DOCUMENT RESUME

ED 114 593 95 CE 005 455

AUTHOR Ammerman, Harry L.; And Others
TITLE Rating the Job Significance of Technical Concepts: An Application to Three Occupations. Research and Development Series No. 105.
INSTITUTION Ohio State Univ., Columbus. Center for Vocational and Technical Education.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE Dec 74
CONTRACT NE-C-00-3-0078
NOTE 71p.

EDRS PRICE MF-$0.76 HC-$3.32 Plus Postage
DESCRIPTORS *Auto Mechanics (Occupation); *Data Processing Occupations; *Fundamental Concepts; Job Skills; Occupational Information; *Rating Scales; Relevance (Education); Research Methodology; *Secretaries; Surveys; Tables (Data); Teacher Response; Vocational Education
IDENTIFIERS *Concept Inventories

ABSTRACT

A methodology for inventorying the technical concepts relevant to the occupations of automotive mechanics, business data programers, and general secretaries is described in the report. Five general types of technical concepts are presented, consisting of specialized knowledge having practical use to workers. Through a process of development, editing, and review, these general concepts resulted in a listing of 440 concepts for automotive mechanics, 382 concepts for business data programers, and 80 concepts for general secretaries. CSR (Concept Significance Rating) booklets for each occupational area containing these listings were sent to selected occupational instructors to obtain their ratings of the job significance of the concepts. Usable returns were obtained from 104 instructors in seven states. Summaries of the ratings obtained for each occupation are presented, along with methodology, rationale, and description; an explanation of the process involved with compiling and rating the concepts; and a summary and implications. Tables supplement the discussion. Ratings for the three occupational areas, additional concepts suggested by instructors, and the CSR booklet are appended. It is stated that summaries of the ratings obtained may be useful to those involved in curriculum development and research, and occupational performance surveys that derive or validate training content. (LH)

Research and Development Series No. 105

RATING THE JOB SIGNIFICANCE OF TECHNICAL CONCEPTS:

An Application to Three Occupations

Harry L. Ammerman
Duane W. Essex
Frank C. Pratzner

The Center for Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210

December 1974

An Interim Report
On A Project Conducted Under
Contract No. NE-C-00-3-0078

The material in this publication was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official National Institute of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE

National Institute
of Education

THE CENTER MISSION STATEMENT

The Center for Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning and preparation. The Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOREWORD

The Center for Vocational Education is continuing its programmatic research efforts to develop effective procedures for the derivation of valid and necessary curriculum content. One product of this effort is this descriptive report of ratings on the job significance of work-related technical concepts. The process for defining and rating technical concepts was tested on three separate occupations. General Secretaries, Automotive Mechanics, and Business Data Programmers. The descriptive data summarized and reported herein were collected nationally. This effort serves as one component of a long range and multifaceted R&D effort directed at establishing effective procedures for identifying appropriate curricular content in vocational education and occupational training. The present report augments performance content for learning with its focus on the conceptual content of a job. The study was conducted at The Center within the "Methods for Curriculum Content Derivation" research and development program.

It is hoped that, while research continues on procedures for determining relevant and critical content for curricula, the initial procedures and technical concept data summarized in this report will be useful to researchers and training practitioners in making broad curriculum decisions for the determination of needed training content. The Center welcomes questions or other comments which may be helpful to the research team in their ongoing efforts.

The Center expresses its appreciation to the 104 postsecondary instructors in seven states for taking the time to provide these ratings of technical concepts. Their cooperation and attention to this rating effort were invaluable personal contributions to its completion. In addition to the authors, several people at The Center have contributed substantively to the work of. defining technical concepts and their relation to occupational learning requirements, preparing the initial listings of concepts for each of the three occupations, and developing and administering the concept questionnaires to gather the ratings. Special recognition is extended to Anna H. Tso, Earl B. Russell, Allen A. Wiant, and Kathrine P. Odom. The study draws heavily from the research work of Jerome Moss, Jr. and his students at the University of Minnesota for the initial definitions and approach to compiling inventories of work-related technical concepts.

Robert E. Taylor
Director
The Center for Vocational Education

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLES PAGE

FIGURES

OVERVIEW

This report is one of the products of a continuing program of methodological research being conducted by The Center for Vocational Education. The focus of this research is the development and testing of methods for deriving relevant and critical curriculum content for secondary and post secondary occupational training programs. Technical concepts are clearly a part of such content. When identified and validated, technical concepts should themselves be useful as one basis or first step in the curricular determination of knowledge content needed in public, private, and industrial programs of occupational instruction. They augment task inventory surveys and task analyses, providing a more comprehensive basis for the determination of necessary learning content in occupational training programs.

Described in this report is a methodology for defining and listing—inventorying—the technical concepts that are relevant to an occupation. Technical concepts are considered to be the special knowledges and understandings that have practical use to workers in the effective performance of their jobs. Three applications of the concept inventory process are included in this report, for the occupations of Automotive Mechanics, Business Data Programmers, and General Secretaries.[1] Concepts for each of these occupations were each rated on their degree of job significance. Both cognitive and performance aspects of the work are important determiners of training objectives if instructional programs are to be responsive to current occupational requirements. The Concept Significance Ratings (CSR) were obtained early in 1974 by mailed questionnaires. Experienced instructors in seven states generously donated their time and effort to provide the ratings.

The full set of methods for deriving curriculum content under development is not limited in application to the three particular occupations reported here. These methods are being designed for use in many occupations of training interest. When fully described and tested, they should be especially important for developing curriculums in situations where there is uncertainty about the occupational requirements and critical training content. In this curriculum content identification process, it is assumed that cost-effective training programs cannot train students for all knowledges and skills of relevance to experienced workers in an occupation, but must assure that at least the more essential learning requirements for initial effective job performance are included.

Several key technical terms are used throughout the report. They are defined here to allow the reader to differentiate between them and to understand their usage in the report.

Occupational Area. A cluster of closely related jobs, where the relationship depends upon commonly accepted groupings of jobs by reason of similarity of systems worked upon, or of common subject-matter content or technical concepts. An occupational area may be called a career ladder or career lattice, but also may encompass jobs of a somewhat broader nature.

---

[1]Companion reports are being published concurrently on the results of occupational performance surveys which provide task inventory data from workers and supervisors on the performance aspects of these same three occupations.

Job. A specific vocation, trade, profession, craft, or occupation serving as a line of work or employment, where most workers typically are called by the same or synonomous job title. A job is not limited to one employment position or one worker category within a single employing firm. However, it is located at only one status level in an occupational area or career ladder, distributed across many employment settings. The term "occupation" is used synonomously with "job."

Technical Concept: A class (or category) of specialized knowledge having practical use to workers in the effective performance of their job.

Concept Inventory. A comprehensive listing of technical concepts used by workers in a job or occupational area.

The next section of the report contains a brief rationale and description of the methodology for inventorying technical concepts, followed by an explanation of the process applied in compiling and rating concepts for the three occupations that serve as research vehicles. Summaries of the concept ratings obtained for each occupation are then presented. These summaries may be of use to individuals involved in curriculum development for these occupations, and may provide a useful data base for reference by individuals who conduct curriculum research and occupational performance surveys for the purpose of deriving or validating training content.

RATIONALE AND DESCRIPTION OF THE METHODOLOGY

Complementing studies on the use of the "Task Inventory Method" for surveying jobs to provide performance data (Melching & Borcher, 1973), it seemed equally reasonable and useful to "inventory" the conceptual content of an occupation. The task inventory approach is intended to produce a comprehensive description of what is done by workers in a particular occupation. As applied to technical concepts, the approach would seek to produce a comprehensive description of the types of information and knowledge that have practical use to workers in the performance of their jobs. Prior research summarized by Moss, Pucel, Smith, and Pratzner (1970) was instrumental in the development of the concept inventory approach. The present study represents an adaptation of their work, consistent with the goals of this study.

The concept inventory approach presently consists of two major functions. (a) compiling a comprehensive listing of potentially-relevant technical concepts, and (b) obtaining experienced judgments regarding the extent to which each concept is significant to the effective performance and accomplishment of the job. The general procedural steps for these functions are outlined in Figure 1.

Comprehensiveness of the listing serves to promote the identification of concepts which are actually relevant to a job, unprejudiced by preconceived notions of what is important for training consideration. In turn, the concept listing allows questionnaire responses to be stimulated by concept recognition, rather than by asking respondents to try to recall those which are relevant. This feature enables respondents to provide their judgments more rapidly and completely in a manner that permits ready comparisons between administrations of the questionnaire. Thus, it becomes possible to assess trends over time, to resolve some uncertainties with respect to regional differences, or to note differences pertaining to newly emerging types of jobs within an occupational area. The same concepts may be relevant to many occupations within an occupational area, but vary in their significance and use by workers in each particular job type in that area. All of this, along with other available information, serves to provide a data base upon which curriculum specialists may make meaningful decisions about appropriate curriculum content.

The concept inventory is but one step in the derivation of training needs. Other steps would need to relate these concepts to their use in the performance of specific job tasks, and to determine the particular component knowledges and understandings needed in such performance. An example of the logical link between concepts and tasks is given in the following sample from the Automotive Mechanics job:

Technical Concept	Job Tasks
Special knowledge and understanding of the concept of "carburetor"	This knowledge and understanding has practical use to workers in the effective performance of such tasks as:

A. Compile comprehensive listing of potentially relevant technical concepts.

1. Generate an initial list of potential concepts.
   a. Examine written technical material.
   b. Group available concepts into five general types.
   c. Discuss with persons experienced in the occupational area.

2. Review and edit list of concept statements.
   a. Edit statements for form and substance.
   b. Obtain suggestions of concept additions and deletions.

B. Obtain ratings of concept significance in job performance.

1. Prepare questionnaire to obtain Concept Significance Ratings (CSR).
   a. Define each occupation of interest.
   b. List concepts alphabetically.
   c. Divide list randomly, if necessary to provide multiple forms.
   d. Prepare background questions for respondents.
   e. Pretest instructions with intended type of respondents.
   f. Print CSR questionnaire with concept lists and response format.

2. Administer the CSR questionnaire.
   a. Design respondent sample desired.
   b. Construct mailing list of possible respondents, or contact employers.
   c. Select representative respondents.
   d. Mail CSR questionnaires, and follow up as necessary.

3. Summarize group responses to each concept.
   a. Compute average rating and measures of response dispersion.
   b. Compute inter-rater consistency measure.
   c. Rank order the concepts within an occupation.
   d. Hand tally any write-in concepts.
   e. Tally the background characteristics of respondents.
   f. Regroup the concepts into the five general types.
   g. Report descriptive summary data, for sharing with others.

Figure 1. Outline of procedural steps for inventorying technical concepts. Subsequent steps may analyze the group summary data to establish differences between related occupations, to relate concepts to job tasks, and to augment other content information used in determining appropriate training content.

1. Inspect, clean, and adjust choke unit (automatic and manual).
2. Perform operational inspections of exhaust emission control systems.
3. Repair or replace fuel injectors.
4. Repair or service carburetors.

These relationships could be graphically displayed by means of a matrix consisting of rows for each concept and columns for each task, with check marks in those cells where a job use for a concept is apparent. Subsequently, more sophisticated processes might be developed to describe the nature and extent of each concept task relationship. With information about the job relevance and training need for each possible job task, the task-concept matrix could be highly useful in justifying the in structional requirement for each concept. The concepts noted as useful in task performance provide an effective cue to curriculum developers for focusing their attention when prescribing the specific teaching/learning content of a curriculum.

Listing the Technical Concepts

For purposes of this study, technical concepts are defined as classes or categories of specialized knowledge having practical use to workers in the effective performance of their job. They are not directly the tools, processes, or information of an occupation, but are the verbal labels for the un derlying work-related concepts and the understandings of them. In general, concepts are identified by the technical vocabulary of an occupation.

Concepts may represent (a) the categories of generalizable information or knowledge content of a job, (b) the body of technical knowledge that is required for competent and high quality per formance in an occupation, and (c) the guiding and organizing conceptions of the work, such as regulative principles influencing how an activity is to be performed. In all instances, technical con cepts are job relevant, they do not include terms used only for instructional purposes. (However, in more traditional terms, technical concepts do appear quite similar to the instructional topics used by some to describe their training content.) Nor do concepts state the nomenclature for specific items that do not represent a class of items. Thus, concepts should not name each particular bit of information used on a job, nor each item from a parts list of a particular piece of equipment.

In some occupational areas a dictionary of technical terms may already have been compiled. This would serve as one good source for generating a list of technical concepts. As many sources as are reasonable to acquire would seem useful in generating an initial, comprehensive listing of the potential concepts. Examination of job manuals, as well as training texts and materials, will provide likely additions to the listing. This follows a suggestion by Johnson (1967), that written technical material may be a useful source of work related technical concepts for an occupation. These might be supplemented by discussions with experienced workers, supervisors, and instructors in the occu pational area. Such persons could be asked to review tentative listings, and asked to add to or mod ify such lists. The concern at this stage is to list every technical concept that may be relevant. Sub sequent ratings would provide a data base for screening out the non relevant or less relevant concepts.

