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ABSTRACT

One possible reason for ambiguous findings regarding changes in work skills is the way work skills are defined and measured. Five conceptual bases for defining work skills are illustrated in the research literature: abilities of individuals, behavior requirements of jobs, ability requirements of jobs, behaviors exhibited at work, and abilities exercised or used at work. Outside of the field of psychology, issues about the dimensions of skills have not received great attention. No universal taxonomy for defining the dimensions of work skills exists. Issues of measurement differ depending on whether the focus is on measuring skills of individuals or measuring skill requirements of jobs. Much interest in work skills concerns issues of change. Existing evidence, based on both large-scale assessments of skill changes and case studies, yields no firm conclusions about whether skill requirements of jobs are changing and, if so, in what ways. One way to further understanding of skill changes is to understand how various forces interact to influence skill requirements. Steps to help improve understanding of work skills and how they change are as follows: (1) studies of job skills should be based on comprehensive measures of both the qualitative and quantitative dimensions of work skills; (2) the concepts and measures of work skills should be applied both to capabilities of individuals and requirements of jobs; and (3) future research should attempt to develop a more complete model of the forces affecting job skill requirements. (Contains 77 references.) (YLB)

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CONCEPTUAL AND METHODOLOGICAL ISSUES IN ASSESSING WORK SKILLS:
A MULTI-DISCIPLINARY ANALYSIS

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Abstract

A major issue of concern to both scholars and a broad community of business, education, and government leaders is whether work skills are increasing or decreasing as a result of technological change, international competition, and other economic forces. To date, evidence on this issue from the research community is ambiguous. One possible reason for such inconclusive findings is the way work skills are defined and measured. This paper reviews the major conceptual and methodological issues about work skills, drawing on the literatures of psychological, sociology, and economics. While these issues are not easily resolved, they must be addressed in any study attempting to ascertain how skills and skill requirements of work change over time.

Issues about work skills have commanded increased attention in recent years from both the scholarly community and a broad community of policymakers, educational practitioners, and business leaders. Interest in the scholarly community, which includes sociologists, economists, and other social scientists, has focused on such issues as trends in the skill level of jobs, the determinants of such changes, and the consequences for individuals and the larger society. A specific example of such interest is the continuing debate concerning Braverman's thesis that capitalist development leads to a secular decline in the skill requirements of jobs (e.g., Braverman 1974; Wood 1982; Spenner 1985; Adler 1986; Attewell 1987; Form 1987).

Interest in issues of work skills among policymakers and business leaders stems from practical concern over two forces that are shaping our economy: technology and international competition. It is widely perceived that computers, robots, and other new technologies are transforming our economy and altering the level and kinds of skills required in the workplace. In addition, the U.S. economy is facing increased competition from both industrialized and developing countries and must respond to this challenge, in part, by raising the skills and productivity of American workers. Within the education community, these concerns have prompted widespread reforms at both the elementary/secondary and higher education levels in an effort to better prepare today's students for a productive role in the

future U.S. economy.

Although the dominant view outside the scholarly community is that the requisite skill levels of jobs are rising, largely because of the widespread adoption of new technologies, existing research fails to support such an unequivocal view. A major review of the research literature on the impact of technology prepared for the National Academy of Sciences states that research "...suggests an uncertain, complicated and contradictory relationship between technological change and the skill requirements of work" (Spenner 1986, p. 1). The Academy itself concludes in its recent report:

...the empirical evidence of technology's effects on skills is too fragmentary and mixed to support confident predictions of aggregate skill impacts. Despite this uncertainty, however, the evidence suggests that the skill requirements for entry into future jobs will not be radically upgraded from those of current jobs (Cyert and Mowery 1987, p. 103)

Other reviews of both case studies and aggregate analyses also suggest complicated and contradictory changes in the skill requirements of work (Rothwell and Zegveld 1979; Spenner 1985; Flynn 1988; Rumberger 1987a).

One reason the existing research literature presents a such mixed view is that technology and other workplace changes may affect work skills in different ways depending on conditions and characteristics of the firms where the changes are introduced. For example, a recent study of firms that use the same automated manufacturing technology found major differences in the amount and type of labor employed between Japanese and U.S. firms

(Jaikumar 1986). Such evidence supports a more agnostic view that changes in skills have no predetermined direction, but rather depend on a host of specific and perhaps conflicting influences that may result in either the upgrading or downgrading of work skills.

Another reason for inconsistent research findings may have to do with the way work skills are defined and measured. Research on work skills can be found in at least three major social and behavioral science disciplines: sociology, economics, and psychology. In general, research in each of these disciplines is based on different conceptions of skills and different methods for measuring them. While it is unlikely that the various scholars working in this field will ever reach a consensus over the proper definition and measurement of work skills, future research may benefit from a broader, multi-disciplinary perspective of the major conceptual and methodological issues that confront any study of work skills.

The most fundamental issue concerns the conceptual basis for defining work skills. Work skills can be defined primarily as attributes of individuals, as attributes of their jobs, or as work outcomes that could be influenced by both. Skills as human attributes denote the ability to perform specific tasks and activities. Yet some scholars argue that it is possible to assess the skill requirements of jobs independently of the skills of the people that hold them. Moreover, it is interplay between the skills of individuals and the skill requirements of their

jobs that influence such important work outcomes as job satisfaction, productivity, and wages (Kalleberg and Sorensen 1973; Tsang and Levin 1985).

Another conceptual issue concerns the dimensions of work skills. Much of the research literature and most of the policy debate are based on a uni-dimensional concept of work skills. Both jobs and individuals are frequently characterized as high-skilled or low-skilled, without any attempt to acknowledge the various dimensions of work skills. Yet, psychologists in particular, have spent considerable effort in developing detailed taxonomies that attempt to capture the various cognitive, physical, and affective dimensions of work skills (e.g., Dunnette 1983; Fleishman and Quaintance 1984). A multi-dimensional view of work skills may be particularly useful if technology, work organization, and other forces have different impacts on different dimensions of skills.

Related to the issue of defining the dimensions of work skills is selecting the correct terminology for encompassing the broad array of human characteristics related to work performance. The following terms have all been used to define this array: skills, capacities, abilities, attributes, traits, and characteristics. Sometimes these terms are used interchangeably; yet these terms can denote a broader or narrower array of characteristics. Skills, when used to denote those characteristics that can be acquired through formal education and training programs, is perhaps the most narrow, while attributes

or traits, which include personality and other characteristics not learned in school, are perhaps the broadest terms. In the remainder of this paper, these terms will be used interchangeably, although the issue of specificity remains.

