that employees at all levels have increasingly interactive relationships with other workers in the firm and even with employees and representatives of other firms. And in plants that have introduced team-based organizations, workers are usually sent to some type of orientation program that may last two or three days or may last a few hours a week spread over several weeks. Public educational institutions, at least so far, do not provide training in dealing with customers or working in groups. Moreover, firms use this process to impart company culture or build group cohesion. Therefore, firms either provide training in social skills and teamwork themselves, if they are large enough, or contract with training vendors or consultants.

Upgrading with a stable technology. Even when technology and work processes are not changing, growth or employee turnover create openings at all levels of a firm's workforce, but it is difficult to generalize about the role of firm-based education in filling these positions. Firms always have the choice to fill them through internal promotions or through outside hires, and the choice depends on a variety of factors including the available labor force and relationships among jobs in the internal job hierarchies. Upgrading that requires only small amounts of training is probably more likely to be carried out through internal promotions based on informal instruction. Changes requiring larger jumps are more likely to be filled by outside hires or, if by internal promotion, only after more formal training, sometimes in outside educational institutions. On the one hand, I have argued that the overall occupational data do not suggest a relative decline in middle level jobs into which lower level workers could be promoted. On the other hand, there are some examples of attempts to move away from internal promotions in banking, textiles, and apparel. These particular cases result from growing skill requirements for the jobs into which workers would be promoted, but there are also attempts to upgrade the lower level positions. This may therefore reduce the gap between the two levels of jobs and once again create more favorable conditions for internal promotions. In sum, the overall trend here is not clear.

Technical and other skills for new technologies and work processes. How do firms provide the new skills needed to operate, maintain, and manage new technology or new work procedures or organization? In practice, it is difficult to separate training for upgrading with a stable technology and training to teach skills for new technologies; nevertheless, it is useful to separate them conceptually. The two present different educational problems and may be most effectively carried out by different institutions. It is a central characteristic of the emerging economy that there is an increasing need for adaptation to a changing work environment. Of course it is always possible to replace employees when they acquire new technology, but

firms are reluctant to carry out this type of personnel exchange. In any case, most changes do not involve the wholesale replacement of factories or even departments but much more incremental developments. Although some new personnel may be taken on, it is likely that current employees will be given some training or instruction. To be sure, firms may need to go to outside vendors to provide the training, since they may not have the skills internally. The paper by Hong Tan prepared for this conference also suggests that employees in firms experiencing faster technological change are likely to receive more firm-based training.[40] In the case studies of textiles and apparel, I have found that this training is usually carried out by private trainers, consultants, software and systems developers, or equipment vendors. In contrast to upgrading with a stable technology, community colleges are less likely to play an important role here since they rarely teach about cutting-edge technologies or work processes. Even in those public educational institutions that are advanced enough to play this role, training for new processes or machines often involves specific information about the particular application. If a community college, for example, does provide training, it must do so in close coordination with the employer.

An understanding of the firm's overall operation, its place in the market and within the supply chain, and the role of the worker in the firm. I have argued that in more compact production systems, workers at all levels must have a stronger understanding of their role within the overall production process. The case studies of apparel and textiles have turned up a small number of examples of firms that are trying to provide their workers with this type of knowledge. Similar efforts are more widely reported in automobile manufacturing. But this type of training must either be provided by the firm itself or by consultants or vendors hired specifically for that purpose.

More specific knowledge about the firm's products and services and the customers that it serves. Employees who deal directly with clients or customers obviously have always had to know about the firm's products and services. The changes in the economy have changed this in at least four ways. First, a firm is now likely to sell more products and services at any one time, and those products are likely to change more often. Second, more people within the firm will be required to interact with individuals outside the firm or, at least in large firms, in other parts of the production process. Third, as noted above, in compact production systems, it is more important for workers to understand the overall production process in which they are involved, and knowing the products and customers is part of that overall understanding. Fourth, given the increasingly rapid market shifts, employees who have contact with clients (or even suppliers) must be more in tune with the operations of those clients so that they will be better able to react to the customers' shifting needs and problems. This type of information and knowledge must also be provided by the firm or a vendor or consultant hired by the firm.

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[40] Hong Tan, 1988.

CONCLUSION

The changing technology and economic structure have increased the need for all six types of skills listed above. With the possible exception of training for upgrading in a stable technology, firm-based training has probably also increased in all of the areas. The training that firms provide in basic skills and in some types of social and behavioral skills would be better accomplished in the outside educational systems, although even with more effective schools, firms will have to pay increasing attention to how their employees work together and interact. For the other categories of skills and knowledge--skills for new technologies and work processes and a better understanding of the overall production process and of the firm's products and markets--there is clearly a central role for firm-based training. Moreover, the changing structure of the economy and the increase in the use of compact production systems make these types of skills more important.

In an economy that puts an increasing premium on innovation in both products and production processes, the firm-based training and education (or at least training closely coordinated with the firm) has an additional advantage. The process of innovation can increasingly be integrated with training. For example, the training provided to teach workers about a new work process can also be used to determine how that process might best be applied to the firm's particular needs. Seminars given to discuss products can be used to develop new products or to generate ideas about how changes in the products might improve the process used to produce them.

Thus firm-based education will play an increasingly important role in the preparation of the country's workforce. If the relationships between firms in the production system are increasingly complex, it is not surprising that work-related education, as an integral part of that production system, would also be drawn more tightly into that sphere. Indeed, the on-going transformation of markets and technology in the economy is challenging the traditional distinction between work and education or learning. Employees at all levels of the firm will be increasingly engaged in a continuous process of learning. Firms must be sure that they provide adequate formal training to keep experienced workers and new recruits current, but work procedures and day-to-day workgroup activities should be designed in such a way as to promote learning and innovation. As the economy moves into a new and challenging era, firms that can make learning an integral part of work will have a strong advantage in both the product and the labor market.

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