To assist in the process of building a comprehensive list of concepts, five general types of tech nical concepts are suggested for grouping the concepts within the total listing. These general types

also may encourage workers, supervisors, and instructors to recall additional concepts by suggesting types of knowledge which they may not have considered to be technical concepts. Thus, they help to define what is meant by "technical concept," even though the distinctions between the several types may not always be clean and clear, nor may each type be equally relevant for all occupations. Below are descriptive labels and comments for each of the five general types. The first three of these types are based on earlier suggestions made by Moss et al. (1970).

A. Processes and functions of the systems which are acted upon by the workers. These are not the functions, activities, or tasks of the workers, but are the classes of operations external to the worker that may be accomplished by the systems on which the worker operates. Thus, automotive systems have processes and functions which are of concern to Automotive Mechanics, computer operations and business data may be of concern to Programmers, and copying and reproduction processes may be meaningful to Secretaries.

B Types of elements (and other objects or devices) of the systems which are acted upon by the worker. These are not the particular specific parts of a piece of equipment, tools used, or other individual items worked on or with, nor are they specific persons with whom workers interact; nor are they specific data, forms, or materials used. However, they may be classes or categories of these things. In the occupation of Automotive Mechanic, concepts might represent such general items as ball bearings, carburetor, voltmeter, power lift, wrenches, and gaskets; but not such specifics as rear main oil seal, manifold gasket, interior cab light, freon control valve, nor defroster hose.

C Measures, descriptive characteristics of system elements and processes, and other system specifications. These may include types of measurements used (e.g., the automotive terms of "horsepower," "dwell angle," or "compression ratio"), but not specific units of measurement scales.

D. System events and conditions. System events are the types of performance and operational contingency situations with which the workers must contend. They include such matters as emergency operations, stressful situations, interpersonal conflicts and other work-related people interactions, work overloads, and equipment malfunctions. System conditions are the states of affairs with respect to personnel, data, things, and other matters involved in and influencing work operations. They include environmental factors such as extreme climatic conditions, hazards, dirty work areas, and lighting problems. Other system conditions include such matters as complexity of work operations, performance symptoms of operational equipment, working conditions, available support services, and other states of affairs dealt with by the workers or which influence the nature of the work situation.

E Regulative and organizing principles used by the worker or directly influencing the work. These are work structures and relationships, guiding or organizing conceptions, as well as standard operating procedures, formats, management directives on procedures to be followed, style guides, and traditions. A major kind of technical concept to be included under this category is that of scientific principles and laws, and other conceptual abstractions relevant to the occupation

Prior to its use in questionnaires to gather data on each technical concept, the list of concept statements should be reviewed and edited. Criteria for editing deal with both the form and substance of the concept statements. Below are editing criteria that seem useful and effective in providing a balance between clarity and brevity in the concept statements. These are an adaptation and extension of criteria developed in an earlier study by Smith (1968).

1. Technical symbols are converted into verbal statements of their referant (e.g., fm = frequency modulation, DC = direct current, mph = miles-per-hour).

2. Acronyms are retained if they are quite obviously in common usage, with no doubt of their meaning to persons in the occupation (e.g., COBOL, FORTRAN, S.A.E., R&D). However, it is generally more appropriate to state the concept fully, adding the acronym or other abbreviated form in parentheses (e.g., solid logic technology [SLT], cathode-ray tube [CRT], American Standard Code for Information Interchange [ASCII]).

3. Elaborations of a concept statement should be added in parentheses to clarify its meaning more fully or to note synonyms used on the job by workers (e.g., AC generator [alternator], carburetor out of adjustment [or faulty], pre-ignition [detonation], instruction register [control register]). Synonyms should not be listed separately. Obviously outdated terms should not be stated, unless there is reason to believe they are still used by workers in some instances. For some occupations the notion of technical concepts as a class of things may appear alien and strange, particularly for service- and people-oriented types of occupations which tend to deal with specific items. Classes of knowledge might be limited to groupings solely for pedagogical purposes, a reason that workers in the field might lose sight of. In such instances a class label for a concept should be followed by illustrative examples of what the concept includes, as for example in the secretarial occupation:

   a. confidential record keeping (e.g., involving personnel records, financial statements).

   b. indexing routine (e.g., coding, sorting, abstracting, classifying, sequencing).

   c. telephone techniques (e.g., incoming calls, outgoing calls, long distance calls, private exchange, dictaphone).

   d. internal communication (e.g., messenger service, pneumatic tubes, conveyer belts, intercommunication systems).

4. Generally, a concept should be stated in a singular form (e.g., "subroutine" instead of "subroutines"), except where the plural version more closely corresponds to common usage (e.g., mechanical brakes, miles-per-hour, data, forms, mailing lists). The gerund form of verb ending, "-ing," is also an acceptable form of statement, particularly for system processes and functions (e.g., editing, coding, indexing, debugging). Other noun-forming suffixes such as "-ant" and "-ion" also may be used to imply a broad class of things (e.g., "distribution" instead of "distribute," "correction" instead

of "correct"). Where either a noun form or a verb form is appropriate for the same basic concept, the noun form is preferred (e.g., "editing" instead of "edit," "modification" instead of "modify," "transcription" instead of "transcribe").

5. Prefixed technical terms usually should be retained as separate concepts, with the root term listed as another concept (e.g., antimagnetic and magnetic, decoder and coder, decentralized filing and centralized filing).

6. Terms used only for pedagogical (teaching) purposes are not to be listed as technical concepts, nor are those which are only peripherally related to the working-level activities of an occupation, such as those involved in acquiring employment or which pertain to only one employment context. Technical concepts must have practical significance within an occupation.

7. The statement represents a class of things, where more than one specific instance of the class exists within the occupation at the working level. The nomenclature (names, terms) or specific part names of a particular device or item of equipment would not be listed.

8. Technical concepts represent things and abstractions inherent in the work itself, not in the worker. Thus, concepts should not be statements about worker feelings and attitudes, worker attributes or personality traits, or the manner in which a worker performs a task. Nor do technical concepts represent the actions and tasks of workers per se, though many terms may imply both worker activity and a system process or function. Affective concepts that are external to the worker may be included, as when personal attributes of others (e.g., customers, clients, patients, foreigners, politicians, competitors) influence the work situation.

9. Brevity is useful. Concepts should be stated as briefly as possible, but remain consistent with the essential need for clarity.

10. Technical concepts are abstractions, not directly the things, processes, or measures themselves. Thus, it is possible to have a hierarchy of increasing semantic generality for a set of concepts (e.g., from "cows" to "animals" to "living creatures"). It is not necessary to distinguish lower-order single concepts from higher-order principles. Both may be listed.

Judging the Job Relevance of the Listed Concepts

Given a listing of the potential technical concepts for an occupation, there is a need to establish which ones are in fact relevant to the work of that occupation. In a sense there is a need to validate the listing, deleting those which are not found to be relevant or are only very marginally relevant.

The combined judgments of a group of knowledgeable persons would be used to establish the job relevancy of each listed concept. For this purpose a modified version of the Hemphill 8-category "part of the position" scale (Hemphill, 1960) was developed to measure the extent to which

a concept was significant to job performance. The Hemphill scale asks the judge to combine a number of factors and to arrive at a single composite rating for an item. Its response categories are anchored with brief definitions for the extreme categories and the middle category, with the middle category representing a fairly high rating. Thus, the scale tends to expand the categories covering the high end of the range, accommodating a general rater tendency on job questionnaires to use the high end of the scale with disproportionate frequency. This scale expansion seems to allow for greater discrimination to be made between the more relevant job items.

As modified for this study, the scale asks the rater to judge the degree of significance of each concept to the effective accomplishment of the job being described. They are to report how critical the use of each concept is in the performance of the job tasks. First, the rater is asked to consider whether the technical concept applies to the job at all. If it does, the rater is then to consider and weigh its importance, frequency of use, relevance, and any other factor which determines the extent of its job significance. The 8-category answer scale, with definitions for four of the rating categories, was defined as follows:

0 = Irrelevant or definitely does not apply in the job.

1 = Under unusual circumstances may be of minor significance in job performance.

2

3

4 = Of substantial significance in job performance.

5

6

7 = Of most critical significance in job performance.

Group responses to an item are summarized by considering the eight categories[2] as an interval scale (Hemphill, 1960). Thus, the central tendency (average response) is computed as a mean. Response dispersion is calculated by use of a standard deviation.

One merit of the use of this modified scale is that raters not only note the relevance of a concept to a job, but also they judge the extent or degree of such relevance. This information can be useful in establishing the differences between two related occupations within the same occupational field. While both occupations may use a certain concept, the significance of such use may be quite

---

[2]If the responses are to be keypunched and processed by a computer system, the reader is cautioned that some computers read a "0" response and a blank (no response) as the same. Thus, omits and "0" responses would be summarized together. It is recommended that the 0-7 categories be converted to 1 8 codes for such automatic data processing. However, it seems best to retain the 0-7 categories for questionnaire responses, since the "0" has a true rational meaning for the respondent.

different between them. When making curriculum decisions about which are the more critical train ing issues for each occupation, this information can be helpful to the curriculum specialist in select ing the most necessary content to include in a particular training program, or in deciding upon the need for multiple or branching programs of instruction. This type of information could also be useful in identifying the cognitive thrusts that are common to several jobs within an occupational cluster.

Additionally, if the concepts listed were those of basic adult literacy, then the scale would produce patterns of basic knowledge content that are significant to an occupation. Producing such literacy patterns across a wide range of occupations (or other meaningful life performance situations) might be an effective way to establish and substantiate a necessary level of adult literacy requirements.

The general rule for selecting the type of raters is to use those who are closest to the actual per formance situation and who are capable of providing reliable responses on such a highly verbal ques tionnaire. In many occupations this can (and should) be the workers themselves, and their immediate supervisors. In other circumstances, or for other purposes, it might be more reasonable and efficient to employ other types of raters who have appropriate knowledge of occupational or situational re quirements.

APPLICATION OF THE METHODOLOGY TO THREE DIFFERENT OCCUPATIONS

Consistent with the use of the same three occupations as research vehicles, the technical concepts were listed and rated for the occupations of Automotive Mechanic, Business Data Programmer, and General Secretary.

Defining Each Occupation

Each occupation was defined to note what related occupations would be included or specifically excluded from consideration. These definitions were based upon descriptions reported in the *Dictionary of Occupational Titles* (U.S. Department of Labor, 1965). The definitions used in the questionnaires for Concept Significance Ratings are quoted below.

Automotive Mechanic (DOT No. 620.281 014). The Automotive Mechanic may be identified by such other job titles as:

a. Automobile Mechanic
b. Automobile Repairman
c. Garage Mechanic
d. Engine-Repair Mechanic

These workers should be qualified in general automotive mechanics, though their immediate job assignment might be limited in scope to a particular repair function, such as:

a. Differential Repairman
b. Drive-Shaft and Steering Post Repairman
c. Front-End Man
d. Brake Mechanic
e. Carburetor Mechanic

In general, the Automotive Mechanic is one who repairs and overhauls automobiles, light busses, light trucks, and other automotive vehicles. They may diagnose damage or malfunctions, remove and replace units, disassemble and inspect parts for wear or servicing, overhaul units, rebuild parts, rewire electrical systems, or reline or adjust units. They do not typically mend damaged body and fenders, nor install or repair accessories such as radios. They may become a specialist in one area of automobile repair, such as transmissions or engines, but must possess the general skills listed above.

These workers should not be:

a. Less than full-fledged mechanics, such as:

1. Automotive-Mechanic Apprentices
2. Automotive-Repair Helpers
3. Automotive-Repair Assistants
4. Mechanic Helpers

b. Specialized in non-automotive or peripheral systems, such as:

1. Industrial Truck Mechanics
2. Diesel-Engine Mechanics
3. Farm Equipment Mechanics
4. Motorcycle Repairmen

c. Limited in qualifications to one specialty area of automotive repair, such as.

1. Automobile Body Repairmen
2. Electrical Systems Mechanics
3. Service Station Mechanics
4. Air-Conditioning Mechanics
5. Automobile Painters
6. Auto Mechanics Instructors

d. Supervisors of Automotive Mechanics, such as:

1. Service Managers
2. Garage Foremen
3. Chief Mechanics
4. Automotive Section Chiefs

Business Data Programmer (DOT No. 020.188-026). The Business Data Programmer may be identified by such other job titles as:

a. Business Programmer
b. Digital-Computer Programmer
c. Senior Programmer
d. Business Systems Programmer

In general, the Business Data Programmer is one who converts statements of business problems into detailed, logical flow charts for coding into computer language and solution by means of automatic data-processing equipment. They may analyze workflow charts or diagrams representing business problems to develop a sequence of program steps, write detailed, logical flow charts in symbolic form to describe the arithmetic and logical operations involved, convert flow charts to a language processable by computer, test program adequacy, correct program errors, prepare written instructions to guide operating personnel during production runs, and rework programs to increase operating efficiency or adapt to new requirements. They do not typically program scientific data, research analyses, engineering studies, gaming simulations, or machine automation processes. They may specialize in writing programs for one make and type of computer.

