THE *DICTIONARY OF OCCUPATIONAL TITLES* AS A SOURCE OF OCCUPATIONAL DATA*

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The fourth edition of the Dictionary of Occupational Titles *(DOT) is potentially a major data resource for sociological analysis. The present paper provides previously unavailable information regarding the production and properties of the DOT data to facilitate assessment of their appropriateness for various research purposes. We describe the data available in the DOT, report on exercises assessing their validity and reliability, consider the desirability of aggregating the data in various ways, present a factor analysis that reduces the 44 characteristics to six factors, compare the third and fourth editions with respect to possible sex bias, and offer a cautionary note regarding the use of successive editions of the DOT to study temporal changes in the American occupational structure.*

INTRODUCTION

Occupation is the dominant variable in American stratification research, and is important in many other research areas. Occupation may determine one's level of both income and prestige and may enhance or limit one's future opportunities and the prospects of one's offspring. Occupation is also one of the major dimensions of social differentiation: occupational groups vary widely in their attitudes and behaviors because of differences in the patterns of recruitment to occupations but in part also because of patterns of occupational socialization and intrinsic differences in the nature of the work performed in different occupations.

The central place of occupation in sociological research has prompted many attempts to improve the conceptualization and measurement of occupational characteristics. The dominant thrust of this work has been the development of occupational-status scales that can be used to score occupations on a single hierarchical dimension (Blishen, 1958, 1967; Duncan, 1961a, 1961b; Bogue, 1963; Rutzick, 1965; Nam and Powers, 1968; Siegel, 1971; Treiman, 1977). Duncan's Socioeconomic Index (Duncan, 1961a, 1961b; Featherman, Jones, and Hauser, 1975) and the prestige scores developed for the U.S. by Hodge, Siegel, and Rossi (Siegel, 1971) and for international comparisons by Treiman (1977) have been particularly influential, serving as the basic measures of occupational status in status-attainment research.

Recently, however, there has been increasing interest in expanding the repertory of occupational variables to include dimensions other than prestige and socioeconomic status. This interest derives from several sources: recognition that other hierarchical dimensions such as power and authority are implicated in status attainment; a greater concern with structural features of inequality, often informed by Marxian or market-segmentation perspectives; and increasing interest in the intrinsic content of occupa-

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tional roles. These concerns have led to several recent attempts to measure additional occupational characteristics in the context of research on determinants of earnings (Stolzenberg, 1975; Wright and Perrone, 1977; Robinson and Kelley, 1979; Kalleberg and Griffin, 1980); male-female earnings differentials and occupational segregation by sex (McLaughlin, 1978; Snyder, et al., 1978; Hartmann, 1979; Wolf and Fligstein, 1979a, 1979b; Roos, forthcoming); mechanisms of intergenerational status-transmission (Mortimer, 1974; Spenner, 1977; Mortimer and Lorence, 1979); and the impact of occupational experience on various aspects of psychological functioning (Kohn, 1969; Tudor, 1972; Kohn and Schooler, 1973, 1978; Kalleberg, 1977; Kalleberg and Griffin, 1978; and Miller, et al., 1979).

Unfortunately, efforts to construct new occupational measures are frequently hampered by the lack of appropriate data. To date, the major source of occupational data has been the U.S. Census, which since 1940 has published summary measures of the characteristics of workers in each of what are now about 500 detailed occupational categories (U.S. Bureau of the Census, 1943, 1953, 1963, 1973). Although enormously useful, these data pertain only to the characteristics of workers in each occupation and not to the content of their jobs.

Another major source of data of potentially great use to sociological researchers is the *Dictionary of Occupational Titles* (DOT), created and published by the U.S. Department of Labor. Originally published in 1939 as a reference manual for use in local offices of the newly established U.S. Employment Service, the DOT has gone through three subsequent editions, issued in 1949, 1965, and 1977. Although designed as a tool to aid the matching of job applicants with jobs—the major function of local Employment Service offices—the DOT contains a wealth of occupational information that makes it valuable for many other purposes. The DOT has been used heavily in vocational education and career counseling. Only recently, however, and still to a very limited extent, has the DOT been exploited by academic social science researchers, mainly using data from the third (1965) edition (Eckhaus, 1964; Scoville, 1966, 1969; Berg, 1970; Bluestone, 1974; Lucas, 1974, 1977; Stolzenberg, 1975; Temme, 1975; Broom, et al., 1977; Spenner, 1977, 1980; Caston, 1978; Dubnoff, 1978; McLaughlin, 1978; Kalleberg and Griffin, 1978, 1980; Cullen and Novick, 1979; Hartmann, 1979; Spaeth, 1979).

In December 1977 the fourth edition of the DOT was published, containing descriptions of 12,099 occupations. Also available, on computer tape, are scores for each occupation on 44 characteristics—measurements of the complexity of work, the education and training required, the aptitudes, interests, and temperaments appropriate for the occupation, the physical demands of the occupation, and the physical conditions under which the work is performed.[1] In contrast to most occupational information, which is based on worker self-reports or which measures characteristics of workers rather than of jobs, the DOT data are based on extensive on-site observation of jobs as they are actually performed and index job content rather than worker characteristics.[2]

Until recently, virtually nothing was

[1] A computer tape containing these data, known as the "DOT master file," may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, by requesting Document No. PB 298 315/AS.

[2] It is useful to distinguish between *jobs* and *occupations*. *Jobs* are specific positions within establishments or the economic activities of specific individuals. They entail particular duties and responsibilities and involve the performance of particular tasks in particular settings. Examples of jobs include "head waiter at Lion D'Or in Washington, D.C.," "welder on Assembly Line 3 at the Ford Motors assembly plant in Los Angeles," "seller of leather goods at a street stall on 5th Avenue in New York," and "cardiologist in private practice in St. Louis." *Occupations* are aggregations of jobs, grouped on the basis of their similarity in content—similarity in the tasks they involve, the duties and responsibilities they entail, and the conditions under which they are performed. The DOT maps the several million jobs held by the 100 million members of the U.S. labor force into 12,099 occupations (e.g., "waiter/waitress, head," "waiter/waitress, captain," "waiter/waitress, formal," "waiter/waitress, informal," "car hop," "canteen operator," and 15 other types of waiters and waitresses) while the 1970 U.S. Census classification maps these same jobs into 441 occupations (e.g., "waiters," "food counter and fountain workers").

known about the properties of these data, making it difficult to evaluate their usefulness. This deficiency has been remedied by research recently completed at the National Academy of Sciences (NAS). Under contract to the U.S. Department of Labor, the NAS Committee on Occupational Classification and Analysis conducted a review of the occupational research program of the U.S. Employment Service, the principal product of which is the DOT.[3] In conjunction with this review, we, as members of the Committee staff, have been engaged in an analysis of the content of the fourth edition DOT and an evaluation of the procedures used in producing the information contained in it. In anticipation of continued and increasing interest in the DOT as a source of occupational data and also a shift to reliance on the most recent (fourth) edition, we offer a summary of those aspects of our work most pertinent to the interests of academic users of the DOT. We hope to accomplish two things: to introduce the DOT to academic researchers who are unfamiliar with it, and to provide previously unavailable information regarding the production and properties of DOT data so as to permit intelligent assessment of its appropriateness for various research purposes.

CONTENT OF THE FOURTH EDITION DOT

As a source of occupational information, the fourth edition of the DOT provides a dictionary of occupational titles in common usage in U.S. labor markets, a classification of occupations, and quantitative information about occupations with respect to a large number of specific characteristics.

Dictionary

As a dictionary, the fourth edition contains 28,801 titles of which 12,099, or 42%, refer to distinct occupations. These 12,099 occupations are assigned "base titles." Each base title is defined according to a format that includes information on the type and purpose of tasks entailed in the occupation, the machines and tools used, and the goods or services produced. Examples of DOT definitions are provided in Appendix A. The remaining occupational titles in the DOT are synonyms of base titles or general or commonly used titles such as "supervisor." The large number of titles in the DOT and the availability of numerous title indexes makes it an invaluable reference for those engaged in occupational research.[4] Recognizing the utility of the DOT's dictionary function, Featherman, Sobel, and Dickens (1975) recommend it to assist in coding to detailed Census categories occupational information obtained from surveys. Treiman (1977) similarly recommends it to facilitate coding occupations with scores from his International Standard Occupational Prestige Scale.

Classification

Base titles in the fourth edition are arranged in order of their classification (in the third edition they were arranged in alphabetical order). The DOT classification code consists of three parts. The first three digits of the DOT code are roughly analogous to the Census's detailed classification and reflect increasing specificity (from the first to third digit) in the kind of work performed. These codes are

[3] The final report of the Committee (Miller et al., 1980) is available for sale from the National Academy Press, 2101 Constitution Ave., N.W., Washington, D.C. 20418. Other, more limited, evaluations of selected aspects of the DOT include those by Kohn (1969), Scoville (1972), Temme (1975), Spenner (1977; 1980), and Broom et al. (n.d.). These are essentially efforts to establish the predictive and construct validity of various DOT indicators, and are not direct evaluations of the measurement properties of the DOT; such an evaluation is unique to the NAS study.