Methodological issues have also plagued past research studies. Many studies, whether focusing on individuals or jobs, have relied on indirect measures of work skills. In economic and sociological research, years of formal schooling often serves as a proxy for individual skill levels, while wages often serve as a proxy for the skill requirements of jobs. Studies based on more direct measures of work skills, such as individual test scores or actual assessments of job requirements, suggest that indirect measures of work skills provide an incomplete and even misleading picture of the complex relationships among individuals, their jobs, and work outcomes. Recent research suggests, for example, that wages reflect both the skills and abilities that individuals bring into their jobs and the characteristics of the jobs themselves (Hartog 1980; Rumberger 1987b; Tsang 1987).

Another methodological issue concerns measuring different levels of work skills. Work skills can differ quantitatively as well as qualitatively. The quantitative dimension is supposed to reflect skill differences in the level or "amount" of skill within the same area, such as differences in upper body strength. While in some areas differences in skill levels may be quite apparent and easy to measure, in other areas such differences may be less clear and thus more difficult to measure. Skill levels

in the social domain, such as interpersonal skills, may be much more difficult to ascertain than psychomotor skills. Measures of skill levels are also difficult to compare across various skill dimensions.

The purpose of this paper is to identify and analyze these and other conceptual and methodological issues involved in the assessment of work skills. The paper addresses these issues by drawing on the research literatures of sociology, economics, and psychology. The intent of this analysis is not to resolve these issues, but to provide a comprehensive review of the major issues that cross disciplinary boundaries.

Conceptual Foundations for Defining Skills

The most fundamental issue in studies of work skills concerns the conceptual foundation for defining skills. Several distinct conceptual foundations have been used in the research literature to study issues of work skills. They differ in two respects: first, whether work skills are considered primarily as attributes of individuals, as attributes of jobs, or as work outcomes that could be influenced by both individual and job attributes; second, whether skills are characterized primarily in terms of work behaviors, which reflect the duties and tasks people perform when they work, or in terms of generic human abilities that enable people to perform those duties and tasks.

These differences have yielded at least five conceptual bases for defining skills in the existing research literature.

These concepts of skills are related to each other and to a variety of other work-related activities and characteristics (Figure 1). Yet they remain distinct and that distinction is important to understanding the measurement of work skills and to fully understand the work process itself.

Skills as Attributes of Individuals

One conceptual basis for defining work skills is based on the notion of work skills as attributes of individuals. In this conception, skills are defined in terms of human abilities, specifically those abilities that enable individuals to perform the duties and tasks associated with work. This concept of skills is a natural one, since skills are, first and foremost, human qualities. Thus it is well recognized in the social and behavioral sciences as an important factor to consider in understanding a variety of work-related activities and outcomes.

In economics, for example, human capital theory views skills as arising from investment decisions of individuals, primarily through formal schooling, that influence their productivity and wages. As Becker (1964, p. 86), one prominent architect of that theory, states, "...education has little direct effect on earnings; it operates primarily through the effect on knowledge and skills." Most social scientists equate formal schooling with skills, as human capital theory posits, although some question whether skills are actually developed in schools or whether schools merely select and certify individuals based on pre-existing skills (Berg 1970; Taubman and Wales 1974; Collins

1979).

Work skills encompass all human abilities that aid in the performance of work activities. Those abilities that are applicable to a wide variety of work activities are referred to as general work skills, while those abilities applicable to only a limited number of jobs or a specific firm are referred to as specific work skills (Becker 1964). It is the definition and measurement of generic work skills that has commanded the attention of so many researchers.

Skills as Attributes of Jobs

Another conceptual approach to defining work skills is based on the fact that most work in contemporary society tends to be organized into discrete units called jobs. A job is simply a set of duties and tasks performed by one individual. The duties and tasks associated with any particular job are determined by the technical requirements of the production process and the way the production process is organized in the firm where the job resides. Although, in theory, every job could involve a unique set of tasks, jobs associated with a set of duties and tasks that are fairly similar across firms and industries are referred to as occupations and often given similar titles. The occupations called secretaries, engineers, and machinists, for example, are commonly used and associated with particular kinds of jobs and tasks. Occupations can denote a relatively narrow and specific set of jobs and tasks, such as legal secretary, or very broad and general set of jobs and tasks, such as office occupations.

The notion of jobs has played an important part in the research literature on work within several academic disciplines. Although many neoclassical economists often do not specifically recognize the notion of jobs, other economists, including proponents of "institutional" and labor market segmentation perspectives, argue that the notion of jobs is useful in understanding the operation of the firm and various work outcomes (e.g., Reich, Gordon, and Edwards 1973; Kerr 1977). In sociology, status attainment research is based on a division of labor arising from the "functional requirements of jobs" (Featherman and Hauser 1978, p. 12). And industrial psychologists recognize the importance jobs play in influencing workplace behavior and attitudes (McCormick 1979).

The notion of jobs gives rise to two additional conceptual bases for defining work skills. One is based on the behavior requirements of jobs, or what individuals are supposed to do in performing their jobs. Work skills in this case are typically assessed through written job descriptions of the principle activities and duties to be performed by the job incumbent. Differences in work activities are often assumed to reflect differences in human abilities needed to perform them. For instance, the activities of a surgeon are very different from the activities of a janitor and are thus supposed to reflect differences in work skills involved in performing the two sets of activities.

The problem with behavior-based conceptions of skills is

that quite distinct and seemingly different activities may involve quite similar human abilities to perform them. Moreover, there is often an implicit assumption that certain kinds of activities are inherently more-skilled than others. Historically, for example, it was often assumed that white-collar occupations involving "mental" activities were generally higher skilled than blue-collar occupations involving "physical" activities (Mills 1951).

Another job-related basis for defining work skills is based on the abilities required by the job incumbent to perform the tasks associated with the job. Skills, in this instance, reflect the functional requirements of the job, not the skills of the job incumbent. The two may not be the same, either because labor markets may not effectively match workers with particular skills to jobs where those skills are required or because employers may not fully utilize the skills of their workers. This suggests that there could be a discrepancy between the skills that workers possess and the skills that their jobs actually require. Such discrepancies have been referred to as overeducation, underemployment, or surplus schooling (e.g., Freeman 1976; Clogg 1979; Rumberger 1987b).

Skills as Work Outcomes

Two additional conceptual bases for defining work skills are based on skills as work outcomes, whether work outcomes are largely influenced by individual attributes (skills possessed), by job attributes (skills required), or a combination of the two.

One is based on the behaviors that individuals exhibit in their work, primarily the activities and duties people actually perform. The other are the skills that people actually utilize to perform their activities and tasks.

Both of these notions are premised on a belief that what people actually do in their work or the skills that they actually exercise are distinct both from the skills that people possess and the skills and behaviors that their jobs may require, at least before they are placed in them.

Choosing a Conceptual Foundation

This discussion has identified five distinct conceptual foundations for defining work skills. Skills have been identified in terms of: (1) abilities of individuals, (2) behavior requirements of jobs, (3) ability requirements of jobs, (4) behaviors exhibited at work, and (5) abilities exercised or utilized at work. Each of these has been used as a means for measuring skills and as a means for addressing research questions on skills. But which one is the best or most appropriate?