These workers should not be:

a. Less than full-fledged programmers, such as:

1. Junior Programmers
2. Program Coders
3. Detail Programmers
4. Programming Clerks

b. Specialized in non-business-data or peripheral systems, such as:

1. Engineering and Scientific Programmers
2. Technical Programmers
3. Systems Analysts
4. Systems Engineers
5. Data Typists
6. Data-Methods Analysts
7. Systems and Procedures Analysts
8. Operations-Research Analysts
9. Computer Console Operators
10. Key-Punch Operators

c. Supervisors of Business Data Programmers, such as:

1. Business-Systems Coordinators
2. Project Directors, Business-Data Processing
3. Computer Programming Coordinators
4. Program Managers
5. Chief Business Programmers
6. Lead Programmers

General Secretary (DOT No. 201.368-018). The General Secretary may be identified by such other job titles as:

a. Secretarial Stenographer
b Girl Friday
c. Secretary

In general, the General Secretary is one who schedules appointments, gives information to callers, takes dictation, types, and otherwise relieves officials of clerical work and minor administrative and business details. They may file correspondence and records, take dictation in shorthand or on machine, transcribe notes or recordings, compose and type routine correspondence, answer telephone and give information to callers, greet visitors, arrange travel and reservations, record minutes of meetings, keep personnel records, and supervise clerical workers. They do not typically concentrate upon only typing, transcribing, filing, receptionist, or clerk activities, but generally have a more versatile role in a business office.

These workers should not be:

a. Less than full-fledged secretaries, such as:

1. Typists
2. Receptionists
3. Switchboard Operators
4. Steno-Typists

b. Specialized in recognized professional or peripheral areas, such as:

1. Legal Secretaries
2. Medical Secretaries
3. Executive Secretaries
4. General Office Clerks
5. Administrative Assistants
6. Stenographers
7. Administrative Secretaries
8. Social Secretaries
9. Office Machine Operators

c. Supervisors of General Secretaries, such as:

1. Office Managers
2. Executive Secretaries
3. Heads of Secretarial Services
4. Administrative Officers

Development of Concept Lists

Several written technical sources for work related technical concepts were examined to generate initial listings of potential concepts for each occupation. For the mechanics' job this included two

automotive repair manuals (*Chilton's Auto Repair Manual,* 1974; Forier, 1973), as well as other occupationally-relevant sources of automotive terms (Gerrish, 1968; Jennings, 1969; Muller, 1964). Initial concepts for the programming occupation were derived from two textbooks of general principles (Awad, 1971; Thierauf, 1973). Technical concepts for secretaries were derived from a textbook on secretarial practice (Agnew, Mechan, & Olivero, 1966) and two secretarial handbooks (Doris & Miller, 1970; Hutchinson, 1969). In addition to these references, a recent curriculum syllabus from each occupation area was reviewed for additional technical concepts (*Automatic Business Data Processing Syllabus,* 1972; Gates & Davison, 1971, Sexton, 1971). Additionally, since the number of technical concepts identified from the written sources on secretarial jobs was much fewer than for either of the other occupations, four qualified General Secretaries were asked to list all the technical words and phrases they could.

These initial lists of concepts were subjected to editing by the project staff, who considered the editing criteria noted earlier in this report. Subsequently, each list was submitted to two judges. Judges were persons with experience in teaching, curriculum development, or research related to the occupation for which concepts were listed. Each noted which concepts were of little or no significance to job performance, and added new concepts as appropriate. All concepts suggested for addition were included in the final list for use in the CSR questionnaire. A concept was deleted only if both judges indicated it was of no significance.

This editing and review resulted in a listing of 440 technical concepts for Automotive Mechanics, 382 for Business Data Programmers, and 80 for General Secretaries. Difficulty was experienced with the listing of concepts for General Secretaries. Being a less "technical" job than mechanics or programmers, it was uncertain what to identify as a technical concept. "Technical language of the trade" seemed virtually absent at the working level, even though a number of organizing schemes may be evident at the pedagogical level. It seemed necessary to provide example components for the statements of classes of specialized secretarial knowledge. This yielded much lengthier items for the secretarial list than for concept statements in the other occupations, with less certainty that they truly represent a good listing of work-related technical concepts. Further formulation of ideas would seem useful on how to derive and state technical concepts for occupations which traditionally do not appear to have much of a technical vocabulary common to that occupation.

The lists for mechanics and programmers were felt to be unnecessarily lengthy for use in the CSR questionnaires. Therefore, each of these lists was randomly divided into two sublists, with CSR questionnaire booklets designated Form A and Form B for those occupations. The Form A booklet for mechanics contained 222 concepts, Form B contained 218. The Form A booklet for programmers contained 190 concepts, Form B contained 192. One form of booklet sufficed for secretaries. Concepts were listed alphabetically in each booklet, omitting any designation of the five general types of technical concepts. Respondents were assigned randomly when there were multiple forms for the same job. It is recommended, however, that future applications of this process should control more rigorously the types of respondents and their backgrounds, to assure a representative balance across multiple forms used for the same occupation.

Administration of the CSR Questionnaire

The CSR booklets were printed with the response scale located directly to the right of each concept listed. Additional concepts were solicited at the end of each list. Preceding sections of the

booklet asked for respondent background information on present work situation, experience, and training, and provided instructions on how to rate the job significance of each concept. These formats are illustrated in Appendix A for the occupation of Automotive Mechanics.

CSR booklets were mailed to selected occupational instructors to obtain their ratings of the job significance of the concepts. Two hundred booklets were mailed, 40 of each form. Mailing lists were obtained of public postsecondary instructors currently teaching in one of the three types of occupational programs. These lists were obtained from state departments of vocational education in seven states which, by their state plans, generally had large postsecondary training programs in all three of the occupational areas. In proportion roughly to the numbers present in each of the seven states of California, Colorado, Georgia, Minnesota, North Carolina, Washington, and Wisconsin, instructors were randomly selected from the total number available.

The CSR booklets were mailed to the 200 selected respondents, along with a cover letter explaining the background and purpose of the study. Subjects not completing and returning their ratings within six weeks were sent a follow up booklet, with a repeat request for their cooperation. Returns from 68% of the instructors (136 of 200) were received, of which 104 (or 52% of the original) were deemed usable. The reason for not using 32 of the returns was generally because of the incompleteness of the ratings. Usable returns were obtained from 37 instructors of Automotive Mechanics (18 on Form A, 19 on Form B), 43 instructors of Business Data Programmers (20 on Form A, 23 on Form B), and 24 instructors of General Secretaries.

Background of the Raters

While the instructor representation may not be a completely accurate sample of public post secondary teachers, it does at least provide a broad array of respondents with diverse backgrounds. Table 1 summarizes their geographic background and experience.

Generally, for all occupational groups, there were six or less teachers at a respondent's school involved full time in that program. Student placement responses were highly diverse, though they tended to average just under 20 students who had been placed the previous year from courses taught by the respondent. This compares to an average of about 47 students currently taught by each respondent. Student enrollment averaged higher for programmer instructors (60) and least for mechanic instructors (34).

The consistency with which raters on each questionnaire form tended to agree was examined by means of an estimate of interrater reliability, using an analysis of variance procedure (Winer, 1962). These estimates are reported in Table 2, after having been adjusted statistically for differences in the mean response of each rater on the concept questionnaire. These seem quite respectable, and generally were about the same for all groups of raters except for those instructors of mechanics using Form A of the questionnaire. In comparing the background data of those using the two mechanic forms, it was noted that Form A respondents did differ somewhat from those on Form B. One difference was that Form A was completed by eight instructors from technical institutes, whereas Form B had no representation from technical institutes. Other differences seemed negligible.

Table 1

Number of Public Postsecondary Instructors Rating Concepts, by Type of Background and Location

Background Factors	Instructor Group		
	Automotive Mechanics N = 37	Business Data Programmers N = 43	General Secretaries N = 24
Geographic Distribution:			
California	3	3	1
Colorado	0	2	1
Georgia	6	8	5
Minnesota	11	6	0
North Carolina	8	9	7
Washington	3	10	3
Wisconsin	6	11	7
Type of Institution:			
Community College	7	12	6
Area Voc-Tech School	20	15	11
Technical Institute	8	11	6
Other or Not Marked	2	5	1
Type of Program Presently Taught:			
Beginning	7	8	8
Intermediate	9	18	6
Advanced	15	8	6
Other or Not Marked	6	9	4
Teaching Experience:			
2-4 Years	5	16	4
5-7 Years	13	16	4
8-10 Years	8	9	6
Over 10 Years	9	1	10
Not Marked	2	1	0
Work Experience:			
1-2 Years	0	11	11
3-4 Years	2	11	6
5-6 Years	7	5	1
7-8 Years	1	3	1
Over 8 Years	25	10	4
Not Marked	2	3	1

Table 2

Interrater Reliability for Each Group of Instructors
(adjusted for mean differences in questionnaire responses)

Type of Instructor Group	Reliability	Number of Instructors	No. of Concepts Rated by Each
Automotive Mechanics			
Form A	.89	18	222
Form B	.93	19	218
Business Data Programmers			
Form A	.93	20	190
Form B	.92	23	192
General Secretaries	.93	24	80

Raters of the two forms of programmer concepts did not evidence much difference. However, none of the raters using programmer Form A were from community colleges, whereas the programmer Form B involved 12 instructors from community colleges.

Subsequent tables in this report ignore which questionnaire forms were used within an occupation, and assume that all data for a given occupation were obtained from reasonably comparable groups of respondents.

Scale Usage

Of general interest was the extent to which each response category of the job significance scale was used by the raters, as summarized in Table 3 for each of the occupational areas. The percentage of total occupational responses falling into each category is noted in parenthesis.

Visual comparisons of the three occupations do not identify major differences in scale usage, though there were some occupational trends apparent on scale values 1, 2, and 7. Instructors of secretaries tended to use the high end of the scale more than did instructors of programmers. Programmer instructors appeared to use the lower scale categories more than did other instructors, but this might be because of a greater number of irrelevant concepts listed initially for programmers. This could be expected in view of the general occupational sources used to generate the initial concept listing for programmers. For both the mechanic and secretary concept lists, about 75% of all responses were at a scale level of 4 or higher as compared with 60% for programmers.

Averages (mean values) were computed for each concept from the individual responses. Table 4 illustrates how these averages were distributed across the scale range from 0.00 to 7.00, with averages grouped for each 0.5 scale increment. It may be reasonable to assume that concept averages 3.00 or lower would indicate technical concepts having little or no significance for job performance. This seems to be a reasonably conservative limit on what might be considered of job significance for consideration in training curricula, particularly in view of the tendency for instructors to rate most concepts toward the high end of the scale. However, future studies may want to explore the merit of more empirically derived and justifiable limits. Workers and others closer to the actual job situation may produce quite different distributions of significance responses. The lower cutting point of 3.00 or less would apply to 37 concepts on the mechanics' list, 91 on the programmers' list, and seven on the secretaries' list. Presumably, then, the remainder would be the more appropriate ones for consideration in determining training content.

Tables of Concept Ratings and Ranks

For the purpose of reporting the average ratings given each technical concept, the concepts were regrouped under the five general types described earlier. Within each occupation the concepts were ranked from lowest job significance (rank 1) to the highest (rank 440, 382, or 80). This order of ranking focuses curriculum attention on the elimination of the least significant concepts. Concepts tied for equal job significance were assigned a rank midway between the concerned ranking numbers. Additionally, for each concept a measure of response dispersion was computed. This is recorded as a standard deviation, the lower values indicating very little deviation of individual responses from the average rating of a concept.

Table 3

Distribution of Individual Responses on the Job Significance Scale
(Frequency of use of each scale category, with percentages
noted in parentheses for each occupation)

	Categories and Values of the Degree of Significance Scale								
Job Type	Irrelevant 0	Minor Significance 1	2	3	Substantial Significance 4	5	6	Most Critical 7	No Response Given
Automotive Mechanics (N = 37)	220 (2.7%)	219 (2.6%)	475 (5.9%)	824 (10.2%)	2109 (26.0%)	1542 (19.0%)	1268 (15.5%)	1348 (16.5%)	133 (1.6%)
Business Data Programmers (N = 43)	426 (5.2%)	756 (9.2%)	912 (11.1%)	913 (11.1%)	1790 (21.8%)	990 (12.1%)	1101 (13.4%)	1050 (12.8%)	278 (3.3%)
General Secretaries (N = 24)	52 (2.8%)	99 (5.2%)	126 (6.5%)	184 (9.5%)	449 (23.4%)	273 (14.3%)	284 (14.7%)	439 (22.8%)	14 (0.8%)

Table 4

Summary Distribution of Average Ratings for Concepts

Job Type	Mean Value on Job Significance Scale														Total No. of Concepts
	0.00 - 0.50	0.51 - 1.00	1.01 - 1.50	1.51 - 2.00	2.01 - 2.50	2.51 - 3.00	3.01 - 3.50	3.51 - 4.00	4.01 - 4.50	4.51 - 5.00	5.01 - 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	
Automotive Mechanics	0	0	2	3	12	20	34	51	54	88	95	58	22	1	440
Business Data Programmers	0	2	8	21	21	39	41	56	58	54	46	29	6	1	382
General Secretaries	0	0	0	1	1	5	5	10	18	11	10	9	8	2	80

Table 5 in Appendix B presents the average ratings and ranks for the 440 technical concepts on the Automotive Mechanic list. Table 6 in Appendix C presents similar data for the 382 concepts on the Business Data Programmer list, and Table 7 in Appendix D does the same for the 80 concepts listed for General Secretaries.