[4] The DOT purports to be a comprehensive compilation of all occupations in the U.S. economy. This, however, is not entirely correct, even in principle, since illegal occupations such as prostitute, numbers runner, and dope pusher are not found in the DOT. Moreover the DOT is very uneven in its coverage, defining occupations in the manufacturing sector much more narrowly than occupations in the service sector. Finally, it is probable that the coverage of occupations found only in small establishments or non-bureaucratic settings is relatively poor. Despite these limitations, the DOT remains the single most comprehensive source of occupational descriptions available.

assigned primarily on the basis of the technology used in the occupation, the industry in which it is found, and the materials or services produced. The fourth through sixth digits of the code indicate the complexity of tasks entailed in the occupation in relation to data, people, and things, respectively. These levels make up a structure of 24 worker functions, each of which is denoted by a unique verb, e.g., "compiling" data or "handling" things. The structure is in the form of three listings (for data, people, and things), each of which is arranged in Guttman-scale fashion from relatively simple tasks (high numbers) to complex tasks (low numbers). Owing to the wide range of functions entailed in the PEOPLE dimension, the DOT cautions that its "arrangement is somewhat arbitrary and can be considered a hierarchy only in the most general sense" (U.S. Department of Labor, 1977:1369). Despite this caution, most researchers assume an interval level of measurement when they use this variable (Temme, 1975). The last three digits of the classification have no substantive referent, but serve to give each base title a unique code, since among the 12,099 titles there are only 3963 unique combinations of the first six digits.

We regard the DOT classification as having limited value to occupational researchers, although we would suggest that occupational responses in sample surveys be assigned nine-digit DOT codes as well as three-digit Census codes in order to exploit the wealth of quantitative occupational data available in the DOT. One reason for our lack of enthusiasm for the DOT classification is that the principles by which the nine-digit codes for specific occupations are aggregated into broad occupational groups do not seem to represent suitable occupational groupings for most sociological research purposes. The DOT major groups are fairly similar to the Census major groups for white-collar and service jobs but differ substantially for manual jobs. Whereas the Census classification distinguishes between "craft," "operative," and "laboring" jobs—a distinction that embodies skill, responsibility, and status dimensions—the DOT classification distinguishes between "processing," "machine trades," "benchwork," and "structural work," a distinction that embodies none of these, nor conforms to any clear conception of the organization of work. In addition, since most current research utilizes the U.S. Census detailed classification, sole use of the DOT classification to aggregate occupational data would preclude comparability with most existing occupational data and research findings.[5]

Occupational Characteristics

In addition to a definition and classification code, each occupation in the DOT is assigned scores on 44 characteristics—the three "worker function" variables included in the nine-digit code (the complexity of the relationship to data, people, and things), two measures of training time (GED[6] and SVP), eleven aptitudes, ten temperaments, five interest factors, six physical demands, and seven working conditions. These characteristics constitute a potentially rich source of data for academic research purposes—a potential that has already been realized to some extent—and hence merit our detailed examination.

Training Times are defined as the "amount of general educational development (GED) and specific vocational preparation (SVP) required of a worker to acquire the knowledge and abilities necessary for average performance in a particular job-worker situation" (U.S. Department of Labor, 1972:8). GED includes

[5] It is possible to convert data from the third and fourth edition DOT classifications to the 1970 Census detailed classification by making use of the Census codes for DOT categories contained in the "DOT master file" described in note 1. Development of a conversion map from the fourth edition DOT codes to the 1980 Census classification will be facilitated by the fact that the 1980 Census classification closely follows the Standard Occupational Classification (U.S. Department of Commerce, 1977), which includes a listing of all third edition DOT occupations corresponding to each SOC category.

[6] In fact, ratings are made of three GED variables, relating to reasoning, mathematical, and language skills. These ratings are then combined into a single summary GED variable by assigning to each occupation the highest of the three component scores. So, while ratings are made on 46 variables, in some cases data are reported for 44 variables.

aspects of formal and informal education which contribute to the worker's reasoning development, ability to follow instructions, and acquisition of language and mathematical skills. SVP includes training acquired in a "school, work, military, institutional, or avocational environment," but excludes schooling without specific vocational content.

Aptitudes are the capacities or abilities required of the worker to facilitate the learning of job tasks, e.g., intelligence or motor coordination.

Temperaments are the personal traits that are useful to the worker in adjusting to the requirements of his or her job, e.g., adaptability to dealing with people or to performing repetitive tasks.

Interests are tastes and preferences for certain kinds of activities that are entailed in job performance, e.g., a preference for activities involving business contacts.

Physical Demands are the physical requirements made upon the worker in carrying out job tasks, e.g., strength, stooping, or seeing.

Working Conditions are the physical surroundings and circumstances in which the job is performed and to which the worker must adapt, e.g., extreme cold, heat, or hazards.

The specific variables included in these groups are described in greater detail in Table 1 and Appendix B. While these variables have a strong vocational-psychology flavor, which reflects their origins, they can also be viewed as describing job requirements and job structure. For example, an occupation requiring a "temperament for direction, control, and planning" is in fact a managerial occupation, involving direction, control, and planning as central duties. Important dimensions of job content derivable from these variables are revealed in the factor analysis reported below.

PRODUCTION OF THE DOT

Historical Background

The purpose for which the DOT was and is most immediately intended, job-worker matching, and the historical context in which it was developed have strongly influenced its content. The first edition of the DOT was produced during the Depression, which meant that typically there were numerous experienced workers available for each job opening and the worker-job matching problem was mainly one of identifying those workers whose previous experience most closely matched job requirements. Information included in the DOT therefore focused on job content, in order to facilitate determination of whether the jobs a worker had done previously conformed closely to the job being filled. Little attention was paid to qualities of workers, such as aptitudes or temperaments, that might affect job performance.

World War II and postwar economic recovery prompted an influx into the labor force of workers who had little or no prior labor-force experience or up-to-date job skills. Increasingly, the Employment Service had to match workers to jobs on the basis of an applicant's potential to perform a given job rather than on the basis of his or her demonstrated experience. In 1949, the Functional Occupational Research Project was begun to systematically investigate various dimensions of worker potential. This research resulted in the incorporation of "worker function" ratings into the DOT classification and in the development of various scales for rating "worker traits"—requirements made upon workers in performing various jobs.

The historical origins of the DOT have another important legacy—a disproportionate emphasis on production occupations. Although the labor force has shifted substantially away from production work and into office and service work in the 40 years since the DOT was first developed, the DOT continues to include a disproportionately large number of definitions of production jobs. In the fourth edition, 67% of all definitions are in manufacturing categories and 12% are in the clerical, sales, and service categories, despite the fact that in 1971 these categories employed 21 and 41% of the labor force, respectively (see Table 2). Since 1971, the labor force has shifted even further toward services. The propensity for the DOT to reflect the character of the occupations and labor force in an earlier era is directly traceable to the procedures used to create successive editions.

Table 1. DOT Occupational Characteristics, Fourth Edition

Variable Label	Description[a]	Scoring
Worker functions		
DATA	Complexity of function in relation to data	0 to 6[b]
PEOPLE	Complexity of function in relation to people	0 to 8[b]
THINGS	Complexity of function in relation to things	0 to 7[b]
Training times		
GED	General educational development	1 to 6
SVP	Specific vocational preparation	1 to 9
Aptitudes		
INTELL	Intelligence	1 to 4[b,c]
VERBAL	Verbal aptitude	1 to 5[b]
NUMER	Numerical aptitude	1 to 5[b]
SPATIAL	Spatial perception	1 to 5[b]
FORM	Form perception	1 to 5[b]
CLERICAL	Clerical perception	1 to 5[b]
MOTOR	Motor coordination	1 to 5[b]
FINGDEX	Finger dexterity	1 to 5[b]
MANDEX	Manual dexterity	1 to 5[b]
EYEHAND	Eye-hand-foot coordination	1 to 5[b]
COLORDIS	Color discrimination	1 to 5[b]
Temperaments		
DCP	Direction, control, and planning	0/1
FIF	Feelings, ideas, or facts	0/1
INFLU	Influencing people	0/1
SJC	Sensory or judgmental criteria	0/1
MVC	Measurable or verifiable criteria	0/1
DEPL	Dealing with people	0/1
REPCON	Repetitive or continuous processes	0/1
PUS	Performing under stress	0/1
STS	Set limits, tolerances, or standards	0/1
VARCH	Variety and change	0/1
Interests		
DATACOM	Communication of data vs. activities with things	−1 to 1[d]
SCIENCE	Scientific and technical activities vs. business contact	−1 to 1[d]
ABSTRACT	Abstract and creative vs. routine, concrete activities	−1 to 1[d]
MACHINE	Activities involving processes, machines, or techniques vs. social welfare	−1 to 1[d]
TANGIBLE	Activities resulting in tangible, productive satisfaction vs. prestige, esteem	−1 to 1[d]
Physical demands		
STRENGTH	Lifting, carrying, pulling, pushing	1 to 5
CLIMB	Climbing, balancing	0/1
STOOP	Stooping, kneeling, crouching, crawling	0/1
REACH	Reaching, handling, fingering, feeling	0/1
TALK	Talking, hearing	0/1
SEE	Seeing	0/1
Working conditions		
LOCATION	Outside working conditions	1 to 3
COLD	Extreme cold	0/1
HEAT	Extreme heat	0/1
WET	Wet, humid	0/1
NOISE	Noise, vibration	0/1
HAZARDS	Hazardous conditions	0/1
ATMOSPHR	Fumes, odors, dust, gases, poor ventilation	0/1

[a] Descriptions are from U.S. Department of Labor (1972). See Appendix B for additional details on variable scoring.