The answer depends, in part, on the particular research questions to be addressed. To address questions about the nature of skills generally or about the level and types of skills that people bring into the workplace, then the concept of skills as abilities of individuals is most appropriate. Hence, much of work undertaken by psychologists on the nature of intelligence and means for measuring it have focuses simply on the mental capabilities of individuals.

To address questions about the nature of jobs and differences among them, concepts of skills based on the behavioral or skill requirements of jobs are most appropriate. Thus much of the descriptive work on occupations and occupational differences are based on information about the stated duties and activities associated with various job roles. Moreover, different kinds of activities and jobs are often grouped into categories that are said to reflect skill differences, such as the common notion that "white-collar" or office work is more skilled than "blue-collar" work (Braverman 1974).

When research questions are limited to issues about individuals or jobs, conceptions of skills tied to these domains are appropriate and uncontroversial. What is more controversial and less clear is the choice of an appropriate conceptual basis for defining skills to address questions about work outcomes. Both individual-based and job-based conceptions of skills have been used to address questions about a wide variety of work outcomes.

In general, individual-based conceptions have dominated past research. For example, the dominant paradigms in both economics--human capital theory--and in sociology--status attainment theory--explain differences in workplace productivity, earnings, and status attainment largely in terms of individual differences in education and other indirect measures of individual skills (e.g., Becker 1964; Featherman and Hauser 1978). Similarly, in field of psychology, proponents of validity generalization claim

that standardized ability tests, which provide a more direct measure of individual skills, are able to predict effective work performance in virtually any kind of job (e.g, Schmidt and Hunter 1977).

Job-related explanations of work outcomes also exist in the research literature. Institutional economists have long maintained that wages and other work outcomes arise, at least in part, from the nature of jobs within firms and industries (Kerr 1977). More recently, Thurow (1975) has developed a theory of "job competition," where both productivity and wages are largely determined by jobs, not by the individuals in them. Institutional influences on wages has also been incorporated in dual and segmented views of labor markets developed by economists and sociologists (Wallace and Kalleberg 1981).

Conceptual foundations of skills based solely on individuals or jobs provide competing explanations for explaining work outcomes. In one view, skills are only recognized as characteristics of individuals since it is assumed that employers can freely substitute among workers and redefine jobs to fully utilize the skills of workers. In the other view, it is assumed that the tasks of jobs and hence job skill requirements are fixed regardless of the skill levels of workers.

Both views have been criticized for providing an incomplete view of work outcomes. Individual-based conceptions of skills have been criticized for ignoring the contributions that jobs, firms, and separate labor market segments make to the

determination of productivity and wages (e.g., Thurow 1975; Kerr 1977; Baron and Bielby 1980). And job-related conceptions of skills have been criticized for presenting an overly rigid and fixed view of jobs and markets that ignores the dynamics of change and the ability of individuals to shape the jobs that they hold (Dickens and Lang 1985).

Alternative approaches to understanding work outcomes have relied on multiple concepts of skills. The most common approach is based on the premise that both the skills of workers and the skill requirements of jobs influence work outcomes. Such an interactive approach has long been used by industrial psychologists to study a variety of workplace behaviors and attitudes (Vroom 1964; Peterson and Bownas 1982). For example, research has repeatedly demonstrated that job satisfaction is influenced by both the education level of workers and discrepancies between their education and the educational requirements of their jobs (Quinn and Mandilovitch 1975; Kalleberg and Sorensen 1973; Burris 1983).

More recently, economists have postulated models explaining worker productivity and wages as functions of individual skill levels and the skill requirements of jobs (Thurow 1975; Tsang and Levin 1985). And an increasing number of studies have provided empirical support for such models based on both U.S. and European data (e.g., Hartog 1980; Duncan and Hoffman 1981; Rumberger 1987b; Tsang 1987; Hartog and Oosterbeek 1988).

Empirical and theoretical literature within a number of

social science disciplines support the view that work skills associated with both individuals and their jobs are important in fully understanding work processes and outcomes. This view also implies that it is important to define and assess skills of individuals and the skill requirements of jobs independently. Yet in both cases it is important to have a suitable taxonomy for identifying the full range of skills that are utilized in the performance of work.

Dimensions of Work Skills

Outside of the field of psychology, issues about the dimensions of skills have not received great attention. Many empirical studies by economists and sociologists, for example, have relied on a single measure of work skills often measured indirectly, through such items as education or wages. Even more direct measures of skills, such as the notion of substantive complexity recently proposed by some sociologists (e.g., Spenner 1986; Form 1987), does not capture the substantial variation in work skills that can exist across jobs.

There are at least two reasons to argue for a more detailed, multi-dimensional view of work skills. First, some of the major determinants of skill changes, such as technology and work organization, may have differential effects on different dimensions of skills. For example, some recent research suggests that new technologies could reduce the physical demands of work yet could increase the conceptual demands of work at the same

time (e.g., Zicklin 1987; Kelley 1988). Second, in order to better prepare and train workers for jobs, it is necessary to know, in some detail, the nature of the skills demanded in the job market.

Qualitative Dimensions of Work Skills

The most comprehensive notion of work skills can be found in the psychological literature. Research on work skills is closely related to and often builds upon the more general concern of defining and measuring intelligence and aptitudes that has long been a central concern of psychologists. The major difference simply concerns one of application. While many psychologists study intelligence to develop more adequate theories or for predicting academic performance and achievement, industrial and organizational psychologists focus on those skills that contribute to effective work performance. In both cases it is necessary to define an adequate and comprehensive map of the skill domain.

Yet after years of research and thousands of studies, there still remains no consensus over what constitutes the domain of intelligence or of work skills (Pellegrino and Varnhagen 1987). That is, there exists no universal taxonomy for defining the dimensions of work skills.

One reason for a lack of consensus is that researchers have approached the tasks of identifying the dimensions of skill from different perspectives. Some (e.g., Harman 1975) have attempted to develop taxonomies of work skills from theories and taxonomies

of human intelligence, such as those of Thurstone (1938) and Guilford (1967). Theory-based taxonomies can vary widely simply because there are currently such widely different conceptions of intelligence among psychologists (Wagner and Sternberg 1984). Other researchers (e.g., Fleishman 1975) have developed taxonomies from longstanding empirical research programs that have attempted to identify new and unique human abilities related to successful work performance. The latter method dominates most research on characterizing the domain of intelligence and work skills. Even work-based taxonomies differ substantially because some attempt to define ability requirements directly, while others focus on work behavior and behavior requirements rather than skills and abilities directly (Fleishman and Quaintance 1984, pp. 50-57).

