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The purpose of this study was to develop a measurement technique for determining skill levels required for various occupations for use in training, counseling, job placement, and measuring labor force quality. Measures related to income and educational levels of workers were selected. It was assumed that higher earnings reflected a higher skill requirement. Data were collected from census information and "The Dictionary of Occupational Titles." Only those mutually exclusive occupations were selected which contained 50,000 workers in a 1960 census and which were clearly defined in "The Dictionary of Occupational Titles." Some of the information collected included: general educational development, specific vocational preparation, aptitude, interest, temperament, physical demands, percent of workers with less than a high school education, percent of workers with 4 years or more of college, median school years by worker in each occupation, median income by worker in each occupation, and median wage and salary. Intercorrelations were obtained and a model for use of canonical correlations with multiple criteria and predictors was developed. Variables were assigned to groups arbitrarily in the model. A list of the references and occupations selected is included. (DM)

Department of Vocational Education

Research Report

DETERMINATION OF OCCUPATIONAL SKILL LEVEL

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JULY 1968

Colorado State University

Fort Collins

FOREWORD

This attempt at finding a single measure of skill required on a job represents an approach that is somewhat different than those which have been used previously. The results indicate that there is a possibility of estimating this skill within the limits of the data used. At the same time, the accuracy of the estimates result only in a tentative skill level index.

I would like to express my appreciation to:

Dr. Ronald Wykstra, Department of Economics, Colorado State University, Fort Collins, Colorado.

Dr. Douglas Sjogren, Director, Research Coordinating Unit, Department of Vocational Education, Colorado State University, Fort Collins, Colorado.

Without their assistance and advice, I would probably not have completed this paper.

G. Dale Gutcher

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DETERMINATION OF

OCCUPATIONAL SKILL LEVELS

The Third Edition of the Dictionary of Occupational Titles, lists some 18,000 jobs each of which is identified by a six digit occupational code number. All listed occupations are grouped into nine categories which are divided and further subdivided until each job is so identified. The last three digits of this occupational code number indicate the degree of relationship between the worker and job requirements with respect to data, people, and things. In the compilation of the Dictionary of Occupational Titles, it was presumed that workers must function, to some degree, with these three job characteristics, and by use of the coding system a useful description of job requirements is thus formulated.

Included also in the Dictionary of Occupational Titles is a "qualifications profile" which presents an analysis of the required worker traits for the different occupational categories.

In 1964, R. S. Eckaus (2) began working with the first two of these worker traits as they are compiled in "Estimates of Worker Traits Requirements for 4000 Jobs", and presented estimates of general and specific education and training requirements by industry. He classified the labor force according to the education and training requirements for each industrial category, and compiled a percentage distribution of the entire labor force in the various GED and SVP categories. He also calculated the average level of training and education for each industry, which provided a detailed description of the education and training requirements of the labor force in each covered industry. This made it possible to

distinguish between industries on the basis of the various types of education and skill which they require.

Working with 1940 and 1950 data obtained from the Occupational Census Report, Eckaus was able to determine that a general upgrading of the education and skill requirements of the labor force was taking place. There were, admittedly, certain inaccuracies and grossness of measures, particularly with the Census of Population job classification, however this does give information about the labor force and its desirable educational background.

In 1966, James G. Scoville (9) applied a similar analysis to the education and training requirements of occupations. His argument was that technological change is not "neutral" with respect to the component occupations of an industry, and that if estimates of the amounts of various types of training required to fill certain jobs can be obtained, the projections of changing occupational patterns will provide predictions of requirements of the educational and training system. Using the information contained in Estimates of Worker Traits Requirements for 4000 Jobs, he listed different occupations along with the general educational and specific vocational requirements. He also concluded that there had been a general increase of both specific and general training requirements. However, when comparing that which was required with median attainment of the workers he found inconsistencies. In a great many instances, the estimates of the required specific and general training exceeded the median attainment of those now in the occupations. It is obvious that some discrepancies exist, either in the Bureau of Employment Security estimates of worker trait requirements or in the Census of Population social-economic groupings, or

perhaps in the author's application of this information.