[b] High scores correspond to low values.

[c] Level 5 is not assigned on this aptitude because it is assumed that every job requires at least a '4' (U.S. Department of Labor, 1972:294).

[d] Interest variables are sets of bipolar contrasts: 0 corresponds to the presence of neither interest in the pair; −1 corresponds to the presence of the second interest in the pair; 1 corresponds to the presence of the first interest in the pair.

Table 2. Percentage Distributions of DOT Titles and Labor Force by DOT Occupational Categories

DOT Occupational Category	Percent of Base Titles (N = 12,099)	Percent of Labor Force
Professional, technical, and managerial	12%	25%
Clerical and sales	8	25
Service	4	16
Agriculture, fishing, and forestry	2	4
Processing	23	2
Machine trades	18	6
Benchwork	19	4
Structural work	7	9
Miscellaneous	7	8
Total	100%	99%

NOTE: Labor force data derived from the April 1971 Current Population Survey; sample (N = 60,441) includes currently employed workers and experienced unemployed for whom a Census code could be assigned. Excluded are 12% of sample for whom DOT codes could not be assigned. Data on distribution of DOT titles by category provided by Department of Labor, Division of Occupational Analysis.

Data Collection Procedures

There is widespread concern among users about the quality of data contained in the DOT and the lack of information regarding it. Spaeth (1979:752) repeats a frequent complaint that there is no information available on the validity or reliability of DOT ratings. Similarly, Spenner (1979:973) notes that the "measurement properties of DOT variables are largely unknown." In this section we review the procedures used to collect data for the DOT, the process by which these data are amalgamated, and what is known about the validity of the data.

The data gathering process. The basic approach to data gathering for the DOT is the use of on-site observations of jobs as they are performed. In principle, an attempt is made to observe all occupations practiced in the United States. To accomplish this, the Department of Labor maintains 10 Occupational Analysis Field Centers scattered throughout the country, each of which has a staff of approximately 10 full-time occupational analysts. These field centers operate under the direction of the Division of Occupational Analysis within the U.S. Employment Service, which is in turn a part of the Department of Labor. The Division of Occupational Analysis, not the Bureau of Labor Statistics, is the unit within the Department of Labor responsible for the production of the DOT, contrary to the assumption of some researchers (e.g., England, 1979). Job analyses are conducted on an industry-by-industry basis, with each field center responsible for specific industries. Typically, an analyst is assigned a particular industry, for example, "wooden furniture manufacturing." He familiarizes himself with the industry, then arranges to visit several establishments in the industry. In each establishment the analyst goes from department to department observing jobs, paying particular attention to those that are specific to that industry. Each job observed is described in a standardized format and rated with respect to the 46 occupational characteristics mentioned above. In large establishments this process may take weeks or even months. Having completed on-site observations within an establishment, the analyst files, for each observed job, a "job analysis schedule" that includes a written description of the job and ratings of each characteristic. These schedules provide the basic data for the creation of the subsequent edition of the DOT.

These procedures provide somewhat uneven coverage of the American occupational structure. Although there is an attempt to cover the range of industries, there is no systematic sampling of occupations. The result is that some occupations are described repeatedly (to cite an extreme example, "materials handler" appeared in 652 job analysis schedules prepared for the fourth edition), and some occupations are not described at all on the basis of actual observation. Of course, for some types of jobs, such as those involving a wide variety of duties spread over an

extended period of time, on-site observation is not feasible; in such cases, information is obtained from professional and trade associations, unions, or employers. About 21% of the occupational descriptions in the fourth edition were not derived from on-site observations. An additional 43% of the occupational descriptions were based on only one or two job analysis schedules. Insofar as DOT occupations are internally heterogeneous, the heavy reliance upon descriptions of only one or two specific jobs would appear to lead to unreliable data. Of course, the small number of job descriptions also makes it impossible to assess the degree of internal heterogeneity within these occupations.

Creation of DOT occupations. To create the occupations described in the fourth edition, job analysis schedules were grouped on the basis of the type of work performed and the level of complexity with respect to data, people, and things. This process is inherently arbitrary, depending heavily on analysts' judgments as to what constitute variants of the same occupation and what constitute different occupations. There are no procedures for ensuring comparability throughout the DOT in the level of aggregation of jobs into occupations. As a result, DOT occupations vary widely in their detail and specificity. For example, there are 70 kinds of "sewing machine operators, garment" with the same six digit code but only six kinds of "secretary" with the same six digit code. Moreover, inspection of the occupational definitions suggests more variability among the six secretarial occupations than among the 70 kinds of sewing occupations (see Appendix A). More generally, the DOT's high percentage of production-process occupations relative to the percentage of production-process workers in the U.S. labor force, as indicated in Table 2, while possibly due to a highly specified division of labor in the production sector, more likely results from tendencies to concentrate on-site observation in industrial establishments and to rely heavily upon definitions contained in previous editions of the DOT. Two-thirds of the establishments in which job analyses were conducted were in manufacturing industries, despite the fact that these industries made up only 8% of total U.S. establishments and employed one-third of U.S. employees in 1974. Retail trades and services, on the other hand, which accounted for approximately 56% of all U.S. establishments and 39% of employees, constituted only 11% of the establishments selected for DOT job analysis. Results from a 1-in-40 random sample of fourth edition DOT occupations show that 81% of fourth edition DOT definitions are identical to those contained in the third edition. The problem is not that production occupations are over-represented but that other occupations are probably under-represented.

Validity and reliability. As noted, little is known about the validity and reliability of the DOT variables. The 44 variables represent a combination of indicators taken from several sources, and details of their development for use in the DOT are not well-documented. The worker-function scales, for example, were an extension and refinement of a classification scheme developed in Great Britain following the Second World War to facilitate demobilization (International Labor Office, 1952). The aptitude items were chosen to correspond to those available in the General Aptitude Test Battery used by the U.S. Employment Service to screen and profile applicants (Dvorak, 1947). The interest items were adapted from work by Cottle (1950) in an extension of earlier work by Strong (1943) and others. GED was designed in recognition of the need to measure training requirements independently of educational credentials or certification, but no attempt was made to validate it against any external criterion related to occupational performance, although it was validated against school curriculum content.

In developing new scales or adapting existing scales for use in the DOT, various checks of the reliability of analysts' ratings of these traits were conducted. To a lesser extent, checks of the validity of the ratings were made as well. Most of these studies were conducted using small samples of jobs and raters, and results were not published. Prior to publication of the third

edition, however, a major study of the rating of 4,000 of the most populous jobs was conducted. For the study, specially trained analysts at the national headquarters of the Division of Occupational Analysis rated occupations on a variety of characteristics, using DOT definitions and job descriptions written by analysts in the field on the basis of on-site observations. These ratings, based on job descriptions only, were compared with ratings made by analysts who observed and rated similar jobs on-site.

Results for ratings of aptitudes show that the median correlation between the average ratings of the two groups across all 10 aptitudes was .90. In addition, inter-rater reliabilities ranging from .74 to .96 were obtained for the national office analysts (Trattner, et al., 1955). Although the validity of the ratings was found to be rather low when compared with test scores for the General Aptitude Test Battery (GATB), this result was ignored by those designing the collection of worker trait data for the third edition DOT. Attention was focused on the reliability exercise, which was more encouraging. The high degree of correspondence between the ratings made on the basis of job descriptions and those based on direct observations was taken as evidence that ratings could be assigned using job descriptions only, but this evidence is somewhat misleading. It is well known that correlations between averages tend to be much higher than correlations between individual observations. It would have been far more compelling to show high inter-rater reliabilities between pairs of raters in which one rated written job descriptions and the other based his or her ratings on on-site observations. Nevertheless, for the third edition DOT, ratings of the 46 characteristics were made primarily by national headquarters personnel using only job descriptions, with some assistance from the field center staff.

The fourth edition saw a change in the procedures used to rate jobs and occupations for the DOT. As noted above, field center analysts not only collected job data and wrote descriptions but also rated each job with respect to the 46 characteristics. In addition, field analysts were responsible for assigning ratings to the occupational composites contained in the DOT, formerly a task of the national office.

Despite changes in the ratings procedure, no checks appear to have been made of the validity and reliability of the ratings during the course of fourth edition production. Their validity is a complex issue that we have not been able to consider in a systematic way. We were able, however, to assess the reliability of the ratings. A complete description of this exercise appears in Cain and Green (1980); here we briefly summarize the exercise and the main results.

We asked experienced analysts at seven field centers to rate 24 job descriptions with respect to DATA, PEOPLE, THINGS, three components of GED, SVP, six physical demands factors, and seven environmental conditions. Job descriptions were taken verbatim from job analysis schedules prepared for the fourth edition. Thus, the rating task closely replicated the procedures used to assign scores for the third edition but was an imperfect simulation of the procedures by which ratings for the fourth edition were actually generated. An exact replication of the fourth edition procedure (comparing ratings made on-site) was beyond the scope of our project.