Another reason that taxonomies of work skills differ is that there is no logical limit on how many attributes or skills may be related to work performance. The same issue confronts the area of intelligence. Some psychologists believe that intelligence can be largely characterized by some single factor (e.g., Spearman 1927), while others have proposed more than 100 discrete factors (Guilford 1967). A related issue concerns the relationships among the various factors, including the notion of a hierarchical relationship between more primary or global factors and secondary or specific factors (Cattell 1971).

Taxonomies of work skills face similar problems. Any taxonomy should be comprehensive yet parsimonious, identifying a

minimal number of attributes that contribute to effective performance in all work settings. Each attribute should also be, at least to some extent, unique and independent of other attributes. One of the criticisms of the Dictionary of Occupational Titles, the most widely used source of information on skill requirements and other attributes of jobs in the United States, is that many of the measures of educational and aptitude requirements are highly correlated and thus appear to measure nearly identical attributes (Miller, et al 1980, Table 7-12).

Another way of thinking about this problem is in terms of specificity. Any taxonomy is composed of a series of attributes that, in turn, can have additional component parts. There is no correct level of specificity in any taxonomy. Many taxonomies, in fact, are derived initially from large numbers of traits and abilities that are then reduced to a more manageable number through a statistical technique known as factor analysis:

An interesting point is that the database for all theories [of aptitudes] is essentially the same. It is derived from performance scores on a number of specific mental tests administered to a large sample of individuals. Individuals' scores on each test are then correlated with scores on all other tests in the battery, resulting in a large intercorrelation matrix. The values in the matrix indicate how strongly individual differences on one test are related to individual differences on all other tests. Factor-analytic and other multivariate techniques are then used to attempt a mathematical reduction of this data matrix. The goal of such multivariate-analysis methods is to represent the underlying factors or aptitudes responsible for the entire pattern of correlations. (Pellegrino and Varnhagan 1985, p. 1).

The remaining discussion will highlight some of the major skill areas that have been defined and measured in the vast

research literature in this area. The purpose of this discussion will be to simply illustrate the range of skill types that have been identified in this literature. Comprehensive reviews of this literature and the various taxonomies that have emerged from it can be found elsewhere (Dunnette 1983; McCormick 1979; Peterson and Bownas 1982; Fleishman and Quaintance 1984).

Work skills can be grouped into three major domains: cognitive, physical, and social. These labels are not exact or universal; neither are the other labels used in this discussion to denote categories or groups of skills. They are simply used here to describe classes of work skills that may have more detailed component parts.

The cognitive domain is perhaps the most studied because it is most closely associated with the study of human intelligence and learning more generally. Thurstone (1938) began with a list of seven primary mental abilities that covered verbal comprehension, word fluency, number, space, memory, perceptual speed, and inductive reasoning. More recent studies by Harman and others at the Educational Testing Service (Harman 1975) and Fleishman and his associates (Fleishman and Quaintance 1984) have identified more than 20 attributes that can be grouped into four areas: verbal, mathematical, thinking, and perceptual. Names and definitions some of the detailed cognitive attributes developed by Fleishman and his associates are shown in Table 1.

The second major domain concerns attributes that involve physical capacities. This area is less widely studied than the

cognitive area, in part, because only certain kinds of jobs have extensive physical requirements. Yet for many production and military jobs, physical attributes are clearly important for effective work performance. Physical work skills can also be grouped into several areas, which can be labeled sensory, manipulative, and fitness. Names for some detailed physical attributes, again based on the work of Fleishman and his colleagues (Fleishman and Quaintance 1984), are shown in Table 1.

The third major domain covers social traits, those attributes that contribute to a worker's effective interaction with people at work. This area is generally the least explored in the research literature, although some psychologists, economists, and sociologists have argued for its importance in defining intelligence and determining job performance and wages (e.g., Gardner 1983; Gintis 1971; Kohn and Schooler 1983).

The social domain of skills may be more important for effective work performance now and in the future than it has been in the past. One reason is simply due to the growth of jobs in service-oriented sectors of the economy that involve dealing with people. Another reason is that many companies are adopting more participative forms of work organization that demand more social interaction among workers (Levin 1987).

At least three types of attributes can be identified within the social domain. One concerns interpersonal skills, those attributes affecting how people get along in the workplace. Fleishman and his associates have identified two attributes that

could be labeled interpersonal skills: social sensitivity and persuasion. Another area could be labeled leadership skills. Two leadership attributes--consideration and structure--were originally identified at Ohio State University and have repeatedly been shown to account for substantial differences in leadership behavior (Fleishman and Quaintance 1984, pp. 118-120).

The third type of attributes concerns personality or temperamental characteristics. Scholars have identified a wide range of personality characteristics that may contribute to effective work performance. Harman (1975) has identified 28 temperamental factors, while Browne and Howarth (1977) have suggested 15 personality characteristics, some of which are shown in Table 1. To date, however, there has been little external validation of these characteristics (Bownas and Peterson 1982, p. 85). Nonetheless, employers have repeatedly stressed that characteristics as punctuality and a good work attitudes are valuable qualities in productive workers (e.g., Wilms 1984).

Quantitative Dimensions of Work Skills

In addition to a qualitative dimension, signifying different types of abilities, skills have a quantitative dimension, signifying different levels of skills. The notion of skill level is widely accepted at both a policy and a research level. Many policy discussions, for example, characterize jobs as being either high-skilled or low-skilled. Among scholars, the notion of skill level is widely accepted, yet characterizing and measuring skill levels is also recognized as problematic and not

trivial.

As in the case of skill types, the notion of skill levels derives from work on human intelligence. Psychologists have long been interested in ways of defining and measuring differences in human intelligence. Early work concentrated on characterizing differences at an aggregate level. But along with the work on identifying different types of human abilities came the problem of identifying different levels of ability within each type.

The problem is that there is no clear distinction between skill types and skill levels. As we explained earlier, there is no consensus among psychologists as to the degree of inter-relatedness among ability types. To the extent that ability types overlap, then measuring an ability level in one area will involve measuring an ability level in an overlapping area. In fact, one of the major challenges in ability measurement concerns classifying a specific task ability by its appropriate type and level of general ability.

In some ability areas, distinctions between high-level skills and low-level skills appear more straightforward. In the case of verbal comprehension, for example, written material used to measure verbal comprehension can be readily classified into more complex material--such as long documents utilizing varied and complex language--and less complex material--such as short documents utilizing fewer and simpler words. In other areas, particularly in the social domain, distinctions between high-level abilities and low-order abilities are less clear.

The difficulty in distinguishing between skill levels and skill types also makes comparisons of skill levels in one area with skill levels in another skill area problematic. If one person is highly skilled in one area and another person is highly skilled in another area, it is difficult if not impossible to infer that one person, in general, is more skilled than another. A multi-dimensional view of skills also implies that general statements about changes in skills due to technology may be misleading if technology affects different skills in different ways.

The Measurement of Work Skills

Any discussion of the measurement of work skills must address two fundamental questions. First, how are work skills measured? Second, are the measures used reliable and valid?