Using Census of Population data, Eckaus determined that the numbers of employed persons that actually had a full high school education exceeded the number of jobs that required this much education.

Scoville, on the other hand, has shown that by using the estimates of required specific and general training, that these requirements generally exceeded that training possessed by the workers. This divergence of conclusions would further indicate that the obtained data was somewhat lacking in precision.

The studies mentioned above, suggest the possibility of utilizing the description of job requirements as it is formulated in the Dictionary of Occupational Titles and other occupational information obtained from various Census reports to obtain a measure of the skill required of a worker on a job.

As was previously mentioned, the last three digits of the occupational code number represent what the worker does on the job. These would seem to indicate the general level of intelligence, the educational attainment, specific educational preparation, and the manipulative dexterity required of the worker in a particular occupation. If this is so, it was hoped that there was a possibility of combining these digits, weighting them, and arriving at some single quantitative measure of skill required of a worker in any occupation. The problem was to determine if a single index of skill could be obtained from use of these three digits.

For some time it has been thought that if it were possible to find some way of measuring the skill level required by various occupations, that this would be of considerable value and used to advantage in several

areas including: (1) training, (2) counseling, (3) job placement and (4) measuring the quality of the labor force. To this end, it was decided that these three digits, the occupation qualifications profile, and information concerning the workers present and/or past status with regard to income and education in several different occupations should be considered and analyzed.

Measures relating to income and education levels were selected on the basis of an assumption of a high degree of correlation between these measures and skill level. The comparisons performed by Eckaus and Scoville suggest that the estimates of required education may not be consistent with actual requirements or the attained education. The measures relating to education that were utilized in this study are the median of the attained education of the workers in the selected occupations, and therefore should be relatively accurate indicators.

It seemed reasonable to assume that a higher degree of skill required of a worker on a job, would be reflected in higher earnings for that worker. Similarly, the greater the skill that is required of a worker could be reflected in a higher level of educational attainment. Thus it would seem that two rational measures of the skill required on a particular job would be the income derived from that job and a measure of the educational attainment of the worker.

OCCUPATIONAL SELECTION

The selection of occupations for which the needed data were collected, was based on three factors. First, the numbers of people earning their living within that occupation whould be large enough so that fairly accurate measures could be obtained. Second, the occupation must be clearly defined in the Dictionary of Occupational Titles, so that the last three digits of the occupational code number could be obtained. Third, the occupation should be distinct in itself and not be included in other occupational categories.

Initial selection of the occupations was based on the total number of persons within an occupation. This level was set at 50,000 workers. Data contained in Table 29, U. S. Census of Population, 1960, were utilized in making this preliminary selection.

The Dictionary of Occupational Titles was then referred to so that the last three digits of the six digit occupational code number, and the qualifications profile, as listed therein, could be obtained.

Some of the occupations selected from the Census data were eliminated from consideration because a duplicate of the occupational title could not be found in the D. O. T. Other occupations were also eliminated because they were grouped with similar occupations in the D. T. O. and therefore bore the same occupational code number and qualifications profile. An example of this is the Civil Engineer which is grouped under Engineering Research and Design (.081), Engineering, Scientific, and Technical Coordination (.168), Drafting and Related Work (.181; .281), Engineering and Related Work (.187), and Industrial Engineering and Related Work (.188 ; .288). Since it was desirable to have

as much distinction for each occupation as was possible, the inclusion of one occupation with one or more similar occupations prevented any discrimination. In this particular instance, specialization within Civil Engineering makes it possible to place these specialists into the other occupational groupings. The occupation of Civil Engineer was obviously too broad to classify specifically and therefore was dropped.