Our design enabled us to separate the effect of six potential influences on ratings: the occupation being rated; the GED level of the occupation (four groups); the job type (whether manufacturing or service); the job description used to represent the occupation (each occupation was represented by two descriptions); the field center of the rater (one of seven); and the individual analyst within the field center (one of six). Reliabilities were calculated under three assumptions. The "minimum" estimate of reliability treats variance associated with the occupation rated, the GED level, and the job type as legitimate, and variance associated with the remaining factors as error. The "medium" estimate treats the job description used as an additional legitimate source of variation in ratings. The "maximum" estimate treats differences between raters and field centers as ad-

ditional legitimate sources of variation. The usefulness of this approach is that the difference between the estimates can be interpreted substantively: the difference between the medium and minimum estimates of reliability is the error introduced by the fact that one job description rather than another is rated, and the difference between the maximum and medium estimates is the error introduced by the fact that raters differ from one another in the way they assign ratings.

Table 3 shows that the estimated reliabilities are in general not very high. The average minimum estimate is only .63 and the average medium estimate is .70, which indicates that a nontrivial portion of the variance in ratings is due to which job description is rated (.07) and to differences among raters (.13). Second, some variables are much more reliably rated than others. In particular, the THINGS and STRENGTH variables are very unreliably measured. In large part this is due to the fact that ratings of these factors vary substantially depending on which description is rated, whereas the description has less influence on ratings of the other factors. It is not clear, however, whether jobs vary more widely in their complexity with respect to things and in their strength requirements than in their other characteristics, or whether the descriptions are simply less adequate with respect to these two characteristics than with respect to the other characteristics. These results do suggest, however, the importance of adequately sampling jobs within each occupation, which, as we noted above, generally was not done in collecting data for the fourth edition.

In a second analysis, we calculated reliabilities separately for manufacturing and service occupations. Considering the historical concentration of the DOT on manufacturing jobs, and in particular the emphasis on features of manufacturing jobs in the development of the worker-trait variables, we suspected that these variables might be more reliably measured for manufacturing than for service jobs. As Table 4 shows, this proved to be the case, with the single exception of the strength scale. The result for the strength scale suggests that this variable should be used with caution. More generally, the lower reliability in the rating of characteristics of service jobs lends credence to the conjecture that these scales will become increasingly ill-suited to measure the job content of the American economy as the labor force shifts away from manufacturing jobs, since it is likely that the characteristics of clerical, sales, managerial, and professional jobs will also be less reliably measured than the characteristics of manufacturing jobs.

In addition to the variables discussed above, five physical demands and six environmental conditions were rated. Since these variables are all dichotomous, a different approach was required, de-

Table 3. Reliability Estimates for Selected DOT Variables

Variable	Minimum[a] (1)	Medium[b] (2)	Maximum[c] (3)	Job description effect [(2) − (1)]	Rater effects [(3) − (2)]
DATA	.84	.85	.90	.01	.05
PEOPLE	.80	.87	.91	.07	.04
THINGS	.25	.46	.65	.21	.19
GED-Reasoning	.75	.82	.88	.07	.06
GED-Math	.58	.61	.85	.03	.24
GED-Language	.67	.71	.90	.04	.19
SVP	.76	.80	.92	.04	.12
STRENGTH	.34	.54	.73	.20	.19
LOCATION	.64	.66	.76	.02	.10
Average	.63	.70	.83	.07	.13

[a] Reliability assuming that job type (manufacturing vs. service), GED level, and occupation (within GED level by job type) are the only legitimate sources of variation in ratings.

[b] Reliability assuming that, in addition to the above, the description rated (one of two per occupation) is a legitimate source of variation in ratings.

[c] Reliability assuming that, in addition to the above, variance due to differences among field centers and among analysts within field centers are legitimate sources of variation in ratings.

Table 4. Estimated Reliabilities, by Type of Occupation

Characteristic	Type of Occupation	
	Service	Manufacturing
DATA		
$r_{minimum}$	.694	.880
r_{medium}	.727	.889
$r_{maximum}$	.798	.918
PEOPLE		
$r_{minimum}$	.666	.908
r_{medium}	.795	.933
$r_{maximum}$	.830	.972
THINGS		
$r_{minimum}$	.107	.186
r_{medium}	.329	.406
$r_{maximum}$	.632	.637
GED-Reason		
$r_{minimum}$	.652	.694
r_{medium}	.717	.794
$r_{maximum}$	.792	.888
GED-Math		
$r_{minimum}$	.422	.629
r_{medium}	.431	.682
$r_{maximum}$	.771	.878
GED-Language		
$r_{minimum}$	.552	.690
r_{medium}	.609	.739
$r_{maximum}$	.853	.862
SVP		
$r_{minimum}$	.724	.768
r_{medium}	.739	.834
$r_{maximum}$	.873	.925
STRENGTH		
$r_{minimum}$	.435	.138
r_{medium}	.594	.495
$r_{maximum}$	.724	.705

NOTES: Reliabilities are calculated under three different assumptions about sources of error. See Table 3.

Reliabilities for the LOCATION scale could not be calculated separately for service and manufacturing occupations because there was no variation on this scale for the manufacturing occupations.

scribed in Cain and Green (1980). The results closely paralleled those we have already reviewed: consistency among raters was moderate, was much greater for some variables than for others, and was generally lower for service than for manufacturing occupations.

PROPERTIES OF THE DATA

As we have noted, for each of 12,099 occupations included in the fourth edition, information is available on 44 characteristics (see Table 1 and Appendix B). In this section we are concerned with two features of these variables: how they are distributed over occupations and over individuals in the labor force, and whether they can be reduced to a more parsimonious set of dimensions.

Occupations and Individuals as Units of Analysis

Occupational characteristics are useful in studying the structure of occupations per se, asking questions such as "What are the properties of occupations that determine their relative prestige?" (e.g., Siegel, 1971; Bose, 1973; Treiman, 1977), and in studying the occupational experiences of individuals, asking questions such as "What is the relationship between the complexity of work a person does and his or her choice of leisure time activity?" (e.g., Miller and Kohn, 1980). In the former case, we would take occupations as the unit of analysis and study the distribution and covariation of characteristics over occupations, while in the latter case we would take persons as the unit of analysis and tag each individual by the characteristics of the job or occupation he or she performs.

In principle it would be desirable to code the characteristics of the *job* a person does rather than the *occupation,* since occupational characteristics will ordinarily be imperfect indicators of job characteristics. To our knowledge, only Kohn and his associates have done this. They asked respondents to describe their jobs and then had trained coders estimate (from the descriptions) the complexity of the jobs with respect to data, people, and things (Kohn, 1969:153–55), from which they developed an overall index of the substantive complexity of jobs (Kohn and Schooler, 1973:104,106,111–12). While the substantive complexity index for jobs can be approximately estimated from the DATA, PEOPLE, and THINGS scores for occupations from the third edition DOT (R^2 = .61), use of the DOT-based estimates tends to result in weaker relationships than use of the index developed directly from descriptions of the jobs held by individuals.

Since people are distributed unequally

over occupations—there are many more bus drivers than brain surgeons, for example—the distribution of occupational attributes over the labor force may differ substantially from the distribution of these attributes over occupations. Moreover, as we noted above, occupations are somewhat arbitrary aggregations of specific jobs. Hence, occupational classifications may differ substantially from one another in the distribution of particular attributes, with the differences depending on the principles of aggregation employed.

To see how the DOT variables are distributed in several populations of interest, we computed various univariate and bivariate statistics for these variables at three levels of aggregation: for individuals in the labor force and for two occupational classifications, the DOT itself and the 1970 U.S. Census classification. Specifically, we show the means and standard deviations of all nondichotomous variables (Table 5), the percentage having the trait for all dichotomous variables (Table 6), and correlations among six variables of special interest (Table 7). Data for individuals in the labor force were derived from the April 1971 Current Population Survey (CPS), in which respondent's occupation was coded directly into both the DOT classification and the 1970 detailed Census classification. Data for the DOT occupations are from a 10% random sample of the 12,099 occupations in the fourth edition. Data for the Census occupations were derived by using the CPS sample to compute a weighted average of scores for

Table 5. Means and Standard Deviations for Nondichotomous DOT Variables, at Three Levels of Aggregation

	Means			Standard Deviations		
	Occupations		Labor	Occupations		Labor
Variable[a]	DOT[b]	Census[c]	Force[d]	DOT	Census	Force
Worker functions						
DATA	4.11	3.27	3.31	2.09	1.80	1.89
PEOPLE	6.83	6.19	6.17	1.85	1.82	1.96
THINGS	4.32	4.44	4.46	2.31	2.09	2.57
Training times						
GED	3.00	3.61	3.58	1.09	1.12	1.06
SVP	4.46	5.34	5.08	2.06	1.85	2.04
Aptitudes						
INTELL	3.19	2.80	2.82	.72	.80	.79
VERBAL	3.43	2.96	2.98	.78	.87	.83
NUMER	3.63	3.26	3.27	.78	.76	.79
SPATIAL	3.47	3.33	3.47	.71	.65	.76
FORM	3.36	3.26	3.29	.67	.56	.71
CLERICAL	3.89	3.54	3.38	.79	.75	.89
MOTOR	3.46	3.47	3.41	.56	.46	.65
FINGDEX	3.56	3.53	3.46	.61	.50	.69
MANDEX	3.21	3.28	3.28	.53	.49	.59
EYEHAND	4.67	4.50	4.49	.60	.56	.70
COLORDIS	4.52	4.38	4.35	.70	.54	.71
Interests						
DATACOM	−.57	−.32	−.25	.66	.69	.80
SCIENCE	−.12	−.14	−.28	.45	.49	.62
ABSTRACT	−.47	−.35	−.40	.53	.45	.55
MACHINE	.62	.38	.28	.55	.57	.66
TANGIBLE	−.05	−.04	−.02	.47	.45	.53
Physical demands						
STRENGTH	2.39	2.43	2.32	.91	.83	.98

[a] For variable descriptions and scoring see Table 1 and Appendix B.

