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ABSTRACT

Changes in skill requirements, training needs, the industrial and occupational mix of employment, and the spatial location of jobs are 'natural' consequences of a dynamic economy. These changes, in turn, influence employers' hiring and staffing patterns, workers' career paths, and economic growth and development. However, the evolving nature of production processes and technological change have not figured prominently in the development and implementation of policies regarding the preparation of the work force of the future. This paper presents a new perspective: "skill-training life cycle," which evolves as the level of demand and standardization of skills change with the development of a technology, including the steps of introduction, growth, maturity, and decline. This life-cycle framework in general, and the skill-training life cycle, in particular, suggest a wide range of human resource policy implications for employers, educators and economic planners. Different, although interrelated, roles for employers, schools, and other providers of education and training emerge over the course of the skill-training life cycle. The following three work force development topics are illustrative of these evolving responsibilities: (1) providing new and emerging skills; (2) anticipating skill obsolescence and plant closings; and (3) balancing short-term and long-term work force needs. (ABL)

Evolving Responsibilities in Work Force Development: Incorporating the Dynamics of Change

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Introduction

Changes in skill requirements, training needs, the industrial and occupational mix of employment, and the spatial location of jobs are 'natural' consequences of a dynamic economy. These changes, in turn, influence employers' hiring and staffing patterns, workers' career paths, and economic growth and development. The ramifications of these phenomena are pervasive: they affect local as well as regional and international markets, high-technology as well as mature industrial sectors, economically depressed as well as "boomtown" economies, and high-skilled as well as low-skilled and unskilled workers.

Yet, in spite of their impacts on labor markets, the evolving nature of production processes and technological change have not figured prominently in the development and implementation of policies regarding the preparation of the work force of the future. Moreover competitive advantages of different education and training institutions suggest that public policy in the United States has traditionally been expecting the schools to do too much in terms of preparing the work force, while other, often large, providers of skills -- e.g., employers, union apprenticeship programs, the military and government training programs -- are not given enough attention.

Uncertainty is a key factor contributing to the failure to incorporate the dynamics of change into human resource development policies -- uncertainty that extends even to interpretation of the findings of the vast literature on the effects of technological change at the workplace. One can find evidence to support almost any thesis. Technological change is found to result in "deskilling", that is, the simplification of tasks, in some instances, but the creation of relatively high-level skills needs in others.[1] The average level of skill has been shown to increase after the introduction of technological change in some firms, but remains constant or decreases in others.[2] Similarly, net employment has been shown alternatively to increase, decrease or remain constant in firms that have adopted technological change.[3] Workers, too, are found to experience diverse effects from technological change.[4] Some workers benefit through upgrading or promotion, and some by being newly hired by the adopting firm. Other workers are downgraded, laid off, or forced to relocate in order to remain with their employer.

Much of the confusion over the impacts of technological change stems from the fact that studies are often conducted at such high levels of aggregation that the actual effects of the changes are masked. This aggregation problem has two dimensions. First, the skill and job impacts of technological change are fundamentally firm-level phenomena. The variety of experiences of employers are often concealed in industry- or nation-wide studies. Second, aggregation in which technologies and product lines at different stages of development are viewed collectively, fail to portray the actual processes of change.

The most relevant and comprehensive data on the effects of technological change are found in case studies on individual firms. While the use of detailed case studies limits quantitative assessments and forecasts of the effects of technological change, this level of disaggregation permits an in-depth view and analysis of the process of change not otherwise possible. As they usually lack a theoretical underpinning and are often viewed as "special cases," however, individual case studies have been found of limited value in explaining the impacts of technological change on a larger scale.

This paper presents a new perspective for developing human resource policies -- a perspective that incorporates the findings of over 200 enterprise-level case studies viewed systematically in the framework of production life cycles. A "skill-training life cycle," identifying common patterns in skill and training needs as products and technologies evolve is delineated.[5] While "new" to the firm, the technology in many cases is in later stages of its development when introduced at the workplace. This distinction in timing proves critical to the understanding of the differential impacts of technological change on skills and jobs.

When viewed in the production life-cycle framework these data help reconcile many of the inconsistencies of previous research. In addition, this dynamic approach allows one to pinpoint those places in the skill-training life cycle in which various public and private sector policies are likely to be most effective.

The following section provides a summary of the skill-training life cycle. Thereafter, the implications of these patterns for discerning institutional responsibilities for human resource development are addressed.