These descriptive data may be useful to other researchers and training personnel, to compare with results that might be obtained from other kinds of occupations. For instance, it is of interest to note the proportion of each general type of concept derived for each occupation, because differ ences can be noted that tend to characterize each occupation. Below are cited the percentages of technical concepts of each occupation which were arbitrarily categorized into each of the five gener al types of concepts, considering only those concepts which received an average significance rating of 3.0 or higher:

General Types of Concepts	Automotive Mechanics (405 Concepts)	Business Data Programmers (292 Concepts)	General Secretaries (74 Concepts)
Processes and Functions of the Systems Acted Upon	7.6%	26.0%	23.0%
Types of Elements (Objects, Devices) of the Systems Acted Upon	40.5%	42.8%	27.0%
Measures, Descriptive Characteristics, and Other Specifications	22.0%	18.5%	16.2%
System Events and Conditions	24.4%	5.1%	8.1%
Regulative and Organizing Principles Used or Influencing Work	5.4%	7.5%	25.7%

From this display it can be observed that Automotive Mechanics tended to have proportionately fewer concepts involving system processes and functions than did the other two occupations. On the other hand, their proportion of concepts involving system events and conditions was far greater than the other occupations. Secretaries tended to have more concepts than did mechanics and program mers involving regulative and organizing principles, and somewhat fewer concepts involving system elements. Obviously, these comparisons are only tentative and highly dependent on the nature and comprehensiveness of the original listings of concepts and their categorization by type. But certain trends make sense in regard to what is known about these three jobs.

Four concepts were duplicated on Forms A and B of the questionnaires for Business Data Pro grammers. In effect, there were only 378 different concepts listed among the total of 382 concepts for programmers. Appendix C reports the results for each of these duplications, treating them as

separate concept items. This permitted some comparison to be made, to note the extent to which raters on each form agreed with each other. These comparisons are presented below:

Programmer Concept	Mean Rating		Job Rank	
	Form A	Form B	Form A	Form B
Operating system	4.95	4.77	293	275.5
Register	4.25	3.95	213.5	181
Storage	5.42	5.09	339.5	309
Check digit	3.70	3.35	154.5	117.5

These concepts were consistently rated higher on Form A than on Form B, but by no more than .35 scale units. Similarly, their overall job rankings differed by only 35 ranks (out of 382), at the greatest. These differences do not seem to be such as to cause any substantial influence upon training content decisions, but they do convey a notion of the margin of error in average rating scores that might be attributed to differences between the two groups of respondents and the reliability of their ratings.

Comprehensiveness of the Concept Lists

For use in the actual process of curriculum development it would seem necessary to have some assurance that the original listings of technical concepts included nearly all those of significance to an occupation. There is one feature in the procedures that provides some evidence on the extent to which lists may not be fully comprehensive. At the end of each questionnaire the rater is asked to enter and rate any additional concepts felt to be significant.

Thirty two of the 104 instructors did add in a total 157 entries across the three occupations. Of these total entries, 52 new concepts were noted for mechanics, 33 for programmers, and six for secretaries. The remaining entries generally were concepts listed on the alternate form from the one being used by the respondent, either exactly as listed or closely related but worded slightly different. Below is a brief breakdown of the number of concept additions:

Type of Add-On	Mechanics		Programmers		Secretaries
	Form A	Form B	Form A	Form B	
New concept	21	32	18	3	6
Actual statement on alternate form	0	11	22	12	NA
Related statement on alternate form	1	0	7	5	NA
Related statement on same form	2	2	0	0	0
Actual statement on same form	0	0	0	2	0

All but one of the new entries for mechanics were added by only one rater. Similarly, there was only one concept added to the programmer list by more than one rater. Thus, from such additions there are but two entries sufficiently meaningful to be noted by at least two respondents.

This does not imply that the others are not meaningful, but it does demonstrate the difficulty of getting people to recall important job information by means of a questionnaire.

The majority of add on concepts for programmers were in fact already accounted for on the alternate form from the one being used by the rater. Thus, it seems reasonable to consider the pro grammer listing to be fairly comprehensive. Too, the secretarial listing yielded few new add ons.

It is the listing of technical concepts for automotive mechanics that tended to yield many new items, with new concepts outnumbering additions available on the alternate form by a ratio of 5 to 1. However, a number of these represent more specific concepts within an already listed general concept statement. Or, conversely, some suggestions were quite general in nature (e.g., time, money, over head, attitudes). It might be questioned whether all of these suggestions do in fact represent tech nical concepts.

Since in all but two instances there was only one rating available per new concept, such ratings were not included in the data analyses. They were, for the most part, each rated at a level of 5, 6, or 7, indicating high significance to the job. Subsequent surveys should include these additions to ob tain a representation of ratings of their job value. Figure 2 in Appendix E lists these new suggestions alphabetically for each of the three occupations.

With the relatively high proportion of additions to the mechanics' list, it would seem best to obtain multiple ratings of these new items before the concepts were used as a basis for making deci sions about the content of a training program. Also, this number of additions would indicate the probable benefit of seeking out even more concepts for mechanics.

SUMMARY AND IMPLICATIONS

This study attempted to develop and try out a systematic methodology for use in deriving that portion of job training content which relates to the technical knowledge aspect of a job. Guidelines were proposed for identifying the relevant technical concepts of practical use to workers on the job. Following these guidelines, potential lists of technical concepts were generated for three different occupations. These comprehensive lists were judged by experienced instructors from each occupational area, rating each concept as to its degree of significance for job performance. Summaries of these ratings are reported for possible use or comparison by others concerned with the process of deriving curriculum content based on job requirements.

The rather straightforward procedures used in this study, and the extent of item discrimination made possible by the ratings of job significance, appear to indicate that it is possible and reasonable to identify the significant technical concepts for workers in an occupation by systematic and empirical means. Thus, instead of depending on the judgments of a few individuals having a limited scope of experience, it should be quite possible to rely on the observations and practical experience of many others who as a group are closely acquainted with job performance requirements in many situational contexts.

This enlargement of the source of judgments about job content, in conjunction with the standardized questionnaire process, would permit the identification and analysis of geographic differences in job requirements, differences between subgroups of questionnaire respondents, trends and changes in jobs over time, and other contrasts that might be of interest. The standard format displayed in Appendix A could be used for rating concepts in many occupations when there is uncertainty as to their present degree of relevance. Additional use of the process might be in identifying the cognitive thrusts that are common to several jobs in an occupational cluster. If the concepts were those of basic adult literacy, the patterns of cognitive content of significance to a wide range of occupations (or other meaningful life performance situations) might be subject to further exploration. All of these comparisons would seem to be most useful in determining the necessary content of particular training programs, or in deciding upon the need for multiple or branching programs of instruction.

There are, however, several limitations that should be noted for this methodology at this time.

1. Though helpful in the comprehensive identification and categorization of technical concepts, the five general types of concepts were derived on a rational and intuitive basis. Further conceptualization of the structure of this domain would be most desirable.

2. Experienced instructors were used in this pilot study to rate the extent to which each concept was significant to the job. This group of raters was most useful for establishing the feasibility of the procedure. However, as with the Task Inventory Questionnaires in other portions of the overall R&D project, it is recommended that appropriate respondents be persons who presently are most closely acquainted

with actual job requirements. Thus, future studies of technical concepts might use workers and supervisors as raters, instead of or in addition to instructors. A variety of situational contexts would be appropriate. For instructors, several types of training institutions, public and proprietary, would be desirable. For workers and supervisors, a variety of key types of employment settings should be represented.

3. The statements of technical concepts are a first attempt by the project staff to state such concepts. Despite editing, there did appear to be considerable difference in the ways used to prepare such statements. Not all are equally brief or communicative. Nor do they all represent a consistent level of specificity. Hopefully, future studies will improve upon the process for formulating such concept statements, with the present study providing a most useful process until such improvements become available.

REFERENCES

Agnew, P., Mechan, J., & Olivero, M. *Secretarial office practice.* Cincinnati. South-Western Publishing, 1966.

Automatic business data processing, 1 and 2 syllabus. Albany, NY. University of the State of New York, State Education Department, Bureau of Secondary Curriculum Development, 1972.

Awad, E. M. *Business data processing.* Englewood Cliffs, NJ: Prentice Hall, 1971.

Chilton's auto repair manual. Radnor, PA: Chilton Book, 1974.

Doris, L., & Miller, B. M. *Complete secretary's handbook.* Englewood Cliffs, NJ. Prentice Hall, 1970.

Essex, D. W., & Liu, C. C. *A methodology to assess the content and structure of the affective and descriptive meanings associated with the work environment* (The Center for Vocational Education, R&D Series No. 98). Washington, DC: U.S. Government Printing Office, 1974.

Forier, L. C. (Ed.). *Motor auto repair manual.* New York: Hurst Corporation, 1973.

Gates, M., & Davison, W. *Secretarial office practice course curriculum.* Grand Forks, ND. Grand Forks Public Schools, 1971.

Gerrish, H. *Gerrish's technical dictionary.* Homewood, IL. Goodheart-Wilcox, 1968.

Hemphill, J. K. *Dimensions of executive positions* (Bureau of Business Research Monograph No. 98). Columbus. The Ohio State University, College of Commerce and Administration, The Bureau of Business Research, 1960.

Hutchinson, L. *Standard handbook for secretaries.* New York: McGraw-Hill, 1969.

Jennings, R. C. *The automotive dictionary.* New York. William Dogan Annual Publications, 1969.

Johnson, P. E. Some psychological aspects of subject matter structure. *Journal of Educational Psychology,* 1967, 58, 75-83.

Melching, W. H., & Borcher, S. D. *Procedures for constructing and using task inventories* (The Center for Vocational Education, R&D Series No. 91). Washington, DC: U.S. Government Printing Office, 1973.

Moss, J., Jr., Pucel, D. J., Smith, B. B., & Pratzner, F. C. An empirical procedure for identifying the structure of the technical concepts possessed by selected workers. In B. B. Smith & J. Moss, Jr. (Eds.), *Report of a seminar. Process and techniques of vocational curriculum development.* Minneapolis. Minnesota Research Coordinating Unit for Vocational Education, 1970.

Muller, W. *Dictionary of automotive engineering.* New York: Macmillan, 1964.

Sexton, G. E. *Course of study for vocational automotive mechanics.* Middletown, OH: Middletown City Schools, 1971.

Smith, B. B. *Testing an empirical procedure for identifying technical associative conceptual structure: Discriminating between flexible and inflexible radio and television repairmen.* Unpublished doctoral dissertation, University of Minnesota, 1968.

Thierauf, R. J. *Data processing for business and management.* New York: Wiley, 1973.

U.S. Department of Labor, Manpower Administration, Bureau of Employment Security. *Dictionary of occupational titles. Volume I: Definitions of titles* (3rd ed.). Washington, DC: U.S. Government Printing Office, 1965.

Winer, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill, 1962.

APPENDIX A

Illustrative Formats of Background, Instructions, and Response Page

SIGNIFICANCE RATING

OF TECHNICAL CONCEPTS

FOR AUTOMOTIVE MECHANICS

General Purpose

In order to form a basis for future curriculum development in automotive mechanics, it is necessary to identify significant technical concepts for use in training programs. The purpose of this study is to help determine the significance of certain technical concepts used by automotive mechanics in performing their job. As an instructional expert, you can help us achieve this objective.

Technical concepts have been defined as classes or categories of specialized knowledges which have practical use to automotive mechanics in the effective performance of their job.

1973-74

THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY

Code No. [ ][ ][ ]

(This code No. is only for follow-up purposes.)

PART I

Card Column Numbers ↓

BACKGROUND INFORMATION

4 CHECK YOUR PRESENT TEACHING ASSIGNMENT (Check The One That Best Describes Your Assignment):

1 ☐ Beginning Automotive Mechanics Course

2 ☐ Intermediate Automotive Mechanics Course

3 ☐ Advanced Automotive Mechanics Course

4 ☐ Professional Refresher Automotive Mechanics Course

5 ☐ Other (specify) _____

5 CHECK THE APPROPRIATE TITLE OF THE INSTITUTION IN WHICH YOU TEACH:

1 ☐ Junior College

2 ☐ Area Vocational-Technical School

3 ☐ Technical Institite (public)

4 ☐ Other (specify) _____

6 NUMBER OF YEARS TEACHING EXPERIENCE IN AUTOMOTIVE MECHANICS:

1 ☐ 2-4 2 ☐ 5-7 3 ☐ 8-10 4 ☐ over 10

7 NUMBER OF YEARS OF WORK EXPERIENCE IN THE AUTOMOTIVE MECHANICS FIELD (Other Than Teaching):

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ over 8

WHERE DID YOU RECEIVE YOUR AUTOMOTIVE MECHANICS TRAINING (Check All That Apply):

8 ☐ On-The-Job

9 ☐ Military Training School

10 ☐ Private Automotive Mechanics School

11 ☐ Company Training

12 ☐ 4 Year College Program

13 ☐ Adult Education Program

14 ☐ Public Vocational-Technical Schools

15 ☐ Other (specify) _____

16 CHECK HIGHEST DEGREE EARNED:

1 ☐ High School

2 ☐ Masters

3 ☐ 2 Year A.B. (Technical Degree)

4 ☐ 6th Year

5 ☐ Bachelor

6 ☐ Doctor's Degree

17-19 NUMBER OF STUDENTS ENROLLED IN AUTOMOTIVE MECHANICS COURSE(S) WHICH YOU ACTUALLY TEACH [ ][ ][ ]

20-22 NUMBER OF STUDENTS IN COURSES YOU TAUGHT WHO WERE PLACED LAST YEAR IN AUTOMOTIVE MECHANIC OCCUPATIONS [ ][ ][ ]

23-24 NUMBER OF FULL-TIME AUTOMOTIVE MECHANICS TEACHERS IN YOUR SCHOOL [ ][ ]

DIRECTIONS FOR REPORTING CONCEPT SIGNIFICANCE

(Please read these directions carefully and completely.)