[b] Ten percent random sample of fourth edition DOT occupations; N = 1172.

[c] All occupations in expanded 1970 Census detailed occupational classification used in published reports (U.S. Bureau of the Census, 1973) for which fourth edition DOT scores available; N = 591. For description of derivation of DOT scores for each Census category see Appendix C.

[d] U.S. labor force in April 1971; N = 60,441 (source: April 1971 Current Population Survey; see Appendix C.

Table 6. Percentage of Cases Having Each Dichotomous DOT Attribute, for Three Levels of Aggregation

Variable	Occupations		Labor Force
	DOT	Census	
Temperaments			
DCP	18	24	21
FIF	1	2	2
INFLU	4	12	12
SJC	17	31	33
MVC	39	41	33
DEPL	23	38	48
REPCON	46	28	23
PUS	2	4	5
STS	60	47	44
VARCH	20	32	41
Physical demands			
CLIMB	8	17	15
STOOP	20	29	30
REACH	89	77	79
TALK	29	46	55
SEE	57	58	56
Working conditions			
COLD	1	3	1
HEAT	5	5	3
WET	7	8	5
NOISE	29	25	18
HAZARDS	15	20	17
ATMOSPHR	12	12	10

See notes to Table 5 for details.

all DOT occupations included in each Census category, with weights corresponding to the proportion of the labor force in each DOT occupation. Additional information on these data sets is available in Appendix C.

To compare the distributions, consider the mean scores for the first five variables in Table 5. The average occupation in the DOT involves substantially less complexity with respect to data and people and substantially less general educational development or specific vocational training than either the average Census occupation or the job done by the average member of the labor force. This, of course, comes as no particular surprise, considering that, as we have seen in Table 2, DOT occupations are heavily concentrated in the production sector. What is of greater interest is that the averages computed over Census occupations and over the labor force are so similar, which belies the sometimes-heard claim that the Census classification includes excessive detail in the professional and technical sector.

It would be a mistake, however, to overemphasize the similarity between the Census and labor force distributions. As Table 6 shows, several DOT traits are found in substantially different proportions of the labor force and the Census occupations. All three populations are quite different and manifest different distributions of occupational characteristics. As a result of this, correlations among DOT variables may vary widely in the different populations. Table 7 shows intercorrelations among six variables of particular interest: the three work-complexity variables, the two training-

Table 7. Correlations Among Selected DOT Variables at Three Levels of Aggregation

	PEOPLE	THINGS	GED	SVP	STRENGTH
DOT occupations					
DATA	.705	.219	.841	.839	−.331
PEOPLE		−.005	.616	.586	−.254
THINGS			.262	.406	.125
GED				.879	−.354
SVP					−.253
Census occupations					
DATA	.666	.046	.885	.887	−.647
PEOPLE		−.313	.755	.616	−.514
THINGS			.006	.194	.163
GED				.897	−.606
SVP					−.489
U.S. labor force					
DATA	.562	−.042	.813	.825	−.427
PEOPLE		−.323	.626	.482	−.359
THINGS			−.018	.117	.131
GED				.837	−.449
SVP					−.304

See notes to Table 5 for details.

time variables, and an indicator of the physical strength required of occupations. While some of the correlations are nearly identical in the three populations, many are different, particularly those involving the THINGS and STRENGTH variables—again no doubt due to the overrepresentation of production occupations in the DOT relative to their occurrence in the Census classification and in the labor force. These results suggest that considerable care should be taken in generalizing results obtained from one population to others.

Apart from the aggregation problem, the DOT variables measuring aptitudes are particularly suspect. They have unusually low standard deviations relative to their potential range, and the means of the various items do not differ much from one another; taken together, these points suggest that the aptitude items were not very reliably measured. The temperament items, by contrast, on the whole exhibit substantial face validity, especially when the three populations are compared. There are two exceptions to this generalization: a temperament for dealing with "feelings, ideas, or facts" is judged to characterize only 1% of DOT occupations and 2% of the labor force. This is implausible on its face, given the responses to the other items. It is likely that the item was regarded by raters as so ambiguous that they were reluctant to use it. Similarly, a temperament for "influencing people," which characterizes only 4% of the DOT occupations and 12% of both the Census occupations and the labor force, would appear to be miscoded, considering that in some sense all sales occupations and all managerial occupations involve influencing people, and these categories together include substantially large fractions of all three populations.

Since so little is yet known about the behavior of the DOT variables, potential users would be well advised to examine the precise content of each variable of interest and also its distribution in the population under study in order to ensure that the chosen variables properly represent the concepts they are intended to measure.

The Factor Structure of DOT Occupational Characteristics

Ostensibly, each of the 44 variables reflects a distinct occupational characteristic. Several researchers, however, have noted a high degree of redundancy among these variables, manifest both in the content of the items and in the substantial correlations between some of them (Spenner, 1977; McLaughlin, 1978). To reduce the data to manageable proportions and to avoid multicollinearity problems in multiple-regression analysis, these investigators have created multiple-item scales. McLaughlin (1978) factor-analyzed a subset of DOT variables from the third edition and used the resulting factor scores to construct indicators of the cognitive, manipulative, and social skill requirements of occupations. Spenner (1977) combined a number of temperament variables and constructed a simple additive scale to measure the routinization of work.

In order to determine the underlying dimensions latent in the full set of 44 DOT variables, we factor-analyzed them using the 10% sample of DOT occupations (N=1,172). The particular, factor-analytic technique used was principal factoring with iterations (option PA2 in SPSS). Factors were orthogonally rotated, using the varimax procedure. Based on two criteria—the rule of thumb that eigenvalues be greater than one, and performance of a skree test (Harman, 1976)—six significant factors emerged from the analysis, which accounted for 95% of the common variance in the correlation matrix. Generally, a loading of .4 was chosen as the cutting point for deciding whether or not to include a specific item in a factor. In a few instances, however, items that corresponded in content to other items in the factor and that had loadings greater than .3 were included in the factor. The item composition of each of the factors plus factor loadings and the percentage of variance explained by each are given in Table 8.

The first factor (top panel of Table 8) explains 49% of the total shared variance and consists of 17 items with loadings

Table 8. Factor Analysis of DOT Occupational Characteristics, Items and Loadings for Six Factors

	Factor 1: SUBSTANTIVE COMPLEXITY[a] 49.3%[b]	
GED	General educational development	.86
SVP	Specific vocational preparation	.86
INTELL	Intelligence[c]	.83
DATA	Complexity of functioning with data[c]	.81
REPCON	Repetitive or continuous processes	−.81
NUMER	Numerical aptitude[c]	.78
VERBAL	Verbal aptitude[c]	.76
ABSTRACT	Abstract and creative vs. routine, concrete activities	.68
MVC	Measurable or verifiable criteria	.64
CLERICAL	Clerical perception[c]	.64
SPATIAL	Spatial perception[c]	.55
PEOPLE	Complexity of functioning with people[c]	.47
FORM	Form perception[c]	.46
TALK	Talking	.44
DCP	Direction, control, and planning	.43
VARCH	Variety and change	.42
DATACOM	Communication of data vs. activities with things	.41
	Factor 2: MOTOR SKILLS 22.6%	
FINGDEX	Finger dexterity[c]	.69
MOTOR	Motor coordination[c]	.68
MANDEX	Manual dexterity[c]	.67
THINGS	Complexity of functioning with things[c]	.66
FORM	Form perception[c]	.52
SPATIAL	Spatial perception[c]	.47
SEE	Seeing	.43
REACH	Reaching	.42
STS	Set limits, tolerances, or standards	.37
MACHINE	Activities involving processes, machines vs. social welfare	.33
	Factor 3: PHYSICAL DEMANDS 9.9%	
LOCATION	Outside working conditions	.67
STOOP	Stooping, kneeling, crouching, crawling	.53
EYEHAND	Eye-hand-foot coordination[c]	.52
CLIMB	Climbing, balancing	.49
STRENGTH	Lifting, carrying, pulling, pushing	.48
	Factor 4: MANAGEMENT 5.4%	
DEPL	Dealing with people	.78
DCP	Direction, control, planning	.74
PEOPLE	Complexity of functioning with people[c]	.70
TALK	Talking	.64
TANGIBLE	Activities resulting in tangible satisfaction vs. prestige	−.63
SCIENCE	Scientific, technical activities vs. business contact	−.57
DATACOM	Communication of data vs. activities with things	.49
DATA	Complexity of functioning with data[c]	.44
	Factor 5: INTERPERSONAL SKILLS 4.9%	
SJC	Sensory or judgmental criteria	.51
FIF	Feelings, ideas, facts	.41
INFLU	Influencing people	.41
MACHINE	Activities involving processes, machines vs. social welfare	−.37
	Factor 6: UNDESIRABLE WORKING CONDITIONS 2.9%	
HAZARDS	Hazardous conditions	.52
ATMOSPHR	Fumes, odors, dust, poor ventilation	.42
HEAT	Extreme heat	.37

[a] This title is borrowed from Kohn (1969), who uses it to describe a conceptually similar but not operationally identical occupational dimension.
[b] Percentage of common variance explained.
[c] Sign reflected on this variable.

greater than .40. An inspection of the items suggests that this factor reflects the substantive complexity of work, as indicated by the high loadings of the training variables, GED and SVP; the worker functions, DATA and PEOPLE; and the aptitudes, INTELL, NUMER, and VERBAL. The loadings of the temperament variables REPCON and VARCH also reinforce the interpretation of this factor as measuring the complexity of routines entailed in occupations.