The Skill-Training Life Cycle

A skill-training life cycle evolves as the level of demand and standardization of skills change with the development of a technology. (See Chart 1) The early stages in a technology's life cycle, characterized by a high degree of product innovation, are relatively skill- and labor-intensive.[6] Engineers and scientists are needed to develop new products, construct pilot models, and implement design changes. These professionals also perform most of the tasks that later on will be done by production and marketing managers, technicians, skilled craftsworkers, assemblers, and so forth. A lot of work is done by hand during this period. Equipment that is used at this stage of a technology's development is general-purpose in nature and requires skilled operatives able to adapt the equipment to the individual company's needs. These operatives are required to perform a wide range of tasks and to adjust to frequent changes. When equipment becomes more complex and specialized as a technology matures, some relatively high-skill maintenance and

Chart 1 The Skill-Training Life Cycle

	I Introduction	II Growth	III Maturity	IV Decline
Tasks	Complex	Increasingly routinized	Segmented	Segmented
Job Skills	Firm-specific	Increasingly general	General	General
Skill training provider	Employer of equipment manufacturer	Market-sensitive schools and colleges	Schools and colleges more generally	Declining number of schools and colleges; some skills provided by employer
Impact on job positions	Job enlargement; new positions	Emergence of new occupations	Relatively rigid job hierarchy; occupations associated with formal education and work experience requirements.	Elimination of occupations

Adapted from Patricia M. Flynn, Facilitating Technological Change: The Human Resource Challenge, Cambridge, MA: Ballinger Publishing Company, 1988, p.19.

repair tasks can also be expected.

As technologies mature, standardization and the expanded use and complexity of equipment permit a greater division of labor and the subdivision of multi-faceted tasks into more narrowly defined assignments.[7] As tasks become "deskilled," the workers' skills, experience, and independent decision making become less important. The tasks of semi-skilled operatives, for example, often shift to monitoring and control of the equipment. In addition, product assembly can be done by low-skilled and unskilled workers who concentrate on a relatively limited number of specific tasks. Skills, once embodied in the work force, are transferred to the production equipment.

Tasks across the whole skill spectrum are vulnerable to the deskilling process. Professional and technical jobs and skilled crafts work can be simplified or eliminated, as can the tasks of lower-level clerical and assembly workers. Empirical evidence suggests that the skill level of the tasks being simplified is inversely related to the degree of standardization of the products and the production processes. When equipment is initially introduced into small-batch production, for example, high-skill handicraft work such as that of machinists and welders is simplified or eliminated. The automation of routinized assembly functions, in contrast, eliminates relatively unskilled tasks.

As the nature and demand for job skills evolve, the availability of skill training and the mix of institutional providers vary. When a technology is new, skill training is usually provided on the job or in programs at the workplace. In the earliest stage of a technology, scientific and engineering personnel design and create a variety of experimental products. Subsequently they teach others what needs to be done for small-batch production.

After a technology becomes more widely adopted and equipment standardized, skills that were once "firm-specific" become "general" skills that are transferable among employers. As with products, increased demand and standardization of skills permit their "production" on a larger scale and at locations away from the R & D sites. Employers are less able to capture the return on investments in general, as opposed to firm-specific, skills and generally prefer that such training be provided in the schools, where the government or individual students will pay for it. Moreover, as demand for such skills grows, it is easier to formalize the training and to provide it in the schools. Together, these two forces encourage the shift of skill development from the workplace to the formal education system as technologies mature. Computer programming, keypunching, word processor training, and the setup and operation of numerical control equipment are classic examples of this transfer.

Over time, training responsibilities also shift among components of the education and training network outside the workplace. Schools and colleges, for example, differ widely in their missions, funding arrangements and decision-making procedures. As a result, types of training are diverse as are the manner and time frame in which the institutions respond to labor market changes. Institutions that are "labor-market sensitive" will respond initially as training shifts from the workplace to the schools. As demands for the skill mature, training becomes more widely diffused among educational and training institutions. One can trace the provision of computer programming skills, for example, from four-year colleges and universities, to two-year colleges and technical institutes, to vocational schools, to comprehensive high schools. The history of the provision of electronics skills follows a similar pattern.

As old technologies become obsolete, training focuses on replacement needs and on the retraining of workers for other fields. A limited market for skills and declining student enrollments result in the termination of various occupational training programs in these fields and the responsibility for training to fill relatively short-term, skilled replacement needs shifts back to the firm.