---

1. Read each of the technical concepts in the following list and judge the DEGREE OF SIGNIFICANCE of each concept to the effective accomplishment of the job of the Automotive Mechanic. In other words, how critical is the use of the concept in the performance of the job tasks of the Automotive Mechanic?

2. For each technical concept, circle the one value between 0 and 7 which best represents your judgment of the significance of the concept to the job performance of the Automotive Mechanic. There is neither a right nor a wrong answer to any of these concepts. The important thing is your judgment.

3. Should there be any particular item you prefer not to respond to, feel free to omit that item and continue with the rest of the booklet. However, your consideration of each item is most important to the effective accomplishment of this study.

4. Please make a rating of every technical concept using the following rating scale:

> 0 = Irrelevant or definitely does not apply in the job
> 1 = Under unusual circumstances may be of minor significance in job performance
> 2
> 3
> 4 = Of substantial significance in job performance
> 5
> 6
> 7 = Of most critical significance in job performance

Use all eight scale values, as appropriate. The values of "2" and "3" represent scale levels in between "1" and "4." Use them to represent ratings that you feel should be somewhere between those two defined levels of the scale. This also is the same way the values of "5" and "6" should be used, to indicate ratings intermediate between the defined values of "4" and "7." Thus, the scale from "1" to "7" is a series of increasingly higher significance levels. Your rating of a technical concept might be at any one of these levels.

5. As you consider each item you are to proceed in two steps:

   a. First, consider whether the technical concept applies to the job of Automotive Mechanic. If your answer is NO then the item is definitely not relevant to the position. You would circle the number "0" in this case.

   b. Second, and only if the item does apply to Automotive Mechanics, you must decide how significant it is to the effective performance of their job. In making this decision

you are to consider and weigh its importance, frequency of use, relevance, or any other factor which you think determines to what extent the item has significance for Automotive Mechanics.

6. EXAMPLES:

   a. To indicate a technical concept judged to be of substantial significance in job performance, circle the 4:

   0 1 2 3 (4) 5 6 7

   b. To indicate a technical concept that is of considerable importance, having major significance in job performance, probably circle the 6:

   0 1 2 3 4 5 (6) 7

7. Space has been provided following the list of technical concepts for you to enter and rate any additional concepts you feel are significant in job performance.

THANK YOU FOR PARTICIPATING IN THIS STUDY.

Rating Scale:	0 = Irrelevant	4 = Substantial Significance
Degree of Significance	1 = Minor Significance	5
of Concept to Job of	2	6
Automotive Mechanic	3	7 = Most Critical Significance

TECHNICAL CONCEPTS FOR AUTOMOTIVE MECHANICS

	Degree of Significance							
1. Accelerator	0	1	2	3	4	5	6	7
2. AC/DC generator and regulator diagnosis procedures	0	1	2	3	4	5	6	7
3. AC voltage	0	1	2	3	4	5	6	7
4. Air bleed	0	1	2	3	4	5	6	7
5. Air cleaner	0	1	2	3	4	5	6	7
6. Air conditioner	0	1	2	3	4	5	6	7
7. Air gap	0	1	2	3	4	5	6	7
8. Air horn	0	1	2	3	4	5	6	7
9. Air resistance	0	1	2	3	4	5	6	7
10. Ampere	0	1	2	3	4	5	6	7
11. Annealing	0	1	2	3	4	5	6	7
12. Antifreeze	0	1	2	3	4	5	6	7
13. Automatic transmission	0	1	2	3	4	5	6	7
14. Auxiliary-air-intake	0	1	2	3	4	5	6	7
15. Babbitt	0	1	2	3	4	5	6	7
16. Balance-wheel	0	1	2	3	4	5	6	7
17. Ball joints	0	1	2	3	4	5	6	7
18. Ball joint wear tolerances	0	1	2	3	4	5	6	7
19. Battery specifications	0	1	2	3	4	5	6	7
20. Bendix drive	0	1	2	3	4	5	6	7
21. Bent connecting rod	0	1	2	3	4	5	6	7
22. Blowby	0	1	2	3	4	5	6	7
23. Blown head gasket	0	1	2	3	4	5	6	7
24. Bore and stroke	0	1	2	3	4	5	6	7

APPENDIX B

Ratings of Technical Concepts for Automotive Mechanics

TABLE 5

Ratings of Technical Concepts for Automotive Mechanics, Grouped by Rational Categories of Concepts

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker							
Air bleed	4.50	1.21	174	Front-end alignment	6.28	0.93	431.5
Air cooling	3.42	1.57	65	Fuel injection	4.53	1.82	178
Alignment	6.26	1.02	429.5	Honing	4.94	1.16	245
Annealing	2.72	1.28	24.5	Ignition timing	6.21	1.06	426.5
Atomization	3.95	1.82	111	Intake stroke	4.39	1.30	153
Auxiliary-air-intake	3.59	1.65	74	Ionization	3.39	1.46	62.5
Blowby	5.28	1.28	315.5	Lubrication	5.28	1.33	315.5
Break-in	4.00	1.63	117	Oil cooling	3.74	1.89	91
Cavitation	3.00	1.89	36.5	Porting	3.22	1.08	52
Charge	4.22	1.27	136	Power stroke	4.26	1.55	138.5
Combustion	4.83	1.34	234	Reface	4.47	0.78	168.5
Compression-stroke	4.28	1.33	142	Reseat	4.58	1.98	187.5
Crossfire	5.44	1.34	354	Run-in	3.94	1.00	109.5
Demagnetize	2.56	1.86	18	Spark advance	5.79	1.24	403.5
Depolarize	2.39	1.70	15	Splash lubrication	2.05	1.10	6
Discharge	5.11	1.10	280.5	Static balancing	4.82	1.46	228
Dynamic balancing	5.44	1.01	354	Voltage viscous damping	2.11	1.79	8.5
Exhaust stroke	4.56	1.34	182.5	Vulcanize	1.53	1.35	3
Flame hardening	2.72	1.37	24.5	Water cooling	4.82	1.10	228
Friction drive	2.89	1.74	32				

[a]Job rank of 1 has lowest job significance; 440 is the highest ranking of job significance.

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker							
Accelerating Jet	4.47	1.72	168.5	Camber	5.72	1.37	391.5
Accelerator	3.33	2.05	59	Carbon monoxide	5.67	1.67	380.5
AC generator (Alternator)	6.47	0.82	439	Carburetor	6.33	1.20	435.5
Additives	2.42	1.43	16	Caster	5.67	1.37	380.5
Air cleaner	4.61	1.57	194.5	Choke	4.78	1.40	219.5
Air cooled engine	3.89	1.33	106	Circuit breakers	4.61	1.16	194.5
Air conditioner	5.06	1.35	270	Clutch	5.17	1.42	294.5
Air filter	4.74	1.97	210.5	Clutch release mechanism	4.72	1.24	208
Air horn	3.22	1.93	52	Coil spring	4.06	1.27	123.5
Analyzer	5.26	1.68	310	Combustion chamber	4.50	1.64	174
Antifreeze	3.89	1.82	102.5	Compression gauge	4.83	1.30	234
Automatic choke	5.68	1.22	385	Compressor	4.28	1.59	142
Automatic transmission	6.11	1.10	420	Concealed headlamps	2.11	1.45	8.5
Axle bearings	5.16	1.42	289	Cooling system	5.67	1.15	380.5
Babbitt	3.12	1.64	43.5	Cowl	1.39	1.25	1
Baffle	3.11	1.21	41.5	Crankshaft	5.44	1.01	354
Balance-wheel	5.50	1.46	358	Creeper	2.28	1.88	13
Ball bearings	4.47	1.57	170.5	Current regulator	5.83	1.07	405.5
Ball joints	5.89	1.41	410	Cutout relay	5.11	1.29	280.5
Battery	5.84	1.04	407.5	Cylinder	4.76	1.35	214
Bendix drive	4.67	1.33	202.5	Cylinder head	5.39	1.01	339
Bezel	2.06	1.65	7	Dashpot	4.33	1.11	147.5
Braking surface	5.00	1.49	260	DC generator	4.44	1.89	165.5
Breaker point	5.76	1.00	398.5	Dead axle	3.28	1.73	54.5

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Dehydrator	3.12	1.87	43.5	Flywheel	4.56	1.64	182.5
Detergent oils	4.61	1.16	194.5	Front suspension	6.06	1.03	418.5
Diesel engine	3.72	2.42	88	Fuel pump	5.28	1.33	315.5
Differential	5.78	0.85	401	Fuel system	5.84	1.14	407.5
Diode	5.39	1.64	339	Fuses	4.83	1.34	234
Disc brakes	6.28	0.73	431.5	Gasket	4.68	1.22	206
Distributor	5.89	1.15	410	Gear train	5.11	1.29	280.5
Downdraft carburetor	4.78	1.55	219.5	Hand brake	3.74	1.37	91
Drag link	4.56	1.34	182.5	Headers	2.83	1.26	29
Drive axles	5.22	1.31	299	Heater system	4.00	1.59	117
Electrical system	6.26	1.12	429.5	Horn relay	4.06	1.03	123.5
Electrolyte	4.44	1.30	165.5	Hotchkiss-drive	3.68	1.62	84.5
Engine	5.74	1.33	395.5	Hydraulic brakes	6.33	0.82	435.5
Ethylene glycol	4.00	1.00	117	Hydraulic valve lifter	5.00	1.30	260
Exhaust emission controls	6.32	0.80	433	Idling jet	5.06	1.47	270
Exhaust manifold	4.16	1.04	129	Ignition switch	4.58	1.23	187.5
Exhaust system	4.67	1.20	202.5	In-line engine	3.83	1.64	97.5
Feeler stock	3.33	1.76	59	Journal	4.44	1.38	165.5
F-Head engine	2.79	1.32	27.5	Kingpin	3.05	1.28	39
Filter	4.83	1.34	234	Leaf	2.71	1.56	22.5
Firewall	1.74	1.33	4	Leaf spring	3.89	0.94	102.5
Flange	2.89	1.15	30	L-Head engine	3.21	1.54	49
Float system	5.67	1.00	380.5	Lighting system	5.56	1.26	365.5
Floating axle	3.74	1.37	91	Limited-slip differential	4.84	1.23	238.5
Fluid coupling	3.68	1.26	84.5	Liner	3.29	1.78	56

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Live axle	3.47	1.87	70.5	Power steering pump	4.95	1.19	253
Magnetic clutch	4.41	1.14	158	Power train	5.44	0.96	354
Main bearing	4.79	1.10	224.5	Pressure cap	4.95	1.64	253
Manifold	4.56	1.17	182.5	Pushrod	4.28	1.19	142
Manual steering gear	4.63	1.22	197.5	Races	2.89	2.10	32
Master cylinder	5.89	1.10	410	Radiator	4 94	0.97	249
Mechanical brakes	2.26	2.12	11.5	Rear suspension	4.21	1.44	133
Motometer	2.69	1.83	21	Reciprocating engine	4.67	1.20	202.5
Muffler	4.17	1.26	131	Rocker arm	4.39	0.89	153
Needle bearing	3.89	1.48	106	Rocker shaft and pushrod	4.95	1.28	253
Negative ground	4.44	1.21	165.5	Rotor	4.78	1.18	219.5
Odometer	3.05	1.57	39	Sealed-beam light	3.05	1.54	39
Oil cooler	4.00	1.11	117	Sediment bowl	3.88	1.08	101
Oil filter	4.58	1.66	187.5	Self-adjusting brakes	5.11	1.37	276
Oil pan	3.83	1.34	97.5	Semifloating axle	4.00	1.28	117
Oil pump	5.16	1.27	289	Separators	2.95	1.67	34.5
Overdrive transmission	4.00	1.41	117	Shift linkage	4.59	1.19	191
Overhead valve	4.82	1.25	228	Slip joint	3.74	1.16	91
Petcock	2.21	1.44	10	Solenoid	5.24	1.31	305.5
Planetary gears	5.33	1.20	327	Spark plug	5.68	1.34	385
Point gauge	3.78	0.85	94	Speedometer	2.79	1.20	27.5
Poppet valve	3.28	1.88	54.5	Standard transmission	5.24	1.06	305.5
Port	3.67	1.37	80.5	Starter	5.42	1.31	349
Power brakes	4.95	1.28	253	Stator	5.24	1.39	305.5
Power steering gear	5.22	1.27	299	Steering idler arm	4.79	1.51	224.5