Where two or three occupations, closely related, carried the same occupational code number and qualifications profile, an arbitrary decision was made as to which occupation would be listed and which one dropeed. A listing of the ninety-nine selected occupations is appended.

D. O. T. DATA DESCRIPTION

For each of the selected occupations, the last three digits of the six digit occupational code number, as listed in the D. O. T., was determined. The fourth digit pertains to the degree of relationship between the worker and data, the fifth digit the degree of relationship between the worker and people, and the sixth digit the degree of relationship between the worker and things. Nine levels of significance are established for each, ranging from no significant relationship to a high degree of relationship, as illustrated by the following table:

LEVEL	DATA (4th digit)	PEOPLE (5th digit)	THINGS (6th digit)
0	Synthesizing	Mentoring	Setting-Up
1	Coordinating	Negotiating	Precision Working
2	Analyzing	Instructing	Operating-Controlling
3	Compiling	Supervising	Driving-Operating
4	Computing	Diverting	Manipulating
5	Copying	Persuading	Tending
6	Comparing	Speaking-Signaling	Feeding-Offbearing
7	No Significant Relationship	Serving	Handling
8	No Significant Relationship	No Significant Relationship	No Significant Relationship

Full definitions of these relationships are given in Appendix A, Vol. II, Dictionary of Occupational Titles, Third Edition.

The qualifications profile for each occupation was also determined. These constitue the abilities, personal traits, and individual characteristics required of a person to achieve average job performance success. The profiles contain six worker trait components for which a ranking or coding system has been devised to indicate the level, amount, degree, etc., of that particular component that is considered necessary for average

performance of that job. The six worker trait components are:

I General educational development.

II Specific vocational preparation.

III Aptitudes.

IV Interests.

V Temperaments.

VI Physical demands.

I General educational development

This includes learning achievement, both formal and informal, which contribute to a workers (a) reasoning development and ability to follow instructions, and (b) acquisition of "tool" knowledges, such as language and mathematical skills. The following is a table explaining the various levels of general educational development.

II Specific vocational preparation

This refers specifically to the amount of time required to learn the techniques, acquire information, and develop the facility needed for average performance in a specific job-worker situation.

The various levels of specific vocational preparation are as follows:

LEVEL	TIME
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.

The following is a table explaining the various levels of general educational development.

GENERAL EDUCATIONAL DEVELOPMENT (8:652)

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 nonverbal 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 contract. —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 hygeine, 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.		
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.	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.
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.	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.
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.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	
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.	Perform simple addition and subtraction, reading and copying of figures, or counting and recording.	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.

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

III Aptitudes

The aptitudes referred to pertain to the abilities and capacities of an individual required in order to adequately function on the job. These are the same nine aptitudes included in the General Aptitude Test Battery of the U.S. Employment Service, plus eye-hand-foot coordination and color discrimination.

A brief summary follows:

G — Intelligence: General learning ability.
V — Verbal: Ability to understand and use word meanings and ideas associated with them.
N — Numerical: Ability to perform arithmetic operations.
S — Spatial: Ability to comprehend forms in space and understand relationships of plane and solid objects.
P — Form Perception: Ability to perceive pertinent detail in objects or in pictorial or graphic material.
Q — Clerical Perception: Ability to perceive pertinent detail in verbal or tabular material.
K — Motor Coordination: Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed.
F — Finger Dexterity: Ability to move the fingers and manipulate small objects with the fingers.
M — Manual Dexterity: Ability to move the hands easily and skillfully.
E — Eye-Hand-Foot Coordination: Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.
C — Color Discrimination: Ability to perceive or recognize similarities or differences in colors.

Each of these aptitudes are scaled to indicate the level of aptitude considered necessary for average job performance. The following scale is used:

1 The top 10 percent of the population.
2 The highest third exclusive of the top 10 percent of the population.
3 The middle third of the population.
4 The lowest third exclusive of the bottom 10 percent of the population.
5 The lowest 10 percent of the population.