In the shoe and apparel industries in New England, for example, employers now train their own stitchers. The relatively older work forces in these industries have been retiring at high rates in recent years, however, hiring trained workers to fill these skilled positions has been virtually impossible. Schools in the area offer little, if any, job-related training for these needs as related labor demands have been falling for years. Even cooperative arrangements with schools, whereby employers have donated time, money, equipment and instructors, have proven unsuccessful at this stage as programs failed to attract students. School officials indicate that students and their parents view training for these "declining industries" as highly risky, and at best a short-run employment strategy. In fact, employers in these industries indicate that they, too, have discouraged their children from entering these fields.

Beyond skill requirements and training needs, the skill-training life cycle helps to understand the evolution and development of occupations and job structures. The unsettled environment surrounding the adoption of an emerging technology encourages firms to incorporate the newly created tasks into "enlarged" existing jobs rather than add new types of positions to job hierarchies. In contrast, as technologies mature, declining uncertainty regarding the quality and quantity of skill requirements, and increasing demands for such skills promotes creation of a more well-defined set of occupations.

Taking this process one step further, the skill-training life cycle suggests that as technologies mature, a growing proportion of the better positions created by technological adoptions will be filled by workers from outside the firm. In the early stages of development of a technology, the relative importance of "job enlargement" and a lack of appropriately trained workers, favors the selection and retraining of current employees to perform many of the new tasks. At later stages, current workers are more likely to be bypassed as individuals trained outside the firm are hired to fill the better jobs created by the technological change. Moreover, as schools and colleges take over the training responsibilities in these fields, educational credentials become associated with particular skills and occupations. Previously established internal job ladders are jeopardized as formal educational requirements or related work experience become criteria for certain skilled positions.

Policy Implications

The life-cycle framework in general, and the skill-training life cycle, in particular, suggest a wide range of human resource policy implications for employers, educators and economic planners. Overall, they accentuate the need for policies for both the "up side" and the "down side" of technological change. Failure to adapt to the newly created skill needs generated by technological change can restrict the productivity of workers and of firms, undermining industrial competitiveness and economic growth. Failure to minimize the negative impacts of such change, as jobs are simplified or eliminated, can further constrain the benefits of technological progress.

Different, although interrelated, roles for employers, schools, and other providers of education and training emerge over the course of the skill-training life cycle. The following 3 work force development topics are illustrative of these evolving responsibilities: (1) providing new and emerging skills; (2) anticipating skill obsolescence and plant closings; (3) balancing short-term and long-term work force needs.

(1) Providing new and emerging skills. Demands for new, highly skilled labor created by the adoption of new technologies appear to be relatively small quantitatively compared to total employment needs. Anticipating new and emerging skill requirements, however, is particularly difficult: they do not appear in past employment trends, not can they be identified by traditional forecasting techniques. Employment projections frequently used to guide occupational education in the schools are best able to indicate growth and replacement needs in more traditional industries with relatively stable products and technologies. They are least effective in anticipating "turning points" in employment, training gaps in areas of emerging skill needs, or sudden spurts in employment growth

Schools cannot prepare workers for the most advanced skills in companies at the forefront of technological change. On-the-job training and employer-sponsored training programs are critical for the determination and acquisition of skills required in emerging fields. When skills are firm-specific, or when there is considerable uncertainty regarding the demand for various skills -- schools should not be pressured into providing these skills. However, training can and should be transferred to the educational system as a technology develops, as demands for new skills expand, and as skills become more general and transferable among workplaces.

The skill transfer process from the workplace to the schools as technologies evolve could benefit from closer coordination between employers and other education and training institutions than has occurred in the past. Studies show, for example, that active cooperative education programs help facilitate the skill transfer. Educators initiate and monitor the programs, but the acquisition of job-related skills takes place on equipment at the workplace. When the time comes for the schools to pick up more of the skill training, the process is relatively smooth as the educators and employers had been working together all along.

In recent years public policy has tried to move in directions that should favor a greater understanding of how changing skill needs or workers and employers can be better integrated. For example, the Perkins Vocational Education Act and the Jobs Training Partnership Act have more actively promoted industry-school partnerships and public-private cooperation and coordination. Given their relatively low funding levels, however, it seems unlikely that these programs will bring about significant change.

(2) Anticipating skill obsolescence and plant closings. In the production life cycle framework, skill obsolescence, plant closings and worker displacement are seen as "natural" consequences of technological progress. Rather than trying to prevent these events, policies should be geared toward integrating change and facilitating the readjustment of workers caught in the transition. The life cycle model suggests the need for an on-going retraining capacity even in prosperous times.