In the case of work skills and intelligence generally, the measurement issue is closely tied to the conceptual issue since most schemes for classifying skills and abilities are empirically derived from performance measures on specific tests and tasks. In fact, in most cases the measurement of skills and abilities actually precedes their conceptualization and definition (Pellegrino and Varnhagan 1985, p.1). The process is sometimes more iterative, with researchers constantly moving back and forth between the conceptualization of general skills and abilities and the measurement of specific tasks (e.g., Fleishman and Quaintance 1984, pp. 312-327).

The interrelatedness between the concepts and measures of skills also complicates the issue of validity. If most taxonomies of work skills are empirically derived from performance on specific tests and tasks, there are no clear standards to measure the validity of the constructs that are derived from that procedure. That is, there are no ready standards to test concurrent validity of the skill measures. One method for establishing validity is to see how experts familiar with the abilities' constructs rate the validity of the measures for those constructs, which is referred to as face or content validity (Kerlinger 1973, Chapter 25). The other approach is to test the predictive validity of the skill measures--to see whether individuals with more of a measured skill perform better on some criterion task than individuals with less of the measured skills. In the case of work skills, predictive validity can be measured against performance on actual work tasks.

Issues of measurement differ somewhat depending whether the focus is on measuring the skills of individuals or measuring the skill requirements of jobs. As we stated earlier, though related, the two concepts of skills are distinct and present different problems of measurement.

Measuring the Skills of Individuals

The primary concern in measuring the skills of individuals is developing a suitable battery of tests to accurately measure the full range of abilities required at work. In the cognitive domain one of the most exhaustive of these efforts has taken

place over a number of years at the Educational Testing Service (ETS). Beginning with the work of French (1951) and ending most recently with the work of Harmon (1975), ETS has expanded and refined the definition and measurement of a wide variety of cognitive abilities. The latest effort yielded a list of 23 factors along with a series of tests used to measure them. A similar longstanding effort has been undertaken in the physical domain and more recently in the cognitive and social domains by Fleishman and his associates (Fleishman and Quaintance 1984). Other well-known test batteries for measuring human abilities include the General Aptitude Test Battery (GATB) and the Armed Services Vocational Aptitude Battery (ASVAB).

In most cases, measures of human abilities are based on an individual's performance on a series of tests and specific tasks that are supposed to require various human abilities to carry them out. The face validity of the performance measures that are used is established through repetitive experiments and judgments rendered by experts familiar with those abilities.

Establishing the face validity outside of the cognitive domain, where assessments may be more often made by individual evaluators rather than tests, is more problematic. Evaluators' assessments can be biased. This issue has been raised most specifically with respect to sex bias of individual skills, where at least some evidence suggests that evaluators rate the skill levels of male job holders higher than the skill level of equally-qualified female job holders (Trieman 1979, pp. 43-46;

McCarther 1985).

There have also been attempts to verify the predictive validity of such measures. In the case of work skills, predictive validity is established by seeing how well persons with measured abilities perform in various work settings. If the abilities that are measured represent a comprehensive set of the abilities that are required in a particular work setting, then measures of work skills should be able to predict effective work performance.

Comprehensive reviews of previous validation studies suggest that tests of abilities have moderate success in predicting job performance (Ghiselli 1966, 1973). The predictive validity of ability tests varies depending on the type of ability being measured and the type of job being evaluated. Most of these earlier studies only examined a few of the many work-related abilities that have been identified in most comprehensive taxonomies (e.g., Fleishman and Quaintance 1984, Chapter 12). Thus we would expect the overall predictive validity to ability tests to increase as the range of measured abilities is increased. Of course, as we pointed out earlier, the abilities of workers is only one of the factors influencing effective work performance (see Figure 1).

To the extent that different jobs require similar sets of abilities, then the predictive validity for ability tests for one set of jobs could be generalized to other jobs. That is exactly what is claimed by some proponents of validity generalization who

argue that ability tests can predict effective work performance in a wide variety of jobs even though criterion validation studies have only been carried out on a few occupations (Schmidt and Hunter 1977). These claims have been challenged, however, in part because the ability tests used in the sampled occupations have largely been validated on correlates of work performance, such as job knowledge and supervisory ratings, rather than on actual measures of work performance (Levin 1988). Moreover, to the extent that jobs differ in the abilities that they require, then the predictive validity of ability tests in one set of jobs would not readily apply to another set of jobs. At this point, the degree to which validity studies can be generalized across occupations remains an open question (Fleishman and Quaintance 1984, pp. 434-436).

Measuring the Skill Requirement of Jobs

Measuring the skill requirements of jobs is equally problematic. The major task in this exercise is characterizing a variety of jobs--jobs that differ widely in the specific tasks that are performed, the conditions of work, and a host of other characteristics--by a common set of ability requirements. Such assessments can be performed on a small set of jobs within a particular company or on virtually all jobs in the U.S. economy, which is the focus of the DOT or Dictionary of Occupational Titles (U.S. Employment Service 1977). Ability requirements can also be ascertained for particular characteristics of jobs, such as specific activities (e.g., McCormick 1979, pp. 146-149),

rather than for jobs as a whole.

In each case, specific jobs or job characteristics are rated on a series of ability measures by job analysts, job incumbents, or supervisors. The raters use descriptions of each ability and, in some cases, task examples that demonstrate various levels of each ability, to rate the ability requirements of specific jobs or job elements. Descriptions for the three major cognitive abilities assessed in the DOT are shown in Table 2.

Studies of inter-rater reliability suggest fairly high levels of agreement among job analysts, job incumbents, and supervisors, with correlations ranging from .5 to .9 (Fleishman and Quaintance 1984, pp. 328-330). As in the case of skill assessments of individuals, the validity of skill requirements assessments can be established by examining both face validity and predictive validity. Proponents of these techniques claim that both the face validity and predictive validity of skill requirement assessments appear to be supported by research. There does appear to be less potential for sex bias in the assessments of skill requirements of jobs compared to the skill levels of individuals, especially with respect to cognitive skill requirements (Trieman 1979, pp. 43-45; McArthur 1985, pp. 62-63). With respect to predictive validity, studies to date have been carried out on only a limited number of jobs and primarily with respect to physical attributes (Fleishman and Quaintance 1984, pp. 321-328).

Additional validity studies are needed to more fully support

the notion of ability requirements, especially across a broader array of cognitive, physical, and social abilities. In addition, predictive validity of skill measures are likely be improved through the design of studies based on interactive models of work outcomes using multiple conceptions of skills, as the earlier discussion pointed out.

Assessing Changes in Skill Requirements

Much of the interest in work skills concerns issues of change. It is widely believed that the skill requirements of jobs are changing and that the skills that need to be developed through education and training programs need to change accordingly. In other words, much of the policy interest in the issue of skills does not simply concern work skills as much as changes in work skills. Assessing changes in skills and skill requirements introduces additional conceptual and methodological complications in the study of work skills, particularly with respect to skill requirements of jobs.