IV Interests

Preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. A positive preference for one factor of a pair also implies rejection of the other factor of that pair.

1- Situations involving a preference for activities dealing with things and objects.	vs.	6- Situations involving a preference for activities concerned with people and the communication of ideas.
2- Situations involving a preference for activities involving business contact with people.	vs.	7- Situations involving a preference for activities of a scientific and technical nature.
3- Situations involving a preference for activities of a routine concrete, organized nature.	vs.	8- Situations involving a preference for activities of an abstract and creative nature.
4- Situations involving a preference for working for people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations.	vs.	9- Situations involving a preference for activities that are nonsocial in nature and are carried on in relation to processes, machines, and techniques.
5- Situations involving a preference for activities resulting in prestige or the esteem of others.	vs.	0- Situations involving a preference for activities resulting in tangible, productive satisfaction.

V Temperaments

These involve different types of occupational situations to which the workers must adjust.

1- Situations involving a variety of duties often characterized by frequent change.
2- Situations involving repetitive or short cycle operations carried out according to set procedures or sequences.
3- Situations involving doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems.
4- Situations involving the direction, control, and planning of an entire activity or the activities of others.

5- Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions.
6- Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others.
7- Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things.
8- Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks.
9- Situations involving the evaluation of information against sensory or judgmental criteria.
0- Situations involving the evaluation of information against measurable or verifiable criteria.
X- Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint.
Y- Situations involving the precise attainment of set limits, tolerances, or standards.

VI Physical demands

These are categorized according to the amount and/or type of physical activities required of a worker in a job.

1- Lifting, carrying, pushing, and/or pulling (strength).

S- Sedentary work.
L- Light work.
M- Medium work.
H- Heavy work.
V- Very heavy work.

2- Climbing and/or balancing.
3- Stooping, kneeling, crouching, and/or crawling.
4- Reaching, handling, fingering, and/or feeling.
5- Talking and/or hearing.
6- Seeing.

CENSUS DATA DESCRIPTION

In addition to the above information, all of which is contained in the Dictionary of Occupational Titles, educational information was obtained from the U. S. Census Report, which concerned the workers in each of the selected occupations.

The percentage of workers in each occupation with less than a high school education was obtained. Also the percentage of workers with four or more years of college, and the median school years that had been completed by the workers in each occupation. This information was compiled for both 1950 and 1960 so that comparisons could be made over a period of time.

In addition, income information for the years 1950 and 1960 was collected. This was in the form of the median income of workers within each occupation, and also the median wage and salary income.

Income, as defined in both the 1950 and 1960 Census of Population reports, is the sum of money received from wages or salaries, net income from self-employment, and income other than earnings.

Not included in income is money received from the sale of property unless the recipient was engaged in the business of selling properties; the value of "in kind" income, such as free quarters or food produced and consumed in the home; withdrawals of bank deposits; money borrowed; tax refunds; gifts and lump-sum inheritances or insurance benefits.

Three types of incomes make up the total reported income. These are:

<u>Wage or salary income</u>--this is defined as the total money earnings received for work performed as an employee. It includes wages, salary, pay

from the Armed Forces, commissions, tips, piece-rate payments, and cash bonuses earned.

Self-employment income--this is net money income from a business, farm, or professional enterprise in which the person was engaged on his own account.

Income other than earnings--money income received from sources other than wages or salary and self-employment, such as net income from rents or receipts from roomers or boarders, royalties, interest, dividends, and periodic income from estates and trust funds; Social Security benefits, pensions, veterans payments, Armed Forces allotments for dependents, and other government payments or assistance; and other income such as contributions for support, alomony, and periodic receipts from insurance policies or annuities.

All figures represent the amount of income received before deductions for personal income taxes, social security payments, bond purchases, union dues, etc.