The second factor accounts for 23% of the shared variance. The high loadings of FINGDEX, MANDEX, REACH, SEE, as well as those of the machine-related THINGS and MACHINE variables, clearly indicate that this factor reflects the motor or sensory skills required by occupations.

The third factor (which explains 10% of the shared variance) also taps a dimension of the physical requirements of jobs, but the high positive loadings of LOCATION, STOOP, EYEHAND, CLIMB, and STRENGTH indicate that this factor reflects the arduous physical requirements of occupations, i.e., those characterized more by brawn than by fine motor skills.

The fourth factor explains only 5% of the shared variance, but the items that load significantly on it clearly represent the organizational or administrative components of occupations such as dealing with people (DEPL and PEOPLE) and directing or planning (DCP). It should be noted that Factors 1 and 4 share a number of items in common (DATA, PEOPLE, DCP, DATACOM, TALK), which indicates that there is a close relationship in the DOT between the substantive complexity of occupations and their managerial responsibilities.

The fifth and six factors explain 5% and 3% of the shared variance in the matrix, respectively. Factor 5, which is composed of only four items, is labeled "interpersonal skills." An inspection of the item content reveals that this dimension involves working with feelings and ideas and sensory or judgmental criteria and that it involves influencing people and dealing with their social welfare. The sixth factor, although it explains only 3% of the variance, is readily interpretable as distinguishing occupations with undesirable working conditions.

By and large, the results of this factor analysis are straightforward. Only five variables (COLORDIS, PUS, COLD, WET, and NOISE) failed to load significantly on any of the factors, and of these five variables, all but COLORDIS are dichotomous variables with limited variance. Several variables did load on more than one factor, however: as noted, there is some overlap between Factors 1 and 4; Factors 1 and 2 also share two items in common. This loading of items on more than one factor suggests that our assumption of orthogonality in specifying the factor-analytic model is probably untenable and should be relaxed in future work. One reviewer questioned whether the overrepresentation of manufacturing occupations in the DOT might bias the results of the factor analysis. Although this is a legitimate concern, substantially similar results emerged in a parallel factor analysis of the DOT variables aggregated to the Census classification (Roos and Treiman, 1980). In that analysis four interpretable factors emerged, corresponding to Factors 1, 2, 3, and 6 reported here.

These results suggest that DOT variables might be efficiently exploited by using factor scores to create composite indices of the dimensions just discussed. In addition to their parsimony, scales created in this way have the advantage of greater internal consistency or reliability than scales created by simple summing of items. They are also more reliable than single indicators. Although we have not created factor scales for the DOT occupations, it would be possible to do so utilizing the information reported in Miller, et al. (1980: Chapter 7). Factor-based scale scores are, however, available for the Census classification (Roos and Treiman, 1980: Table F.2). The utility of such scales will of course depend upon the specific problem being addressed. In some instances, factor or factor-based scales summarizing major occupational dimensions should prove very helpful; in others, however, it may be better to rely on particular items that measure the specific characteristics of interest. For example, a variable such as PUS, the temperament

for performing under stress, which characterizes the jobs performed by five percent of the labor force (Table 6), may prove very important in studying the relationship between occupational experience and personality.

More generally, we urge the exploration of a variety of factor models. The results of our analysis suggest that the DOT variables can be reduced to a small number of dimensions. The precise specification of these dimensions, via confirmatory factor analysis (Jöreskog, 1969; Bielby and Hauser, 1977), is beyond the scope of the present paper and is, moreover, properly problem-dependent. We do know from preliminary analysis conducted by Baron and Bielby that the emergent factor structure is highly sensitive to model specification (Baron, 1980, personal communication). Thus the results reported here should be regarded as suggestive rather than definitive.

CHANGES IN SUCCESSIVE EDITIONS OF THE DOT

Sex Bias in the Rating of Occupations

Recent interest in women's occupational attainment and labor force behavior has prompted a series of inquiries into the determinants, correlates, and consequences of the gender composition of occupations, several of which have made use of third edition DOT variables (McLaughlin, 1978; Roos, forthcoming). The use of third edition ratings to compare the characteristics of men's and women's jobs is called into question, however, by recent charges that both the occupational descriptions and the ratings of occupational characteristics in the third edition undervalue women's work. In particular, the charge has been made that ratings of the complexity of work in relation to data, people, and things reflect traditional stereotypes regarding the relative complexity of the kinds of jobs typically held by women and the kinds of jobs typically held by men (Witt and Naherny, 1975). On the basis of impressionistic evidence, there appears to be some basis for these charges. In the third edition of the DOT, the DATA, PEOPLE, and THINGS variables included as the lowest response level a judgment that an occupation has "no significant relationship to . . . (data, people, or things)." "Typist," a job held mainly by women, was coded as having no significant relationship to things, whereas "typesetting-machine tender," a job held mainly by men, was coded at a higher level of complexity. Such jobs as "nursery school teacher" and "practical nurse" were coded as having no significant relationship to data, people, and things, while such jobs as "dog pound attendant" were rated at higher levels of complexity.

In response to the charge of sex bias in the third edition, the "no significant relationship" category was dropped in the fourth edition and the lowest complexity levels were redefined to include all occupations that did not score above the minimum level. In addition, a small number of scores were changed between the third and fourth editions for occupations with significant relationships. Presumably this was done to reflect changes in job content or to correct errors in the third edition. The changes sometimes involved upgrading the complexity level and sometimes involved downgrading it.

Our present purpose is to evaluate the changes made between the third and fourth editions to determine whether the ratings of occupations commonly pursued by women have been upgraded as claimed. We do this by utilizing the April 1971 Current Population Survey of a representative sample of the labor force. By comparing third and fourth edition scores on the DATA, PEOPLE, and THINGS variables separately for males and females, we can determine the effect of scoring changes between the third and fourth editions on the relative status of male and female workers. Note that our sample is comprised of workers, not jobs. Since the CPS sample consists of a single set of occupational descriptions coded and scored in two different ways—with third and fourth edition codes and scores—any observed differences are entirely attributable to coding changes in the two editions. An analysis of the nature of these changes permits an indirect inference about the extent of sex bias remaining in the fourth edition DOT.

The top panel of Table 9 shows that for

Table 9. Changes in the Scoring of DATA, PEOPLE, and THINGS Between the Third and Fourth Editions of the DOT[a]