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Storage battery	5.29	1.07	321	Vacuum brake	5.24	1.39	305.5
Tachometer	3.42	1.87	65	Vacuum tank	2.89	1.62	32
Temperature, ammeter, fuel and oil gauges	4.74	1.68	210.5	Valve float	4.41	1.24	158
Thermostat	5.00	1.59	260	Valve grinder	5.05	1.32	265.5
Throttle linkage	4.74	1.52	210.5	Valve pump	3.00	1.70	36.5
Throw out bearing	4.41	1.19	158	Valve spring	5.32	1.38	323
Thrust bearing	4.42	1.53	161.5	Valve system	5.35	1.08	330
Tie rod	5.24	1.21	305.5	V-engine	4.32	2.08	145.5
Tilt and telescoping steering columns	3.16	1.35	45.5	Vibrational dampener	4.47	1.46	170.5
Timing chain	5.00	1.19	260	Voltage regulator	5.71	1.07	388
Timing gear	5.16	1.29	289	Water jacket	3.89	1.41	106
Torque tube	3.71	1.23	87	Water pump	4.76	1.31	214
Torsional balancer	4.11	1.37	126.5	Welsh plugs	4.00	1.72	117
Transistorized ignition	6.18	1.04	425	Wheel bearings	5.71	1.23	388
Universal joints and drive shaft	5.00	1.21	260	Wheel cylinders	5.58	1.14	369
Upper and lower control arms	5.24	1.11	305.5	X-member	3.47	1.2[illegible]	69
Vacuum booster	4.16	1.78	129				
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications							
Acceleration	4.42	1.66	161.5	Ampere	5.61	1.34	373.5
AC voltage	4.67	1.89	202.5	Ampere-hour capacity	4.32	1.62	145.5
Advance/retard	6.21	0.83	426.5	Ball joint wear tolerances	5.67	1.41	380.5
Air gap	4.22	1.44	136	Battery specifications	5.22	1.23	299

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications (continued)							
Bolt specifications	5.39	1.42	339	Eccentric	3.89	1.37	106
Bottom-dead-center	4.28	1.37	142	Effective duration	4.33	1.15	147.5
Brake drag	5.39	1.25	339	Effective horsepower	3.16	1.50	45.5
Brake horsepower	3.67	1.49	80.5	Efficiency	5.06	1.22	270
Brake specifications	5.06	1.27	270	Engine specifications	6.06	1.03	418.5
Cam angle	5.78	1.13	401	Equivalent braking forces	3.68	1.75	84.5
Center-of-gravity	3.61	1.70	75.5	Exhaust backpressure	4.89	1.10	240.5
Charging efficiency	4.78	1.40	219.5	Fast idle	4.83	1.46	234
Chassis specifications	4.22	2.07	136	Flashpoint	4.00	1.33	117
Coefficient of friction	4.50	1.50	174	Flat spot	5.05	1.36	265.5
Compression	5.39	1.42	339	Flooding	5.61	1.01	373.5
Compression balance	5.28	1.04	315.5	Fluidity	3.11	1.62	41.5
Compression ratio	3.61	1.50	75.5	Foot pound	5.56	1.34	365.5
Concentric	4.28	1.48	142	Four-wheel drive	3.37	1.87	61
Coolant capacities	3.17	1.46	47	Front-wheel drive	3.84	1.72	99.5
Cranking compression	5.17	1.38	294.5	Fuel-air ratio	5.58	1.43	369
Crankshaft bearing journal specifications	5.83	1.57	405.5	Fuel pump pressure	5.33	1.25	327
Cubic inch displacement	3.22	2.04	52	High-flash-point	3.67	1.83	80.5
Deceleration	4.00	1.20	117	Idle speed	5.00	1.52	260
Decimal equivalents	4.39	1.80	153	Kingpin inclination	5.11	1.52	280.5
Developed horsepower	4.11	1.05	126.5	Lean mixture	5.37	1.31	332
Developed torque	3.39	1.53	62.5	Low gear	3.63	1.63	77
Discharge rate	4.39	1.77	153	Magnetic pulse	4.16	1.84	129
Distributor dwell angle	6.22	0.79	428	Mechanical efficiency	4.78	1.58	219.5

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications (continued)							
Mechanical efficiency equation	2.26	1.45	11.5	Streamlining	1.42	1.50	2
Miles per gallon	4.39	1.11	153	Synchronization	4.82	1.15	228
Miles per hour	2.32	1.69	14	Tappet clearance	5.12	1.08	284.5
Octane rating	4.35	0.97	149	Tetraethyl-lead	3.94	1.16	109.5
Oil capacities	3.68	1.45	84.5	Thermal efficiency	3.56	2.17	72
Oil pressure	5.11	0.94	280.5	Three-point suspension	3.82	1.76	95.5
Otto-cycle	2.71	1.52	22.5	Top dead center	5.00	0.84	260
Overhead cam	4.26	1.74	138.5	Torque specifications	6.12	1.08	421
Percolation	4.83	1.30	234	Tune-up specifications	6.16	1.31	423
Pounds per square inch	4.53	1.73	178	Turning radius	4.94	1.16	245
Reciprocating motion	3.42	1.60	65	Underslung	2.47	1.58	17
Resistance	5.17	1.07	294.5	Valve intake setting	5.63	1.22	376.5
Rolling resistance	3.21	1.51	49	Valve specifications	5.74	1.16	395.5
Rotary motion	3.32	1.62	57	Valve overlap	4.59	1.61	191
S.A.E.	4.06	0.94	125	Valve timing	5.59	1.29	371
S.A.E. horsepower	2.56	1.63	19	Venturi	4.65	1.33	199.5
Spark plug gap	5.24	1.44	305.5	Viscosity rating	3.74	1.92	91
Spark plug appearance	5.53	1.43	361	Viscous friction	4.00	1.53	117
Specific gravity	5.06	1.21	274	Voltage	5.41	1.14	345.5
Starter specifications	5.12	1.28	284.5	Volumetric efficiency	2.95	2.19	34.5
D. System Events and Conditions							
Air resistance	2.78	1.65	26	Back lash	5.58	1.23	369
Backfire	4.21	1.61	133	Bent connecting rod	5.06	1.31	270

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
D. System Events and Conditions (continued)							
Bent valve	4.53	1.82	178	Distributor troubles	6.00	1.05	415.5
Blown head gasket	5.56	1.21	365.5	Distributor vacuum control defective	5.94	0.91	412
Blow-out	1.89	1.21	5				
Brake fade	5.56	1.38	365.5	Driveshaft vibration	5.11	1.37	276
Broken piston rings	5.06	1.58	270	End play	5.42	1.18	349
Broken valve spring	4.89	1.20	240.5	Engine misfires	5.67	0.88	380.5
Build-up	3.65	1.88	78	Excessive carbon	4.21	1.64	133
By-pass valve stuck	4.39	1.77	153	Flooding of carburetor	5.72	1.15	391.5
Carburetor filter clogged	4.94	1.65	249	Fouling	4.74	1.68	210.5
Carburetor icing	3.67	1.86	80.5	Free-wheeling	2.63	1.75	20
Carburetor out of adjustment (or faulty)	5.72	1.15	391.5	Friction	4.56	1.30	182.5
Clogged air filter or inlet	5.44	1.07	354	Fuel line blocked or open	5.39	1.01	339
Clogged oil pump screen	5.00	1.37	260	Fuel tank not vented	5.22	1.23	299
Clogged or saturated oil filter	5.33	1.11	327	Generator not charging	5.79	1.24	403.5
Condensation	3.33	1.49	59	High compression	3.58	1.43	73
Cooling system failure	5.28	1.19	315.5	High engine operating temperature	5.39	1.30	339
Cracked distributor cap	5.39	1.11	339				
Cracked or broken piston	5.06	1.31	270	High speed misfire	5.53	0.99	361
Crankshaft bearing noise	5.50	1.17	358	High starter draw	5.78	1.03	401
Crankshaft misalignment	5.00	1.56	260	Icing	3.89	1.89	106
Dead battery	5.28	1.19	315.5	Ignition timing incorrect	6.33	1.00	435.5
Dirty oil	4.61	1.86	194.5	Improper fuel-air mixture to cylinders	6.00	1.17	415.5
Distributor advance faulty	6.00	0.88	415.5	Improper lubrication	5.17	1.34	294.5

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
D. System Events and Conditions (continued)							
Improper viscosity or quality of oil	4.42	1.66	161.5	No-spark	5.42	1.23	349
Inadequate spark	5.50	1.34	358	Oil contamination	4.56	1.01	182.5
Incorrect firing sequence	5.95	1.05	413	Oil pump sucking air	5.16	1.42	289
Incorrect spark plugs	5.61	1.06	373.5	Performs poorly	5.11	1.77	276
Leaking carburetor float	5.42	1.27	349	Piston noise	4.50	1.21	174
Leaky heat riser or stuck heat control valve	4.83	1.21	234	Poor compression	4.89	1.65	242
Leaky intake manifold or carburetor gasket	5.68	1.30	385	Poorly seating exhaust or intake valves	5.28	0.99	315.5
Loose connecting rod bearing	5.39	1.01	339	Pre-ignition (detonation)	5.37	1.35	332
Loose connections	5.63	1.18	376.5	Pushrod bent or worn	4.39	1.34	153
Loose flywheel or converter	5.33	1.05	327	Regulator out of operation or adjustment	5.37	1.56	332
Loose generator or alternator drive belt	5.74	1.16	395.5	Reversed coil polarity	5.33	1.05	327
Loose main bearing	5.39	1.21	339	Ring shimmy	4.00	1.20	117
Low compression	4.95	1.23	253	Rocker arm loose	4.84	1.39	238.5
Low engine operating temperature	4.78	1.23	219.5	Scored piston or cylinder wall	4.94	0.87	245
Low oil level	4.68	1.72	206	Shimmy	4.58	1.63	187.5
Low vacuum gauge reading	5.61	1.06	373.5	Short circuit	5.41	1.09	345.5
Misalignment	5.11	1.33	280.5	Short or open coil	5.53	1.14	363
Moisture and dirt in ignition system	5.16	1.63	289	Short or open condenser	5.16	1.56	289
Neutral shifting switch bad	5.28	1.41	315.5	Sticky valves	5.24	1.21	305.5

Table 5 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
D. System Events and Conditions (continued)							
Stuck or dry hydraulic valve lifters	4.63	1.42	197.5	Wandering	4.42	1.31	161.5
Tire deflections	3.84	1.46	99.5	Weak coil	5.22	1.31	299
Vacuum leak at carburetor or intake manifold	5.53	1.79	361	Wheel alignment	5.71	1.56	388
Valve noise	4.59	1.37	191	Won't run	5.76	1.06	398.5
Valve timing incorrect	5.74	1.21	395.5	Won't start	6.00	1.11	415.5
Valves out of adjustment	4.76	1.31	214	Worn distributor points	4.94	0.94	245
Vapor lock	4.94	0.94	245	Worn or broken rotor	5.28	1.24	315.5
Warped valve head	4.82	1.25	228	Worn or sludged-up rings	4.65	0.76	199.5
E. Regulative and Organizing Principles Used by the Worker or Directly Influencing the Work							
AC/DC generator and regulator diagnosis procedures	6.33	1.00	435.5	Fuel system diagnosis procedures	6.16	0.93	423
Alternating current (AC)	5.32	1.81	323	Gravity	3.44	1.57	67.5
Battery diagnosis procedures	6.16	1.09	423	Ignition system diagnosis procedures	6.61	0.76	440
Bore and stroke	4.50	1.80	174	Internal combustion	4.68	1.75	206
Centrifugal force	3.44	1.57	67.5	Load/no load test	5.28	1.33	315.5
Chassis ground	4.78	1.51	219.5	Magnetic field	4.78	1.55	219.5
Compression diagnosis procedures	5.72	1.10	391.5	Manifold vacuum	5.32	1.26	323
Cranking/starter diagnosis procedures	6.39	0.68	438	Ohm's law	4.94	1.51	249
Direct current (DC)	5.39	1.42	339	Torque sequence	5.16	1.84	289
Energy	3.47	1.76	70.5	Traction	3.82	1.04	95.5
Firing order	5.42	1.43	349	Turbine	3.21	1.73	49

APPENDIX C

Ratings of Technical Concepts for Business Data Programmers

Table 6

Ratings of Technical Concepts for Business Data Programmers, Grouped by Rational Categories of Concepts

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker							
Address modification	3.70	1.88	152	Desk check	5.84	1.18	364.5
Automatic data processing	5.16	1.81	316.5	Diagnostic routine	3.70	1.83	152
Batch processing	5.26	1.26	328.5	Dump	5.74	1.26	360.5
Blocking	5.70	1.00	356.5	Duplicating	2.33	1.53	41.5
Block sort	3.45	1.20	128	Dynamic relocation	3.26	1.75	111.5
Branch	5.90	1.04	371.5	Editing	5.70	1.23	356.5
Bubble sort	2.10	1.69	33	Edit mask	5.25	1.58	324.5
Card feed	3.73	1.93	157	Emitting	1.27	1.05	6
Classifying	3.52	1.92	135	Emulating	2.61	1.86	60.5
Clearing	5.10	1.41	311	Encoding	3.68	2.03	149.5
Collating	4.61	1.63	259	Error routine	5.22	1.53	322
Compiling	5.17	1.66	319	Executive program	3.70	1.68	154.5
Conditional transfer	5.85	1.06	367	Feedback	2.84	2.00	77
Data acquisition	3.96	1.79	182.5	File maintenance	5.74	1.03	360.5
Data collection	5.30	1.76	331	Flip-flop	1.56	1.31	15
Data communications	4.13	1.80	202	Flowcharting	6.05	1.02	376.5
Data reduction	4.05	1.88	193.5	Gangpunching	2.52	1.66	53.5
Debugging	6.52	0.88	382	Group printing	4.40	1.69	234.5
Decision	5.47	1.14	345	Housekeeping routine	5.40	1.29	337

[a]Job rank of 1 has lowest job significance; 382 is the highest ranking of job significance.