For the overall economy, changes in the skill requirements of work stem from two factors: (1) changes in the composition of jobs in the economy, and (2) changes in the skill requirements of individual jobs within the economy (Rumberger 1981; Spenner 1986; Attewell 1987). Each factor can independently influence skill changes. For example, even if the skill requirements of jobs did not change, changes in the compositions of jobs could affect aggregate skill requirements because jobs differ in the level and

kind of skills they require. Similarly, even if the composition of jobs in the economy were to stay the same, changes in the skill requirements of individual occupations could affect aggregate skill requirements in the economy. What, then, do we know about these two kinds of changes?

Changes in the composition of jobs in the economy are easier to assess than changes in the skill requirements of individual occupations. The former can be ascertained using figures on the composition of industries within the economy and the composition of jobs within industries. Such figures are compiled regularly by the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor for past periods as well as for a period of a decade or so into the future. Recent BLS figures suggest that the future economy will produce both higher-skilled and lower-skilled jobs, with the result that aggregate skill requirements based on compositional shifts will not be greatly different than they are today (Levin and Rumberger 1987).

While changes in the composition of jobs in the economy can be forecast with some confidence, changes in the skill requirements of jobs themselves are much harder to predict. The reason is that there are literally thousands of jobs in the economy that differ widely in the type of work that is performed, the working conditions, and the skills that are required for successful job performance. Just as jobs themselves differ, the skill requirements of jobs are likely to change in different ways as well. Since it is virtually impossible to assess the skill

requirements of all jobs in the U.S. economy, any predictions about past or future changes in skill requirements must be based on only a limited sample of jobs. This basic problem limits our understanding of changes in the skill requirements of jobs. But it has not prevented numerous studies of changes in job skill requirements.

Some of these have attempted to assess overall changes in skill requirements based on assessments of skill changes for large numbers of jobs. Most of these have been based on the Dictionary of Occupational Titles (DOT), which is the only source of information that attempts to document characteristics of all jobs in the U.S. economy. Yet even the DOT, which in its latest edition provided detailed descriptions and characteristics for more than 12,000 jobs, is often based on samples of a few jobs within each occupational area (Miller, et al., 1980, Chapter 7). Thus, at best, the DOT only provides information about an "average" job within each occupational category while ignoring the great deal of variation that can exist between jobs even with the same title. One important source of variation is the organization of the firm, which can produce widespread differences in the composition and skill requirements of jobs (Baron and Bielby 1984). A final criticism of the DOT is that ratings of job characteristics, including skill requirements, are not particularly valid or reliable (Miller, et al. 1980, Chapter 7).

Despite these shortcomings, the DOT remains the most

comprehensive source of information on job characteristics in the U.S. And assessments of changes in skill requirements based on the DOT have been undertaken. The results of these analyses suggest that the skill requirements of jobs have not changed noticeably between the latest two editions of the DOT, which covers the years between 1966 and 1977 (Spenner 1979; Rumberger 1981). Yet it should be pointed out that these assessments were based on single measure of skill requirements rather than a composite covering various dimensions of work skills. Moreover, assessments of changes over time are based on different samples of jobs rather than changes in skill requirements in the same set of jobs.

The other major source of information on changes in skill requirements comes from case studies. Case studies tend to focus on relatively small samples of jobs within a small set of occupations or firms. One advantage of this approach is that those jobs can be studied in great detail and the same set of jobs or firms can be studied over time. The major disadvantage is that the conclusions of the case study, because it is based on a particular set of jobs or firms, cannot be generalized to other jobs and firms in the economy. Case studies also differ widely in the procedures that are used to assess skill requirements. Most, for example, rely on a single measure of skill requirements that cannot adequately assess the qualitative and quantitative dimensions of skills that were discussed above.

These differences in job coverage and methods make it

difficult to reach any general conclusions about changes in the skill requirement of jobs. Recent reviews of case studies on the impact of technological change reach that conclusion (Flynn 1988; Spenner 1986). As Spenner points out in his review:

Past research contains considerable gaps in quality and coverage such that judgments about how technological change affects work contain substantial uncertainty. Much of what we do know, when systematically organized, suggests an uncertain, complicated and contradictory relationship between technological change and the skill requirements of work. Technology has substantial effects on the composition and content of work in the economy, but these effects vary for different dimensions of skill, for different jobs, occupations, industries, and firms, and for different technologies (Spenner 1986, p. 1).

Case studies reveal, for example, that the same technology can have very different impacts on jobs and skills depending on how the firm is organized and managed (e.g., Baron and Bielby 1980; Kelley 1986, 1988; Jaikumar 1986). Another concern is whether studies of the impact of past technologies can be used to accurately predict the future impact of new technologies (Rumberger 1987a).

Existing evidence, based both on large-scale assessments of skill changes and case studies, yields no firm conclusions about whether skill requirements of jobs are changing and, if so, in what ways. One way to further our understanding of skill changes, in addition to using more comprehensive measures of skills, is to better understand the way various forces interact to influence the skill requirements of work.

Two important forces identified in past research are work organization and technology. The influence of work organization

on work skills was recognized long ago by Adam Smith in this treatise, The Wealth of Nations. Smith illustrated how the many work tasks associated with producing pins can be grouped into a single job where all the tasks are performed or into several jobs where only certain tasks are performed (Smith 1937, pp. 4-5). This division of labor, arising from the organization of work, has direct implications for skill requirements since different tasks generally require different kinds and levels of skills needed to perform them.

Smith's thesis suggests, therefore, that the same technologies can be employed in different ways in different work settings, resulting in different skill requirements. It also suggests that to study the impact of particular technologies on the skill requirements of jobs, one must also study the kind of workplace organization in which those technologies are introduced because they may result in different impacts on skills.

To illustrate how these differences might arise, one could study work activities of a similar nature--such as office accounting or production assembly--in different work organizations employing different technologies. Assume for the moment that there are only two types of work organizations--hierarchical, where work is fragmented into many different jobs with several layers of management, and participative, where work activities, including managerial activities are shared among relatively fewer jobs. Assume also that they are only two kinds of technologies that can be used in this activity--old technologies and new

technologies. Finally, assume that the skill requirements for the most common production job in a traditional work organization utilizing old technology can be characterized by the profile shown in Figure 4, Part I.

Comparisons across these different settings might reveal, for example, that in more participative work organizations, where workers are given more joint, decision-making responsibilities, skill requirements in the verbal, reasoning, and interpersonal areas are higher than in more traditional work organizations (Part II, Panel B). In work settings employing new technologies, where machines perform carry out sophisticated computational and psychomotor activities, skill requirements in the perceptual, motor, and mathematical areas could be lower than in work settings employing older technologies (Panel C). At the same time, skill requirements in the verbal and reasoning areas might be higher because workers will need to constantly learn new ways to use these machines. In work settings employing both new technologies and new forms of work organization we may find increases in skill requirements in some areas and decreases in other areas (Panel D).