	DATA		PEOPLE		THINGS	
	Male	Female	Male	Female	Male	Female
Total labor force						
Pct no significant relationship in 3rd edition	34.4	33.2	60.6	37.9	39.9	72.6
Mean in 4th edition, of those with no significant relationship in 3rd edition	5.41	5.34	7.23	7.38	6.21	4.76
Pct in lowest category in 4th edition, of those with no significant relationship in 3rd edition	75.8	68.1	61.6	68.9	92.7	82.9
Pct upgraded—3rd to 4th edition[b]	3.6	5.0	3.2	1.8	2.6	3.1
Pct constant—3rd and 4th edition	95.1	93.1	94.2	97.6	96.1	95.7
Pct downgraded—3rd to 4th edition	1.4	1.1	2.6	.6	1.3	1.2
Total mean—3rd edition[c]	3.97	4.51	6.58	6.28	5.13	6.92
Total mean—4th edition	3.10	3.63	6.14	6.22	4.39	4.55
Difference in means (4th minus 3rd)	−.87	−.88	−.44	−.06	−.74	−2.37
Clerical and sales						
Pct no significant relationship in 3rd edition	7.5	4.7	32.6	38.2	83.8	91.4
Mean in 4th edition, of those with no significant relationship in 3rd edition	4.50	5.03	7.10	7.08	5.87	3.60
Pct in lowest category in 4th edition, of those with no significant relationship in 3rd edition	24.1	51.9	55.5	54.5	75.7	31.9
Pct upgraded—3rd to 4th edition[b]	8.4	7.4	8.2	.7	.2	0.0
Pct constant—3rd and 4th edition	88.7	91.7	91.5	98.9	94.4	99.2
Pct downgraded—3rd to 4th edition	3.1	.9	.3	.4	5.5	.8
Total mean—3rd edition[c]	3.40	3.61	6.16	6.68	7.68	7.63
Total mean—4th edition	3.07	3.40	5.77	6.32	5.94	3.61
Difference in means (4th minus 3rd)	−.33	−.21	−.39	−.36	−1.74	−4.02
Service						
Pct no significant relationship in 3rd edition	75.5	82.9	55.7	29.1	37.9	64.0
Mean in 4th edition, of those with no significant relationship in 3rd edition	5.54	5.18	7.32	7.54	5.63	5.90
Pct in lowest category in 4th edition, of those with no significant relationship in 3rd edition	81.3	62.2	65.9	76.8	62.1	63.9
Pct upgraded—3rd to 4th edition[b]	0.0	0.0	1.8	1.5	0.0	.5
Pct constant—3rd and 4th edition	99.3	99.9	97.9	98.4	100.0	99.3
Pct downgraded—3rd to 4th edition	.7	.1	.2	.1	0.0	.2
Total mean—3rd edition[c]	6.56	7.03	7.18	7.17	6.09	6.67
Total mean—4th edition	4.72	4.71	6.78	7.02	5.19	5.32
Difference in means (4th minus 3rd)	−1.84	−2.32	−.40	−.15	−.90	−1.35
Benchwork						
Pct no significant relationship in 3rd edition	55.9	77.7	92.1	97.7	.3	0.0
Mean in 4th edition, of those with no significant relationship in 3rd edition	5.74	5.84	7.90	7.83	7.00	—
Pct in lowest category in 4th edition, of those with no significant relationship in 3rd edition	88.2	94.2	95.1	91.6	100.0	—
Pct upgraded—3rd to 4th edition[b]	4.3	8.1	0.0	0.0	7.1	7.1
Pct constant—3rd and 4th edition	91.3	85.7	96.2	100.0	90.7	89.8
Pct downgraded—3rd to 4th edition	4.4	6.2	3.8	0.0	2.2	3.0
Total mean—3rd edition[c]	5.48	6.68	7.64	7.92	3.32	3.47
Total mean—4th edition	4.33	5.38	7.55	7.76	3.18	3.37
Difference in means (4th minus 3rd)	−1.15	−1.30	−.09	−.16	−.14	−.10

[a] Data from the April 1971 Current Population Survey of a representative sample of the adult labor force, N=60,441.

[b] Percent assigned a higher complexity level (a lower score) in the fourth edition than in the third edition. excluding those with no significant relationship in the third edition. Percent constant and percent downgraded similarly defined.

[c] Mean is computed on entire sample, including those with no significant relationship, a score of 7 or 8 on data, 7 on people, and 8 on things.

the labor force as a whole, about a third of both sexes in 1971 were in occupations that were judged in the third edition to have no significant relationship to data. In contrast, a much larger proportion of males than females were in occupations having no significant relationship to people and a much larger proportion of females than males were in occupations having no significant relationship to things. The second line of the table, which shows the mean fourth edition score for occupations with "no significant relationship" in the third edition, tells us what happened to these occupations in the fourth edition. On average, the occupations held by men and those held by women were assigned similar scores on the DATA and PEOPLE variables, but on the THINGS variable the occupations held by women were judged to be more complex than the occupations held by men. In short, the major effect of the abolition of the "no significant relationship" category was to substantially upgrade occupations held by women with respect to their complexity in relation to things. This conclusion is also evident in the bottom line of the top panel of the table, which shows the difference in the average score between the third and fourth editions. Since a low score means greater complexity, the fact that all the numbers in the row are negative indicates an average upgrading of complexity levels between the third and fourth editions. The only change of substantive importance, however, is the upgrading of female occupations on the THINGS variable.

The remaining point to note before leaving the top panel is that except for changes required by the abolition of the "no significant relationship" codes, there were few changes in ratings between the third and fourth editions. More than 93% of the scores remained unchanged between the two editions, as perhaps was to be expected given the way in which DOT occupational data were generated.

Inspection of the second panel of Table 9 allows us to identify a major source of change in the THINGS ratings—the upgrading of clerical and sales jobs done by women. Most clerical and sales jobs, whether held by men or women, were identified in the third edition as having no significant relationship to things. However, in the fourth edition the occupations held by women were coded substantially differently on the THINGS variable from those held by men; on average, the clerical and sales occupations held by women were judged as having much greater complexity than those held by men. No doubt this reflects the greater propensity of female clerical and sales workers than male clerical and sales workers to operate office machines. Whereas in the third edition the task of typing was rated as *not* involving a significant relationship to things (level 8), in the fourth edition it was rated as involving the "operating-controlling" of things (level 2). The same sort of coding change was made for a large number of office machine-operating positions. Hence, while both females' and males' clerical and sales occupations tended to be upgraded in the fourth edition, the upgrading was much greater for the jobs done by females. Thus, based on fourth edition scores, the average female clerical and sales worker is scored as doing more complex work in relation to things than the average male clerical and sales worker.

In contrast to the clerical and sales sector, the service and benchwork sectors—included here because they are also large employers of women—do not exhibit radically different patterns of upgrading for jobs held by men and women, although they do show significant differences in the proportion of occupations in the third edition with no significant relationship to data, people, and things.

These data suggest that the fourth edition of the DOT is substantially free of bias, at least with respect to these variables. The evidence for this is to be found in the next-to-last row of each panel. Comparison of the mean complexity scores for males and females reveals surprisingly small differences. For the total labor force, the means for DATA vary by only about half a point and the means for PEOPLE and THINGS by even less. Although all the means are lower for males (indicating greater complexity in the jobs

men do), the size of the differences is well within what would be expected from well-known patterns of occupational segregation by sex.

The judgment that the fourth edition DOT is largely unbiased is hardly definitive in the absence of an independent criterion of work complexity. Indeed, the possibility exists that the fourth edition scores overcorrect the third edition bias and create a bias in *favor* of the jobs done by women. This, however, seems unlikely, especially in light of a bit of evidence showing that the substantive complexity of occupations is slightly negatively related to the proportion of women in them, holding constant the average educational attainment of incumbents (a plausible independent indicator of complexity): for the 574 Census occupations for which complete data exist, $\hat{S} = -.127(F) + .857(E)$, where S is the factor-based substantive complexity scale referred to above, F is the proportion female, E is the average years of school completed by incumbents, and the coefficients are expressed in standard form.

Given these results, it seems reasonable to use the occupational characteristics contained in the fourth edition to investigate sex differences in job content and occupational rewards. We recommend against use of the third edition characteristics, however, because the evident bias against women's occupations in the third edition will necessarily result in an overstatement of the differences between the attributes of work performed by men and women.

Using the DOT to Study Changes in the Job Content of the Economy: A Cautionary Note

Because the DOT includes occupational descriptions based on on-site analyses of jobs, it has been assumed by some researchers that changes in the content of successive editions of the DOT mirror changes in the job content of the economy over time. On this assumption, it would be possible to study changes in the job content of the economy by studying changes in the distribution and nature of occupational descriptions over the four editions of the DOT published since 1939. Spenner (1979) has carried out such a study, comparing mean scores on the DATA, PEOPLE, and THINGS variables in the third and fourth edition DOT for a five percent sample of fourth edition occupations. On the basis of these comparisons, Spenner finds some support for the hypothesis of increased occupational complexity between 1965 and 1978: "the levels of work with data, people, and things have become more complex over the last ten to 15 years" (1979:971).[7] A similar analysis by Horowitz and Herrenstadt (1966), which compared data from the second (1949) and third (1965) editions of the DOT, concluded, in contrast, that there was little change in the skill levels required of occupations during the 16-year period under study. And an analysis by Rumberger (1980), which compared third and fourth edition GED scores for the occupations of a representative sample of the labor force in 1976, concluded that there had been a narrowing over time in the skill requirements of jobs.

Unfortunately, these studies are based on a fundamentally incorrect premise—that successive editions of the DOT involve independent evaluations of jobs. The fact is that each edition of the DOT has incorporated a substantial portion of the preceding edition.[8] Most of the evidence on this point is from the fourth edition. As Spenner himself notes, 75% of his sample of fourth edition titles were verbatim replicates of titles in the third edition (recall that our own estimate is 81%). This replication arises from the way data were collected for the fourth edition. Analysts were encouraged to write an abbre-

[7] Incidentally, Spenner (1979:973), attempting to discount alternative explanations for this conclusion, notes that the mean differences in DATA, PEOPLE, and THINGS scores he observed could be due to changes in coding procedures between the third and fourth editions. He posits, but rejects, the nonrandom upgrading of a large number of jobs. This, however, is precisely what happened, as we have seen in the previous section. It may be that this accounts for the fact that Spenner found evidence of an increase in job complexity.