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker (continued)							
Indexing	4.65	1.66	261	Overlay	3.86	1.58	172
Information retrieval	5.25	1.41	324.5	Paging	3.50	1.98	131
Initialize	5.04	1.71	302	Parity check	3.21	2.02	105.5
Inquiry	4.90	1.14	289	Printing	4.68	1.87	264
Integrated data processing (IDP)	3.24	1.51	109.5	Process control	2.33	1.60	41.5
Interpret	2.74	1.92	64	Programming	6.21	1.10	380
Interrupt	4.13	1.54	202	Read in	4.76	1.06	274
Joggle	2.28	1.45	38	Read out	3.82	1.77	165
Limit check	4.06	1.98	195	Reproducing	3.64	1.97	146.5
Linear programming	2.00	1.82	30	Responsibility reporting	3.54	1.72	137
Load	4.04	1.33	189.5	Roll-back	1.71	1.33	21
Load-and-go	4.00	2.12	186	Sequence checking	4.86	1.63	286.5
Magnetic ink character recognition (MICR)	3.16	1.35	99.5	Sequential processing	6.05	0.98	376.5
Mark sensing	2.83	1.40	75.5	Serial operation	3.45	1.88	128
Matching	4.59	1.70	255.5	Sight checking	3.55	1.86	140
Merge	4.91	1.32	291.5	Simulation	3.09	1.81	96
Message switching	2.58	1.63	59	Storage allocation	4.27	1.71	217.5
Modify	3.83	1.71	169	Straight line coding	4.50	1.67	244.5
Modular programming	4.00	1.82	186	Summarizing	4.73	1.66	267
Nondestructive read	3.77	2.09	162	Summary punch	3.55	1.72	140
Numerical control	1.78	1.55	24	Symbolic coding	4.13	1.57	202
Off-punching	3.16	1.84	99.5	Table look-up	5.90	1.00	371.5
Operation	4.14	1.88	205	Tagging	3.24	1.57	109.5
Optical character recognition (OCR)	2.94	1.02	83.5	Throughput	4.23	1.16	212

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker (continued)							
Trace	4.53	1.70	251	Validity check	3.96	1.97	182.5
Unconditional transfer	5.04	1.60	302	Verifying	4.30	1.65	220
Updating	6.15	0.80	378	Zero suppression	4.52	1.95	248.5
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker							
Accumulator	3.00	2.00	88.5	Cathode-ray tube (CRT)	3.65	1.66	148
Address	4.78	1.98	278				
Address register	3.52	1.98	133.5	Central processing unit (CPU)	5.45	1.07	343.5
Analog computer	0.79	1.06	1	Channel	3.74	1.59	158
Arithmetic unit	3.04	1.97	92	Character	5.40	1.74	337
Assembler program	4.95	1.24	293	Checkpoint	3.95	1.91	179.5
Asynchronous computer	1.73	1.61	22	Circuit	1.56	1.58	15
Background	3.32	1.33	116	Code	5.00	1.87	298
Background program	3.41	1.34	123	Collator	2.30	1.27	39
Band	1.39	1.46	8.5	Command	4.40	1.98	234.5
Base address	4.00	1.98	186	Compiler program	4.56	1.74	254
Block diagram	5.78	1.18	362	Computer utility	5.15	1.28	314.5
Break character	2.00	1.93	30				
Buffer storage	4.80	1.50	281	Computer output microfiche (COM)	2.78	1.86	69.5
Bulk memory	2.45	1.44	46.5	Console	3.75	1.64	159.5
Calculator	2.63	2.00	62.5	Control card	5.20	1.78	320.5
Card code	5.04	1.76	302	Control panel	2.48	1.69	49.5
Card deck	5.39	1.66	334.5	Control program	4.90	1.58	289
Card punch	3.79	1.80	163	Control storage	3.72	1.79	156
Card reader	4.74	1.54	269.5	Control unit	2.83	1.83	75.5

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Counter	4.50	1.88	244.5	General purpose computer	4.55	1.69	252.5
Cylinder	4.60	1.47	257	Generator	2.90	1.59	80
Data	5.65	1.68	354	Hardcopy	3.56	1.58	142.5
Data base	4.65	1.34	261	Hardware	3.91	1.47	177
Data file	5.80	1.63	363	Head crash	3.04	1.77	93.5
Data set	4.74	1.42	269.5	Header card	4.05	1.80	191.5
Data transmission equipment	3.55	1.07	140	Header label	4.83	1.40	284.5
Decision table	4.22	1.53	211	Hybrid computer	1.79	1.76	25.5
Decoder	2.50	1.34	51.5	Index-register	3.83	1.86	167.5
Digital computer	4.83	1.92	284.5	Index word	2.85	2.13	78
Disk file	5.95	1.07	374.5	Input device	5.40	1.74	337
Disk pack	5.00	1.32	298	Instruction	5.90	1.30	371.5
Disk storage	5.95	1.07	374.5				
Documentation	6.20	1.12	379	Instruction register (control register)	2.78	1.96	69.5
Drum memory	3.39	1.44	121	Interface	3.26	1.45	113
Duplex channel	2.00	1.41	30	Internal storage	4.00	1.76	186
Edge-notched card	2.30	1.33	40	Key	5.74	1.12	358.5
Edge-punched card	1.60	1.50	18	Leased channel	1.27	1.12	5
Electrical accounting machine (EAM)	1.74	1.29	23	Linkage	4.39	1.24	231.5
Electronic data processing systems	5.10	2.12	311	Listing	5.05	1.94	306.5
External label	4.33	1.58	225	Loop	5.74	1.25	358.5
External storage	5.15	1.65	314.5	Machine language coding	2.87	2.01	79
Flag	3.56	1.76	142.5	Magnetic card	2.74	1.75	65
Foreground	3.26	2.07	111.5	Magnetic core	4.21	1.61	210

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Magnetic disk	4.96	1.83	295	Optical scanner	2.91	1.41	81.5
Magnetic drum	3.90	1.37	174	Output device	5.42	1.42	339.5
Magnetic film	3.00	2.08	88.5	Page	3.82	1.80	166
Magnetic ink	2.53	1.50	56.5	Paper tape	2.91	1.62	81.5
Magnetic ink character reader (MICR)	3.30	1.63	114	Paper tape punch unit (PPT)	2.53	1.23	56.5
Magnetic tape	5.16	1.53	316.5	Parity bit	3.21	2.02	105.5
Management information system	4.35	1.55	226	Password	3.38	1.25	120
Master card	4.37	1.75	228.5	Peripheral equipment	4.32	1.84	223.5
Master file	5.43	1.10	341.5	Photo-optic memory	1.40	1.40	10
Matrix	3.32	1.45	115	Processor	4.29	1.44	219
Memory	4.79	1.48	279	Program file	4.45	1.92	240.5
Memory dump	5.30	1.20	332	Program flow chart	5.89	1.12	369
Modifier	3.62	1.76	144	Program library	5.00	1.17	298
Modulator	1.55	1.36	13	Pseudo instruction	2.76	1.66	67
Monolithic circuits	1.56	1.38	15	Punched card	4.86	1.84	286.5
Multiplexor	3.10	1.77	97	Raw data	4.32	1.49	223.5
Network	2.27	1.89	37	Read-only memory	2.79	1.61	72
Object language	3.68	1.89	149.5	Read/write head	3.64	1.80	146.5
Off-line storage	4.78	1.55	277	Record	5.60	1.67	352
On-line storage	4.14	1.89	204	Reentrant	3.20	2.25	104
Operand	5.17	1.30	318	Register (rated on Form A)	4.25	2.21	213.5
Operating system (rated on Form A)	4.95	1.67	293	Register (rated on Form B)	3.95	2.20	181
Operating system (rated on Form B)	4.77	1.44	275.5	Selector channel	2.77	1.68	68

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)							
Simplex channel	2.18	1.70	36	Test deck	5.26	1.77	328.5
Software	4.82	1.19	293	Test routine	4.74	2.12	268
Sort/merge routine	4.77	1.38	275.5	Track	4.17	1.52	208
Source document	5.04	1.46	304.5	Trace routine	4.37	1.60	228.5
Source program	5.68	1.06	355	Trailer record	5.05	1.46	306.5
Special character	4.67	1.82	263	Transaction code	5.63	1.26	353
Special purpose computer	2.47	1.84	48	Transistor	1.96	1.63	28
Statement	5.35	1.64	333	Translator	3.13	1.60	98
Storage (Rated on Form A)	5.42	1.31	339.5	Unit record	3.75	2.07	159.5
Storage (Rated on Form B)	5.09	1.56	309	User file	4.40	1.79	231.5
Subprogram	4.65	1.27	261	User number	4.09	1.86	196.5
Subroutine	5.85	0.96	367	Utility program	5.20	1.33	320.5
Switch	4.43	1.93	237.5	Virtual address	3.00	1.93	88.5
Symbolic address	4.90	1.61	289	Virtual memory	3.45	1.80	126
System flowchart	5.26	1.39	328.5	Voice band channel	1.54	1.34	12
System library	4.70	1.60	265.5	Working storage	5.85	1.06	367
Tabulating system	2.48	1.50	49.5	X-punch	4.15	2.17	206.5
Telecommunication	3.80	1.12	164	Y-punch	1.33	1.42	7
Terminal	3.95	1.20	179.5	Zone punches	4.50	2.13	244.5

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications							
Access time	3.40	1.50	122	Fixed point	4.40	1.69	231.5
Alphanumeric code	5.25	1.61	324.5	Fixed word length	4.45	1.99	239
Backup	5.25	1.95	324.5	Floating point	3.52	2.18	133.5
Bandwidth	1.39	1.46	8.5	Hash total	4.15	1.71	206.5
Baudot code	1.52	1.56	11	Heuristic	1.58	1.70	17
Binary coded decimal (BCD)	4.75	1.58	272	Hexadecimal numbering systems	4.52	1.86	248.5
Bit	4.52	1.95	248.5	High-order position	5.10	1.76	311
Block	5.55	1.07	349	Idle time	2.60	1.96	58
Byte	4.80	2.16	281	Indirect address	4.05	1.72	191.5
Check digit (rated on Form A)	3.70	2.15	154.5	Input and output timing	3.35	1.78	117.5
Check digit (rated on Form B)	3.35	1.86	117.5	Iterative	3.94	1.68	178
Computer capacity	4.30	1.76	221.5	Line speed	3.09	1.50	95
Computer word	4.60	1.98	258	Literal	5.48	1.53	346
Constant	5.43	1.24	341.5	Logical operations	5.04	1.30	304.5
Continuous form	5.00	1.53	298	Low-order position	5.00	1.81	298
Delivery dates	3.54	1.90	137	Machine cycles	2.61	1.66	60.5
Density	3.84	2.30	170.5	Machine-oriented language	3.84	1.60	170.5
Direct access	5.26	1.42	328.5	Macro instruction	3.83	2.04	167.5
Direct address	4.30	2.11	221.5	Mass storage	4.00	1.74	186
Extended Binary Coded Decimal Interchange Code (EBCDIC)	4.91	1.53	291.5	Microprogramming	2.52	1.64	53.5
Field	5.55	1.77	349	Microsecond	3.00	1.89	88.5

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications (continued)							
Millisecond	2.79	1.76	72	Real-time	4.05	2.01	193.5
Mnemonic	4.09	1.35	196.5	Record length	5.90	1.04	371.5
Modem	2.82	1.59	74	Run time	3.91	1.47	175.5
Multiprocessing	3.70	1.83	152	Serial	3.23	1.95	107.5
Multiprogramming	4.47	1.46	242	Serial access	5.06	1.75	308
Nanosecond	2.63	1.75	62.5	Set-up time	2.95	1.64	85
Octal	2.50	1.72	51.5	Solid state	2.36	1.69	44
Parallel	2.52	1.84	55	String	3.04	1.74	93.5
Parameter	4.09	1.73	198.5	Subset	3.89	1.94	173
Picosecond	2.37	1.60	45	Symbolic program	4.80	1.75	281
Presumptive address	1.88	1.13	4	Variable word length	4.50	1.94	244.5
Problem-oriented language	4.58	1.99	255.5	Word	4.75	2.02	272
Procedure-oriented language	4.27	1.89	217.5	Word length	3.43	1.86	124.5
Random access	5.14	1.49	313	Word mark	3.37	2.03	119
D. System Events and Conditions							
Auxiliary operation	3.17	1 76	101	Facilities management	2.79	1.70	72
Bug	5.45	1.83	343.5				
Card jam	2.15	1.50	35	Garbage in, garbage out (GIGO)	4.04	2.16	189.5
Communications executive	2.14	1.52	34	Internal control	3.50	1.77	131
Configuration	3.45	1.59	128				
Downtime	3.00	1.26	88.5	Machine-service maintenance	1.79	1.61	25.5