Because figures include income other than earnings, they are an overestimate of the acutal earnings received by each worker. Other data which were available include the wage and salary income, which does not include self-employment income, and therefore would be an underestimate of actual earnings. For this reason, both sets of figures were included in the analysis.

RESULTS AND CONCLUSIONS

PEARSON CORRELATIONS

The fifty-nine variables in each of the ninety-nine occupations were coded, and Pearson product-moment correlation coefficients were calculated.

A previous assumption, that income and educational attainment are reasonable indicators of skill level, implies a certain relationship between these two indicators. To determine the extent of this relationship, the correlation between the following 1960 measures were determined: (1) the median educational attainment of workers, (2) the percentage of workers with less than a high school education, (3) the percentage of workers with four or more years of college, (4) the median income, and (5) the median wage and salary. Table 1 presents these coefficients.

TABLE 1: Correlation coefficients for 1960 measures of education, income, and wages and salary.

	1	2	3	4	5
1. Median Education	1.000				
2. Percent with less than high school education	-.964	1.000			
3. Percent with four or more years of college	.887	-.804	1.000		
4. Median Income	.702	-.720	.581	1.000	
5. Median wage and salary	.651	-.690	.499	.958	1.000

r= .195 significant at .05 level.
r= .256 significant at .01 level.

As can be seen by an inspection of this table, all of the coefficients are well above the value needed for significance at the .01 level. Not only is there a high positive relationship between educational attainment and income derived from that occupation, but the negative coefficients show that the higher the percentage of persons that have not completed high school, the lower the median income and wage and salary.

The theory advanced by several leading economists that persons with greater ability strive for higher levels of education and would probably earn more even without additional education has little relevance here. Within the context of this study, the fact that there is a high degree of relationship between educational attainment and earnings was one desired answer.

The coefficients for the same measures for 1950 were also calculated, but since they were very similar they have not been reported.

Two of the worker trait components that would appear to be promising measures of the skill required of the worker are the GED and SVP ratings assigned to the occupations and listed in the Dictionary of Occupational Titles. The relationship between these ratings and the measures of education and earnings is shown in Table II and as can be seen, a high positive relationship exists here also.

The relatively large coefficients obtained between the measures of earnings and the GED and SVP ratings would lend support to the assumption that those occupations which require more general and specific training bring higher monetary returns to the workers.

TABLE II: Correlation coefficients for 1960 measures of education, earnings and the GED and SVP ratings.

	1	2	3	4	5	6
1. GED	1.000					
2. SVP	.735	1.000				
3. Median Education	.638	.424	1.000			
4. Percent with four or more years of college	.537	.372	.887	1.000		
5. Median income	.610	.581	.702	.581	1.000	
6. Median wage and salary	.621	.639	.651	.499	.958	1.000

r = .195 significant at .05 level.
r = .256 significant at .01 level.

One other worker trait that more directly relates to the abilities of the worker as opposed to personal qualities or job requirements, is the component of aptitudes. The eleven aptitudes previously described, were correlated with the GED and SVP ratings to determine the extent of the relationships that exist between these measures of worker ability which are required by the occupations. In addition, it was desirable to determine what relationship these measures had to the last three digits of the occupational code number. In interpreting these coefficients in Table III, the scales used for each of the variables must be kept in mind. The GED and SV P scales utilize smaller number to indicate lesser amounts of general specific training requirements with these numbers growing larger as greater training is required. The aptitudes scale uses smaller numbers to indicate higher levels of required aptitudes with the largest number (5) indicating lower aptitude requirements. The last three digits of the code number similarly uses larger numbers to indicate no