The bulk of retraining in the United States occurs at the workplace -- thus plant closings and mass permanent layoffs impede the process whereby most workers are retrained for alternative employment. The pending plant-closing legislation, mandating 60-day employer notice to workers prior to large-scale layoffs, will provide considerably more time than public officials have usually received in the past to implement programs for re-employing workers displaced from their firms.

This plant-closing legislation should not, however, be viewed as a panacea for displaced workers. In communities with limited alternative employment opportunities, for example, re-employment problems will continue as most workers in the United States are reluctant to relocate their homes and families. In addition, those workers most in need of retraining may well require assistance beyond a 4-to-6 week period.

The skill-training life cycle provides guidance in assessing the likelihood and nature of skill obsolescence over time. It suggests the need for public officials to better understand the firms and jobs that make up the local employment base, and to seek to anticipate major structural changes before being faced with large-scale layoffs and plant closings. Local planners should be addressing questions such as. What types of products and product lines are major employers involved with? What kinds of production activities are taking place in local plants? Which skill areas are experiencing declining demands and why?

More generally, production life cycle models suggest that education and training policies should be a cornerstone of a more broadly-based economic development strategy that recognizes the importance of a diversified employment base. The vulnerability of a particular community or region to the destabilizing effects of technological change depends on the area's mix of businesses and industries. A diversified employment base mitigates the likelihood of significant swings in an area's economic activity over the course of technological change and industrial development. Diversification provides alternative local job opportunities to counteract the deskilling process and job shifts to other locations. In contrast, an area whose employment base is dependent on a small number of products or a group of firms with production activities requiring similar skill needs is at high risk of experiencing the negative side effects of technological progress.

Common sense suggests a policy of industrial diversity, however, market forces can generate the opposite result. The success of a booming, dominant industry, for instance, can "crowd out" alternative employment and accelerate the departure of traditional manufacturing from an area. In Massachusetts, for example, labor shortages, particularly in the blue collar and clerical fields, attributable to the growth of high technology firms, have been spilling over into other sectors less able to compete for workers in terms of both wages and image. At the same time, replacement needs of employers in the more traditional industries are becoming increasingly more difficult to meet, as training programs in these fields take a back seat to skill training for the fast-growing, newer industries.

While new and emerging businesses and industries can provide the stimulus for reindustrialization, jobs in more traditional

sectors continue to comprise the bulk of employment in local communities. Public policy needs to address potential human resource "spillover" effects that could impair the competitiveness of established employers and prompt their "premature" departure from the area.

(3) Balancing short-term and long-term work force needs. The life-cycle framework underscores, more generally, the need for public policy to reflect a sensitivity to distinctions between short-run and long-run employment conditions, to guard against being so "labor market responsive" as to undermine long-term economic growth and the ability of workers to adjust to structural changes over time.

In recent years, many states and regions have sought to attract firms -- particularly in high technology fields -- by promising "tailor made" or custom-designed, work forces. Public programs offering employers a work force tailored to meet their relatively specific production needs, tend to reduce worker flexibility in the labor market. Programs geared to youths, in particular, need to be broad enough to prepare them to work in a variety of situations.

Policy makers need to assess the trade-offs of various policy options before implementing new programs and policies. Similarly, there is a need to recognize that the time frame in which planning and evaluation decisions are made differs between educators and employers -- with that of the latter generally far shorter than that of the former. Moving quickly in response to employer requests to alleviate skill shortages may foster skill mismatches in the future. Under the immediate pressure of unfilled jobs, it is tempting to implement quick and ambitious programs to expand the supply of trained workers, rather than relying on employers to solve some of their immediate staffing difficulties through changes in recruitment and internal training practices. Ample evidence suggests caution against rapid installment of programs to build up skill supplies unless the shortage is large and continued demand can be demonstrated.[8]

The skill-training life cycle provides guidance in developing ways to integrate the dynamics of change into human resource development policies and programs. It highlights distinct, but evolving and complementary roles of institutions in preparing the work force of the future. It suggests that schools and public officials have much to learn from human resource development professionals at the workplace, particularly in terms of defining skill requirements in new and emerging fields, and of understanding hiring and staffing practices of employers. It also suggests that human resource professionals within firms can benefit from greater understanding of the functioning of various types of labor markets and of the diversity among components of the occupational education and training network outside the firm.

Endnotes

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