This example illustrates how technology and new forms of work organization could have independent and differential impacts on different dimensions of job skill requirements. And it suggests one way that future research might yield more insight into how skill requirements of work change.

Conclusions

Interest in issues of work skills is widespread among government officials, business leaders, and scholars. Yet most discussions of work skills are simplistic and misleading. They are often based on a very limited conception of work skills, ignoring the wide variety of skills that are associated with work. They are also based on simplistic notions of how skills change and of the way technology, work organization, and other forces influence the skill requirements of jobs. This criticism applies as well to much of the scholarly research on work skills as it does to the rhetoric of government officials and business leaders.

There are a number of steps, however, that could help to improve our understanding of work skills and how they change. First, studies of job skills, whenever possible, should be based on comprehensive measures of both the qualitative and quantitative dimensions of work skills. At the qualitative level, they should cover the full range of cognitive, physical, and affective domains of human abilities that influence effective work performance. The research literature in industrial and organizational psychology, in particular, provides valuable information on the various dimensions of work skills and how to measure them.

Second, the concepts and measures of work skills should be applied both to the capabilities of individuals and the requirements of jobs. An increasing body of research suggests that these two notions of skills and their interaction can improve our

understanding of a variety of work outcomes.

Third, future research should attempt to develop a more complete model of the forces affecting job skill requirements. Reviews of past research suggest, for example, that technology alone has little uniform impact of the skill requirements. Rather it appears that technology, alternative forms of work organization, and perhaps other forces exert an influence on the nature and skill requirements of work. These forces, and how they interact and operate to affect skill requirements, need to be studied in a more comprehensive fashion.

Issues of work skills are not just a concern to scholars. They have important political and economic dimensions. For this reason alone, they require careful and systematic study. The vast research literature in this field already provides the basis for conducting more complete and comprehensive investigations of the nature of work skills and how they change.

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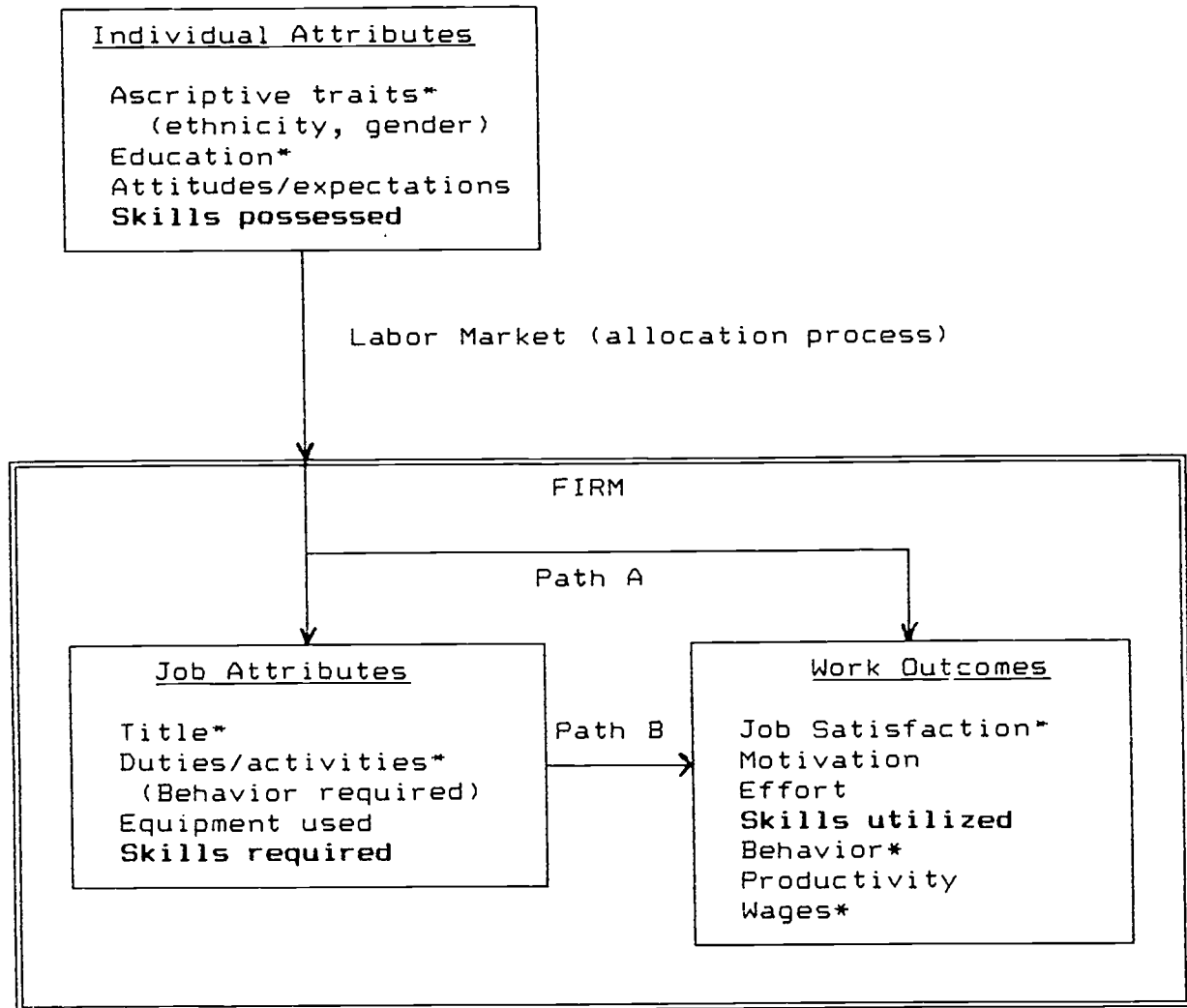
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Figure 1

Conceptual Foundations for Defining Work Skills



Path A: Individual/Outcome Model

Path B: Job/Outcome Model

Paths A+B: Interactive (Individual + Job)/Outcome Model

*Characteristics most often observed and studied.