TABLE III: Correlation coefficients for worker ability requirements and the last three digits of the occupational code number.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. GED	1.000															
2. SVP	.735	1.000														
3. G	-.742	-.568	1.000													
4. V	-.799	-.594	.850	1.000												
5. N	-.787	-.699	.807	.825	1.000											
6. S	-.565	-.601	.251	.358	.567	1.000										
7. P	-.435	-.403	.271	.309	.503	.767	1.000									
8. Q	-.499	-.280	.566	.625	.626	.128	.113	1.000								
9. K	-.060	-.197	.000	.019	157	.574	.613	-.103	1.000							
10. F	-.255	-.312	.137	.162	.328	.611	.725	.073	.986	1.000						
11. M	-.131	-.181	-.033	-.068	.138	.551	.602	-.143	.683	.736	1.000					
12. E	.006	.001	.079	.064	.098	.028	-.009	.025	.284	.167	.294	1.000				
13. C	-.300	.095	.173	.289	.155	.206	.388	.195	.424	.473	.303	.241	1.000			
14. DATA	-.863	-.731	.617	.797	.774	.521	.423	.613	.158	.333	.083	.007	.354	1.000		
15. PEOPLE	-.335	-.206	.471	.498	.216	-.149	-.152	.265	-.068	.013	-.098	.061	.265	.344	1.000	
16. THINGS	-.151	-.491	-.175	-.141	.151	.665	.576	-.289	.557	.562	.583	.087	-.056	.172	-.410	1.000

r = .195 significant at .05 level
r = .256 significant at .01 level

Description of aptitudes:

G- Intelligence
V- Verbal
N- Numerical
S- Spatial
P- Form perception
Q- Clerical perception
K- Motor coordination
F- Finger dexterity
M- Manual dexterity
E- Eye-hand-foot coordination
C- Color discrimination

relationship between the worker and data, people, and things. This results, as seen in Table III, in negative coefficients between nearly all of the variables and the GED and SVP variables.

As might be expected, those occupations which require more general and specific training as well as mental abilities show more competencies needed in working with data. In like fashion, those occupations which require greater motor and manual abilities show more competencies needed in working with data. In like fashion, those occupations which require greater motor and manual abilities show more competencies needed in working with things.

Of considerable interest is the low correlation coefficient of .151 obtained between GED and things while a highly significant coefficient of .491 was obtained between SVP and things. This tends to substantiate the importance of specific vocational training for those jobs requiring higher levels of manual operation as compared to those jobs involving higher proportions of thinking.

Table III supports the thinking that there is a relatively high degree of correlation between those measures of worker ability requirements as listed in the Dictionary of Occupational Titles and the last three digits of the occupational code number. One caution should be noted however. It is not known to what extent the ability requirements were used to establish the three digit designation or vice-versa. If the qualifications profile has been used as a determinant for the three digit numbering system we would of course expect a high correlation between the two systems.

The measures of education and earnings are highly correlated

with the GED and SVP ratings of the occupations and the data, people, and things designations are also highly correlated with the GED and SVP ratings. One way of possibly checking for any bias introduced by the dependency of the three digit code on the ability requirements is to look at the correlation between the education and earnings measures and the data, people, things desigation. Table IV shows these coefficients which for the most part are highly significant.

TABLE IV: Correlation coefficients for 1970 measures of education and earnings and the three digit occupations number.

	1	2	3	4	5	6	7
1-Data	1.000						
2-People	.344	1.000					
3-Things	.172	-.410	1.000				
4-Median Education	-.596	-.576	.264	1.000			
5-% w/four or more yrs. col.	-.440	-.629	.265	.887	1.000		
6-Median Income	-.606	-.401	-.052	.702	.581	1.000	
7-Median wage & salary	-.648	-.289	-.150	.651	.499	.958	1.000

r = .195 significant at .05 level.
r = .256 significant at .01 level.

The negative coefficients are due to the reversed order of scaling for the data, people, things, designations; smaller numbers are used to indicate the higher levels.

One curious aspect of Table IV is the low correlation (.150) between median wage and salary, and the things digit. As previously shown,

things correlates quite highly with SVP and the median wage and salary does also. It seems reasonable to expect a fairly high correlation then between the wage and salary measures and the things designation, though this is not a necessary condition.