[8] In fairness to these authors it should be noted that there was no way for them to have known this fact, since the work establishing it had not been done at the time of their writing.

viated, "confirmation" job-analysis schedule whenever they encountered a job already described in the third edition; about two-thirds of the 75,000 job analyses prepared for the fourth edition were of this type. This mode of operation is bound to maximize correspondence between successive editions. Also, as we noted above, the sampling procedures used to locate jobs for analysis in the fourth edition were not well-suited to identify new jobs in the economy. Moreover, they resulted in probable undercoverage of jobs in the service sector, which has grown very rapidly in recent years, with many changes in job content. The unhappy implication of these two points is clear; the DOT cannot legitimately be used to study changes in the job content of the economy over time.

CONCLUSION

As noted in the introduction, academic research use of the DOT has been increasing in recent years, and various developments point to its even greater use in the future. The point of this paper has been to facilitate such use. We do not, however, consider the DOT to be the panacea for all the data needs of the occupational researcher. Although it does contain information about a large number of characteristics for literally thousands of occupations in the U.S. economy, the evidence we presented suggests that many of these characteristics are redundant. Furthermore, despite their number, the DOT characteristics are not exhaustive of all of the kinds of information one would like to have about occupations. Missing, for example, are explicit measures of the authority relationships entailed in jobs, the responsibility exercised, the number of persons supervised, and so on. Also missing is information on the interrelationships among occupations, such as their place in job ladders.[9] Such information would be especially useful to researchers interested in career processes or in sex differences in occupational attainment.

Notwithstanding these considerations and the other problems and peculiarities we have explored in this paper, the DOT is indisputably a rich and unique source of occupational data. We therefore encourage the increased use of these data by academic researchers, both because we believe that the potential of the data has not yet been fully realized and because increased use will afford a still better understanding of the data's properties. We thus strongly urge that occupational responses in sample surveys be coded with the nine-digit DOT codes as well as with the commonly-used three-digit Census codes. This has been done for the new youth cohort of the National Longitudinal Survey. Current occupation in 1979, the data of the first wave of the survey, was coded with fourth edition DOT codes.

The expectation that large-scale sample surveys will be increasingly and more extensively mined by researchers engaged in secondary analysis makes it particularly important that the capacity to add DOT variables to a data set be built into it at the outset. This can be done by including fourth edition codes in the data set and making use of the "DOT master file" to add worker trait and worker function scores (see footnote 1 for details on how to obtain these data). Researchers may also wish to add DOT occupational characteristics to existing data sets, which is possible for all data sets in which occupational responses have been coded with the 1970 U.S. Census three-digit codes. This can be done by making use of the "Fourth edition DOT scores for 1970 Census categories" (see Appendix C for details on how to obtain these data).

[9] In fact, information on promotion ladders (jobs within firms from which incumbents are recruited and to which they are promoted) is currently included on the job analysis schedules. Information on whether or not a particular job is entry-level is also available from the "staffing schedules" analysts prepare before beginning their detailed job analysis. At the present time, however, none of this information is included when the job descriptions are collated to create DOT occupations. But work underway by Bielby and Baron (1980) should yield such information for at least some of the DOT occupations, since they plan to make publicly available a computerized data base that includes the narrative report, staffing schedule, and job analysis schedules for all job analyses conducted by the Los Angeles Field Center of the Division of Occupational Analysis.

APPENDIX A

Examples of DOT Definitions

201.362–030 SECRETARY (clerical) secretarial stenographer.

Schedules appointments, gives information to callers, takes dictation, and otherwise relieves officials of clerical work and minor administrative and business detail: Reads and routes incoming mail. Locates and attaches appropriate file to correspondence to be answered by employer. Takes dictation in shorthand or by machine [STENOTYPE OPERATOR (clerical)] and transcribes notes on typewriter, or transcribes from voice recordings [TRANSCRIBING-MACHINE OPERATOR (clerical)]. Composes and types routine correspondence. Files correspondence and other records. Answers telephone and gives information to callers or routes call to appropriate official and places outgoing calls. Schedules appointments for employer. Greets visitors, ascertains nature of business, and conducts visitors to employer or appropriate person. May not take dictation. May arrange travel schedule and reservations. May compile and type statistical reports. May oversee clerical workers. May keep personnel records [PERSONNEL CLERK (clerical)]. May record minutes of staff meetings. May make copies of correspondence or other printed matter, using copying or duplicating machine. May prepare outgoing mail, using postage-metering machine.

786.682–010 APPLIQUER, ZIGZAG (garment)

Operates *zigzag sewing machine* to sew appliques, monograms, embroidery, or lace on designated places of garment to decorate or reinforce garment. Performs duties as described under SEWING-MACHINE OPERATOR, REGULAR EQUIPMENT (any ind.).

Appendix B. Summary of Rating Levels of Worker Functions and Selected Worker Traits

Worker Functions

DATA	PEOPLE	THINGS
0—Synthesizing	0—Mentoring	0—Setting Up
1—Coordinating	1—Negotiating	1—Precision Working
2—Analyzing	2—Instructing	2—Operating-Controlling
3—Compiling	3—Supervising	3—Driving-Operating
4—Computing	4—Diverting	4—Manipulating
5—Copying	5—Persuading	5—Tending
6—Comparing	6—Speaking-Signaling	6—Feeding-Offbearing
	7—Serving	7—Handling
	8—Taking Instructions-Helping	

GED 1 to 6 (low to high). See U.S. Department of Labor (1972:210–211) for detailed description.

SVP

1—Short demonstration only
2—Anything beyond short demonstration up to and including 30 days
3—Over 30 days up to and including 3 months
4—Over 3 months up to and including 6 months
5—Over 6 months up to and including 1 year
6—Over 1 year up to and including 2 years
7—Over 2 years up to and including 4 years
8—Over 4 years up to and including 10 years
9—Over 10 years

Physical Demands

STRENGTH: 1—Sedentary Work; lifts 10 pounds maximum with occasonal lifting and/or carrying of light articles.
2—Light Work; lifts 20 pounds maximum with frequent lifting and/or carrying of objects up to 10 pounds.
3—Medium Work; lifts 50 pounds maximum with frequent lifting and/or carrying of objects weighing up to 25 pounds.
4—Heavy Work; lifts 100 pounds maximum with frequent lifting and/or carrying of objects weighing up to 50 pounds.
5—Very Heavy Work; lifts objects in excess of 100 pounds with frequent lifting and/or carrying of objects weighing 50 pounds or more.

CLIMB —Climbing and/or Balancing
STOOP —Stooping, Kneeling, Crouching and/or Crawling
REACH—Reaching, Handling, Fingering, and/or Feeling
TALK —Talking and/or Hearing
SEE —Seeing

Environmental Conditions

LOCATION:	1—Protection from weather conditions but not necessarily from temperature changes 2—Activities occur inside and outside in approximately equal amounts 3—No effective protection from weather
COLD	—Extreme Cold with or without Temperature Changes
HEAT	—Extreme Heat with or without Temperature Changes
WET	—Wet and/or Humid
NOISE	—Noise and/or Vibration
HAZARDS	—Hazards
ATMOSPHR	—Atmospheric Conditions

Source: U.S. Department of Labor (1972).

APPENDIX C

The Current Population Survey

The CPS data set, which includes data for 60,441 members of the labor force, is useful in evaluating the properties of the DOT. In all CPS samples occupational responses are routinely assigned Census detailed occupation codes. The April 1971 CPS was also coded with DOT categories. Third edition DOT codes were assigned to each occupational response by trained occupational analysts in the U.S. Department of Labor Occupational Analysis Field Centers. Fourth edition codes were subsequently added to the data by Lloyd Temme, who utilized a map prepared by the Division of Occupational Analysis that related fourth edition DOT codes to third edition codes. The presence of both third and fourth edition codes in the data set then made it possible to add to it occupational characteristics scores from both the third and fourth editions. The augmented data set includes a number of characteristics of workers—age, education, sex, race, and labor force status—as well as DOT codes and scores on occupational characteristics from both the third and fourth editions of the DOT. The augmented data set is available on computer tape from the Inter-University Consortium for Political and Social Research, University of Michigan, P. O. Box 1248, Ann Arbor, Michigan 48106, and from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. Inquiries should refer to the "April 1971 Current Population Survey augmented with DOT characteristics."

Data for the Census Occupations

For the data on the Census occupations, the Census classification utilized is that appearing in the most detailed published tabulations from the 1970 Census (U.S. Bureau of the Census, 1973). It is an expansion of the 441 category Census detailed occupational classification to 591 categories, created by subdividing some occupational categories on the basis of industry and making a further distinction between self-employed and salaried "managers and administrators, n.e.c." See Roos and Treiman (1980) for further discussion of the creation of DOT scores for these categories. As a convenience for researchers, scores for eight DOT variables (DATA, PEOPLE, THINGS, GED, SVP, STRENGTH, and composite scales for physical demands and working conditions) are shown for each of the 591 categories in Roos and Treiman (1980, Table F.1). Scores for all fourth edition DOT variables created for the 591 category classification are available on computer tape, which may also be obtained from the Inter-University Consortium for Political and Social Research or the National Technical Information Service. Inquiries should refer to the "Fourth edition Dictionary of Occupational Titles (DOT) scores for 1970 Census categories." Parallel scores for the third edition have been prepared by Lloyd Temme and Kenneth Spenner and are available directly from Spenner, % Career Development, Boys Town Center, Boys Town, Nebraska 68010 (see Spenner, Otto, and Call, 1980).

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