Table 1
 Illustrative Taxonomy of Work Skills and Selected Definitions

I. Cognitive Domain	
Verbal	
Oral comprehension	Ability to understand spoken English words and sentences.
Written expression	Ability to use English words or sentences in writing so others will understand.
Mathematical	
Number facility	Ability to add, subtract, multiply, and divide quickly and correctly
Mathematical reasoning	Ability to understand and organize a problem and then select a mathematical method or formula to solve the problem
Thinking	
Memorization	Ability to remember information, such as words, numbers, pictures, procedures.
Deductive reasoning	Ability to apply general rules to specific problems to come up with logical answers.
Speed of closure	Ability to organize different pieces of information into one meaningful pattern quickly.
Perceptual	
Spatial orientation	Ability to tell where you are in relation to an object or an object in relation to you.
Visualization	Ability to imagine how something will look when it is moved around
Time sharing	Ability to shift back and forth between two or more sources of information.
II. Physical Domain	
Sensory	
Depth perception	Ability to distinguish which objects are more distant from or nearer to the observer
Speech clarity	Ability to communicate orally in a clear fashion understandable to the listener
Manipulative	
Control precision	Ability to move controls of a machine or vehicle quickly and repeatedly to exact positions
Reaction time	Ability to give one fast response to one signal (sound, light, picture) when it appears
Fitness	
Static strength	Ability to use muscle force in order to lift, push, pull, or carry objects
Stamina	Ability of the lungs and circulatory systems of the body to perform efficiently over long periods

Table 1 (continued)

III. Social Domain	
Interpersonal	
Social sensitivity	
Persuasion	
Leadership	
Consideration-behavior	Ability to show concern for others needs
Structure-behavior	Ability to define and organize group activities
Personality	
Sociability	Enjoyment of and engagement in social activities: liking to be around and with people.
Persistence	Persisting on a job until it is completed even when others have given up.
Hypochondriac-Medical Dominance I	Complaints about state of physical health. Being easily downed in an argument, considered submissive.
Dominance II	Taking command, exerting leadership, swaying a group.
General activity	Interest in action and energy expenditure.
Social conversation	Talking with others a great deal, being considered a talkative person.
Cooperativeness-considerateness	Inconveniencing one's self to oblige others, being a "Good Samaritan," etc.

Sources: Fleishman and Quaintance 1984, pp. 118-120, 328, Appendix B.
 Peterson and Bownas 1982, Figure 3.3.

Table 2
Ability Definitions from the Dictionary of Occupational Titles

GENERAL EDUCATIONAL DEVELOPMENT

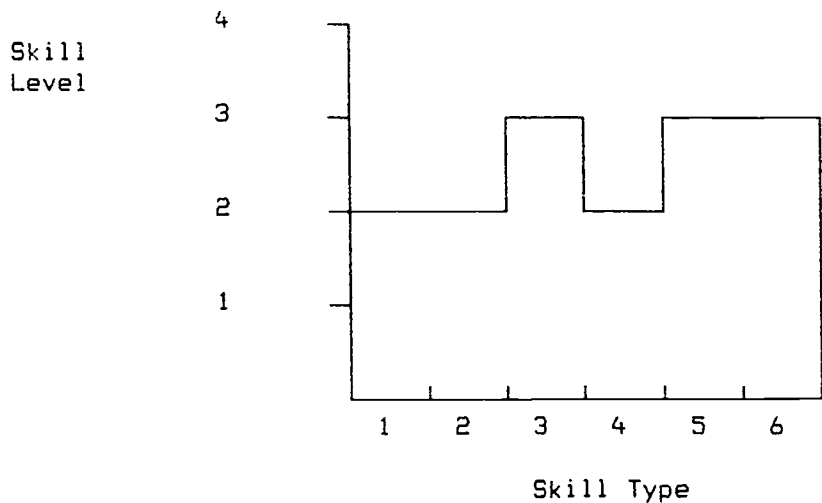
Level	Reasoning Development	Mathematical Development	Language Development
6	Apply principles of logical or scientific thinking to a wide range of intellectual and practical problems. Deal with non-verbal symbolism (formulas, scientific equations, graphs, musical notes, etc.) in its most difficult phases. Deal with a variety of abstract and concrete variables. Apprehend the most abstruse classes of concepts.	Apply knowledge of advanced mathematical and statistical techniques such as differential and integral calculus, factor analysis, and probability determination, or work with a wide variety of theoretical mathematical concepts and make original applications of mathematical procedures, as in empirical and differential equations.	Comprehension and expression of a level to —Report, write, or edit articles for such publications as newspapers, magazines, and technical or scientific journals. —Prepare and draw up deeds, leases, wills, mortgages, and contracts. —Prepare and deliver lectures on politics, economics, education, or science. —Interview, counsel, or advise such people as students, clients, or patients, in such matters as welfare eligibility, vocational rehabilitation, mental hygiene, or marital relations. —Evaluate engineering technical data to design buildings and bridges.
5	Apply principles of logical or scientific thinking to define problems, collect data, establish facts, and draw valid conclusions. Interpret an extensive variety of technical instructions, in books, manuals, and mathematical or diagrammatic form. Deal with several abstract and concrete variables.	Perform ordinary arithmetic, algebraic, and geometric procedures in standard, practical applications.	Comprehension and expression of a level to —Transcribe dictation, make appointments for executive and handle his personal mail, interview and screen people wishing to speak to him, and write routine correspondence on own initiative. —Interview job applicants to determine work best suited for their abilities and experience, and contact employers to interest them in services of agency. —Interpret technical manuals as well as drawings and specifications, such as layouts, blueprints, and schematics.
4	Apply principles of rational systems ¹ to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Interpret a variety of instructions furnished in written, oral, diagrammatic, or schedule form.	Make arithmetic calculations involving fractions, decimals and percentages.	Comprehension and expression of a level to —File, post, and mail such material as forms, checks, receipts, and bills. —Copy data from one record to another, fill in report forms, and type all work from rough draft or corrected copy. —Interview members of household to obtain such information as age, occupation, and number of children, to be used as data for surveys, or economic studies. —Guide people on tours through historical or public buildings, describing such features as size, value, and points of interest.
3	Apply common sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deal with problems involving several concrete variables in or from standardized situations.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	Comprehension and expression of a level to —Learn job duties from oral instructions or demonstration. —Write identifying information, such as name and address of customer, weight, number, or type of product, on tags, or slips. —Request orally, or in writing, such supplies as linen, soap, or work materials.
2	Apply common sense understanding to carry out detailed but uninvolved written or oral instructions. Deal with problems involving a few concrete variables in or from standardized situations.	Perform simple addition and subtraction, reading and copying of figures, or counting and recording.	
1	Apply common sense understanding to carry out simple one- or two-step instructions. Deal with standardized situations with occasional or no variables in or from these situations encountered on the job.		

¹ Examples of "principles of rational systems" are: Bookkeeping, internal combustion engines, electric wiring systems, house building, nursing, farm management, ship building.

Source: U.S. Employment Service 1965, Vol. 2, p. 652.

Figure 2
Hypothetical Differences of Skill Types and Levels
Across Technologies and Organizations

I. Hypothetical Skill Profile: Old Technology/Hierarchical Work Organization



- 1 - Perceptual
- 2 - Motor
- 3 - Verbal
- 4 - Mathematical
- 5 - Reasoning
- 6 - Interpersonal

II. Hypothetical Skill Changes Across Settings