If the original assumption that measures of educational attainment and income derived from a job by a worker is valid, then the correlation coefficients shown in the preceding tables lend support to the selection of the last three digits of the occupational code number as indicators of the skill level required for the worker in a particular occupation.

As has been shown by the zero-order correlations, there is a high degree of relationship between the educational measures and the D.O.T. digits for data, people, and things. They also show a high relationship between measures of income and the three D.O.T. digits. The canonical correlation presents itself as a method of determining the relationship between the two sets of selected variables. This will also show the possibility of combining these variables so that a single index of skill can be obtained.

CANONICAL CORRELATIONS

The canonical correlation method permits the study of the interrelations between two sets of variables which are measures made on the same subject. Multiple variables are used as both predictor and criterion, and the problem is to find two sets of weights, or coefficients, that maximize the correlation between the two sets of variables. The canonical correlation is the maximum correlation that can be obtained between the weighted linear functions of the two sets of variables. The number of linear combinations that can be obtained is equal to the smallest number of variables in either of the two sets. In this study, the least number of variables in any one set is two, therefore, it is possible to obtain two canonicals from the data. (1:35)

The assignment of the groups of variables to the classification as predictors or criterion is arbitrary, and in this case depends only on their location in the resultant equations. Those variables appearing on the left side of the equation are thus termed the predictors, and the other variables the criterion.

The canonical correlations were calculated using the 1960 measures of education and income as the first, or predictor set of variables and the designation of data, people, and things as the second, or criterion set of variables.

The first canonical obtained coefficients for the variables which resulted in the equation:

$$.841Y_1 + .211Y_2 = -.743X_1 - .404X_2 + .244X_3$$

where Y_1 = median educational attainment

Y_2 = median income

X_1 = data digit

X_2 = people digit

X_3 = things digit

Using these coefficients, the correlation coefficient is .749.

The second canonical obtained coefficients for the variables which resulted in the equation:

$$1.125Y_1 - 1.388Y_2 = .260X_1 + .060X_2 + .938X_3$$

Using these coefficients, the correlation coefficient is .385.

Both of the canonical correlation coefficients are statistically significant at the .01 level as is shown in Table V.

TABLE V: X^2 tests of successive latent roots (1:43)

Number of roots removed	Largest latent root	Corresponding canonical R	Λ	X^2	d.f.	P
0	.5605	.749	.3743	94.41	6	> .01
1	.1485	.385	.8516	15.37	2	>.01

The two common factors indicated by the canonicals account for about 71 percent of the variance which leaves 29 percent to be accounted for by factors specific to each measure and to error. The negative coefficients are a result of the reversed scaling that is used with the data, people, and things designations.

The first canonical suggests that the primary relationship between these sets of variables is on education. The basis for this conclusion is that median educational attainment receives the highest loading of all the variables. It would appear that the level of skill implied by the data digit is quite highly related to education. The level of skill implied by the people digit is moderately related to education. The things

digit is slightly related to education apparently, and this is an inverse relationship. The results of these relationships are consistent with the zero-order correlations.

If the assumption is made that the combination of education and income on the left-hand side of the equation is an index of skill level, then the obtained coefficients of the data, people, and things categories on the right side of the equation could be used to obtain a single index of skill level of a job.

The interpretation of the second canonical is not as clear as the first. Although statistically significant, it is not large in that it accounts for only 15 percent of the variance.

The things scale attains a high loading as well as the income and education scales. One interpretation that might be given this canonical is that it accounts for the variance accounted for by jobs that require a high degree of manipulative skill and that are highly paid, but that have relatively low levels of education. The fact that the second canonical was significant suggests that there is not a single set of loadings for the data, people, and things designations that will yield a highly accurate index of skill level.

The first canonical would likely underestimate the required skill level for many jobs that are manipulative in nature and have limited formal educational requirements.

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APPENDIX

SELECTED OCCUPATIONS

001 Accountants and Auditors

002 Clergymen

003 College President, Prof's, & Instr's (N.E.C.)

004 Dentists

005 Draftsmen

006 Engineers, Technical

007 Engineers, Aeronautical

008 Engineers, Industrial

009 Engineers, Mechanical

010 Engineers, Sales

011 Lawyers and Judges

012 Nautral Scientists

013 Pharmacists

014 Sports Instructors and Officials

015 Teachers, Elementary Schools

016 Teachers, Secondary Schools

017 Technicians, Electrical and Electronic

018 Farmers and Farm Managers

019 Farmers (Owners and Tenants)

020 Managers, Officials, & Propr's, Exc. Farm

021 Buyers and Department Heads, Store

022 Managers, Off'ls, and Propr's (N.E.C.)--Salaried

023 Managers, Construction

024 Managers, etc., Transportation

025 Managers, etc., Wholesale Trade

026 Bookkeepers

027 Cahsiers

028 Dispatchers and Starters, Vehicle

029 Mail Carriers

030 Postal Clerks

031 Shipping and Receiving Clerks

032 Stock Clerks and Storekeepers

033 Sales Workers

034 Insurance Agents, Brokers, And Underwriters

035 Newsboys

036 Real Estate Agents and Brokers

037 Motor Vehicles and Accessories, Retailing

038 Bakers

039 Brickmasons, Stonemasons, and Tile Setters

040 Cabinetmakers

041 Carpenters

042 Compositors and Typewetters

043 Cranemen, Derrickmen, and Hoistmen

044 Electricians

045 Excavating, Grading, and Road Machinery Operators

046 Foremen (N.E.C.)

047 Foremen, Metal Industries

048 Electrical Machinery, Equipment, and Supplies Foremen

049 Foremen, Transportation Equipment

050 Linemen & Servicemen, Telegraph, T'phone, & Power

051 Locomotive Engineers

052 Machinists

053 Mechanics and Repairmen

054 Mechanics, etc., Air Conditioning, Heating, and R'frig

055 Mechanics, etc., Airplane

056 Mechanics, etc., Automobile

057 Mechanics, etc., Radio and Television

058 Millwrights

059 Molders, Metal

060 Painters, Construction and Maintenance

061 Plasterers

062 Plumbers and Pipe Fitters

063 Pressmen and Plate Printers, Printing

064 Roofers and Slaters

065 Stationary Engineers

066 Structural Metal Workers

067 Tinsmiths, Coppersmiths, and Sheet Metal Workers

068 Toolmakers, and Die Makers and Setters

069 Assemblers

070 Attendants, Auto Service and Parking

071 Brakemen, Railroad

072 Bus Drivers

073 Checkers, Examiners, and Inspectors, Mfg.

074 Deliverymen and Routemen

075 Filers, Grinders, and Polishers, Metal

076 Meat Cutters, Exc. Slaughter and Packing House

077 Mine Operatives and Laborers (N.E.C.)

078 Oilers and Greasers, Exc. Auto

079 Packers and Wrappers (N.E.C.)

080 Stationary Firemen

081 Switchmen, Railroad

082 Taxicab Drivers and Chauffeurs

083 Truck and Tractor Drivers

084 Welders and Flame-Cutters

085 Operatives and Kind., (N.E.C.) Furniture & Fix. Mfg.

086 Attendants, Hospital and Other Institution

087 Barbers

088 Bartenders

089 Counter and Fountain Workers

090 Elevator operators

091 Kitchen Workers (N.E.C.) Exc. Pri. Household

092 Porters

093 Guards, Watchmen, and Doorkeepers

094 Policemen and Detectives

095 Public Policemen and Detectives

096 Waiters

097 Farm Laborers, Wage Workers

098 Garage Laborers, and Car Washers and Greasers

099 Lumbermen, Raftsmen, and Wood Choppers