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
D. System Events and Conditions (continued)							
Off-line	4.09	1.50	198.5	Resource sharing	2.94	1.81	83.5
On-line	4.18	1.56	209	Security controls	4.35	1.28	227
Open loop control	3.76	2.16	161	System control	3.54	1.67	137
Overflow	4.41	1.47	236	Terminal management	2.75	1.87	66
Over punches	3.23	2.04	107.5	Time sharing	3.63	1.78	145
Remote processing	4.26	1.33	215.5				
E. Regulative and Organizing Principles Used by the Worker or Directly Influencing the Work							
ALGOL	0.85	1.24	2	Format	5.58	1.39	351
Algorithm	4.39	2.10	231.5	FORTRAN	2.00	1.50	32
American Standard Code for Information Interchange (ASCII)	3.43	2.32	124.5	Hierarchical control	3.50	1.92	131
Applications package	4.26	1.62	215.5	Hollerith code	4.52	1.95	248.5
Arithmetic routine	3.91	1.50	175.5				
Assembler language	4.43	1.76	237.5	Input/output control (I/O control)	4.10	1.63	200
Audit trail	5.55	1.20	349	Native language	2.35	2.08	43
Boolean algebra	1.90	1.58	27	Parity	3.18	2.06	103
Card design	5.39	1.81	334.5	PERT/CPM	2.45	2.98	46.5
Card system	4.75	1.00	272	Picture clause	5.84	0.99	364.5
COBOL	6.35	0.86	381	PL/1	3.00	1.51	88.5
Compilation routine	4.55	1.66	252.5				
Cybernetics	1.68	1.72	20	Program instruction format	4.45	1.88	240.5

Table 6 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]	Technical Concept	Mean Rating	SD	Job Rank[a]
E. Regulative and Organizing Principles Used by the Worker or Directly Influencing the Work (continued)							
Queuing theory	3.18	1.79	102	Source language	5.53	1.46	347
Run manual	4.25	1.78	213.5	Total systems concepts . .	4.70	1.76	265.5
Solid logic technology (SLT)	1.61	1.46	19	Wiring principles	1.13	1.08	3

APPENDIX D

Ratings of Technical Concepts for General Secretaries

Table 7

Ratings of Technical Concepts for General Secretaries, Grouped by Rational Categories of Concepts

Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker			
Appointment arranging (e.g., appointment scheduling, appointment canceling)	5.71	1.34	63.5
Coding for data reduction	2.86	1.63	4
Company image promotion (e.g., telephone courtesy)	6.29	1.10	74
Conference preparation (e.g., material gathering, agenda making, minutes writing, formal meetings, informal meetings, corporate meetings)	4.92	1.66	50.5
Confidential record keeping (e.g., involving personnel records, financial statements)	5.17	1.57	55.5
Copying processes (e.g., usage of photography, contact reproduction, xerograph, xerox, thermofax, facsimile methods)	4.79	1.32	45
Correction typing (e.g., erasers, erasing shields, cover up or correction carbon, erasing ribbon, strike over corrections)	6.00	1.32	70
Cross-referencing	4.79	1.35	45
Dictation (e.g., knowledge of appropriate business terms, business dictation standards, punctuation precisions, spelling, vocabulary)	6.46	1.15	77.5
Documenting (e.g., collating)	3.78	1.18	17
Editing (e.g., page numbering, word usage, grammar)	5.61	1.63	62
Imprinting processes (e.g., usage of impression stamps, addressograph, signature machines)	3.96	1.51	21.5
Information retrieving (e.g., reference locating)	4.79	1.44	45
Multicopy duplicating processes (e.g., usage of carbon paper, automatic typewriter, spirit process, stencil process, offset duplication)	5.04	1.46	52

[a]Job rank of 1 has lowest job significance, 80 is the highest ranking of job significance.

Table 7 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]
A. Processes and Functions of the Systems Acted Upon by the Worker (continued)			
Proofreading (e.g., knowledge of proofreading symbols)	5.75	1.64	65
Reception services (e.g., visitor greeting, business speech, scheduled caller, unscheduled caller, problem visitor, terminating calls)	5.88	1.05	66
Reservation making (e.g., travel arrangements, schedules, transportation arrangements)	5.38	1.28	58
Transcription (e.g., involving shorthand notes, magnetic belts, tape recorder, stenographic notes)	5.96	1.43	67
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker			
Abbreviations (e.g., signs and symbols, Greek alphabet)	2.79	1.53	3
Banking services (e.g., knowledge about business and banking paper, checks)	4.88	1.39	48.5
Business letter elements (e.g., letterhead, date line, inside address, attention line salutation, subject line, body of letter, complimentary close, company signature, signer's identification and signatures, reference initials, enclosure notation, postscript, carboncopy notation, blind-carbon-copy notations, page 2 heading)	6.46	1.19	77.5
Correspondence manual	4.71	1.62	42.5
Dummy layout for reproduction	3.61	1.58	14
External communications (e.g., mail service, teletypewriter, telegraph)	4.83	1.55	47
Filing equipment (e.g., vertical files, visible files, open-shelf filing, rotary files, notarized files, tube files)	4.29	1.49	34
Filing materials (e.g., correspondence, reports, forms, records)	5.17	1.25	55.5
Forms (e.g., accounts payable, accounts receivable, billing corporate, cost, financial, maintenance, material control, payroll, personnel, requisitions, invoices)	4.17	1.82	27.5

Table 7 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]
B. Types of Elements (and Other Objects or Devices) Acted Upon by the Worker (continued)			
Internal communication (e.g., messenger service, pneumatic tubes, conveyor belts, intercommunications system)	3.92	1.78	20
Labeling materials (e.g., folders, guides, labels)	4.21	1.41	32
Letter-placement guide (e.g., content estimate, line length, type spaces, locate address, locate date)	5.08	1.80	53
Line-staff relationships (e.g., line organization, staff organization, line-and-staff organization)	3.00	2.00	7
Mailing lists (e.g., cards, sheets, labels, automatic addressing system)	4.04	1.46	23
Office supply	4.04	1.60	24
Punctuation	6.17	0.99	71
Records (e.g., accounts payable, accounts receivable, billing corporate, cost, financial, maintenance, material control, payroll, personnel, requisitions, invoices)	4.09	1.53	25
Reference books (e.g., dictionaries, telephone books, postal guide, directories)	5.71	1.14	63.5
Stationery (e.g., usage of letterheads, second page, envelopes, copies, carbon paper, bond paper)	5.46	1.61	59
Typed page layouts (e.g., spacing, indentations, margins, titles, headings, quoted matter, footnotes, bibliography, index)	4.92	1.63	50.5
Typewritten work (e.g., minutes of meetings, reports, inter-office memorandums, rough drafts)	5.50	1.22	60.5
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specificiations			
Dependability (e.g., punctuality, persistence, ambition, loyalty)	6.88	0.33	80
Effective letter characteristics (e.g., brief, complete, easy to read, up-to-date language, start, ending)	5.96	1.34	68.5

Table 7 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]
C. Measures, Descriptive Characteristics of the System Elements and Processes, and Other System Specifications (continued)			
Mental alertness (e.g., oral or written instructions, judgment, sense of values, speed of mental reaction)	6.29	0.89	74
Office computing machine characteristics (e.g., adding machines, accounting machines, electronic computers)	4.38	1.49	37
Personal appearance (e.g., taste in dress, cleanliness, neatness, health, stamina, poise, posture)	6.29	0.98	74
Pleasing personality traits (e.g., tact, voice and speech, congeniality, compatibility, initiative, expression, manners)	6.58	0.57	79
Production ability/efficiency (e.g., volume of work, quality of work, organization of work, team work, resourcefulness)	6.21	0.96	72
Ribbon types	3.83	1.60	19
Special character of typewriter keys	3.33	1.95	11
Type size	3.71	1.86	15.5
Type style (e.g., gothic, script)	3.21	1.91	10
Typewriter characteristics (e.g., manual typewriters, electric typewriters, proportional-spacing typewriters, noiseless typewriters, portable typewriters)	3.71	1.72	15.5
D. System Events and Conditions			
Air conditioning (e.g., humidity, ventilation, temperature, cleanliness)	3.17	2.01	9
Centralized correspondence service	4.17	1.34	27.5
Centralized filing	4.46	1.78	39.5
Centralized office services (e.g., filing, stenographic, duplication, supply)	4.46	1.47	39.5

Table 7 - Continued

Technical Concept	Mean Rating	SD	Job Rank[a]
D. System Events and Conditions (continued)			
Color conditioning (e.g., color harmonies)	1.92	1.68	1
Decentralized filing	4.71	1.77	42.5
Decentralized office services (e.g., filing, stenographic duplication, supply)	4.54	1.80	41
Lighting conditions (e.g., distribution of light, glare, incandescent lighting, flourescent lighting, foot-candle)	2.91	1.72	5
Sound conditioning (e.g., decibel levels, acoustical treatment)	2.08	1.68	2
E. Regulative and Organizing Principles Used by the Worker or Directly Influencing the Work			
Business letter styles (e.g., semiblocked letter, blocked letter, full-blocked letter, indented letter, simplified letter)	5.96	1.40	68.5
Company personnel policies	5.12	1.62	54
Company travel restrictions	4.35	1.66	36
Company vacation policies	4.33	1.80	35
File retention schedules (e.g., consideration of nonessential items, temporary items, retention period, transfer methods)	4.13	1 75	26
Filing policies (e.g., consideration of statute of limitations, reference ratio, accuracy ratio, transfer files, microfilming, disposal of records)	4.17	1.58	29.5
Fiscal period	3.79	2.12	18
Indexing routine (e.g., coding, sorting, abstracting, classifying, sequencing)	4.17	1.49	29.5
Indexing systems (e.g., alphabetical systems, numerical index systems, coded index, chronological index, phonetic index)	4.21	1.55	32
Instruction following (e.g., errand running, message taking)	5.50	1.55	60.5

Table 7 · Continued

Technical Concept	Mean Rating	SD	Job Rank[a]
E. Regulative and Organizing Principles Used by the Worker or Directly Influencing the Work (continued)			
Inventory controlling (e.g., inventory manual, requisitioning) . . .	3.04	1.77	8
Job description procedures (e.g., comptroller, office manager, coordinator, section supervisor, bridge of faoyle, responsibility, authority, accountability, span of control)	2.96	1.88	6
Job evaluation procedures (e.g., point weighting, ranking, grading, merit pay, incentive pay)	3.54	2.02	13
Letter preparation (e.g., as for form letter, form paragraph) . . .	5.33	1.60	57
Shorthand techniques (e.g., simplified, diamond, jubilee)	4.42	2.22	38
Simplified letter style	3.96	2.19	21.5
Standardized filing procedures	4.88	1.59	48.5
Telephone techniques (e.g., incoming calls, outgoing calls, long distance calls, private exchange, dictaphone)	6.33	0.94	70
Typing techniques (e.g., justified typing, decorative typing, table display typing, figure display typing, envelope typing)	4.21	1.44	32
Work simplification procedures (e.g., usage of work distribution charts, flow process chart, work flow chart, man process chart, operation process chart, operator-machine process chart, job enlargement standards)	3.38	2.12	12

APPENDIX E

Additional Concepts Suggested by Instructors

AUTOMOTIVE MECHANIC CONCEPTS

Air conditioning compressor
Air conditioning - concept
Air conditioning diagnosis
Air conditioning expansion valve
Air conditioning principles
Attitudes
Automatic transmission diagnosis
Auto riding height
Belts
Brake hydraulic system
Business management
Diagnosis and proper tune-up involving emission controls
Differential action
Different types of noises
Doing a complete brake job
Drum brakes
Electrical theory
Electronic fundamentals
Electronic regulation
Exhaust gas recirculation system
Fan clutch
Front end - geometry
Fuel evaporation control system
General nomenclature
Governors (transmission)
Head lights - aiming
Ignition oscilloscope
Infra-red emissions tester
Integral alternator regulator
Interest
Manifold gauge (air conditioning)
Master cylinders overhauled or replaced
Mechanics certification
Money
Multiple disc clutch (transmission)
Oscilloscope patterns
Overhead
PCU systems
Pulleys
Relays
Rotary engine
Safety
Servos
Test instruments
Time
Torque converters
Transmission controlled spark
Transmission coolant
Turn signal switches
Vacuum pump
Valve body
Wheel cylinder overhauled or replaced

BUSINESS DATA PROGRAMMER CONCEPTS

Ability to define requirements as functional needs and not solutions
Binary
Binary number system
Chain file usage
Compiler languages, COBOL and Nat/3
Data management
Development of and adherence to standards in data base systems
Father-son file processing
File design
Forms design
Humanistic principles (management)
Indexed-sequential
Index sequential files
Index usage
Job control
Job control language
Job streams
Logic
Methodology to convert user requirements to data base logical concepts
Multi-file ending procedures
Object program
OP code
Pack
Padding
Problem solving
Record layouts
Reporting techniques (error lists, exception RPTs, multi-use report, multi-output from one well-designed sort, etc.)
Rescue procedures
RPG
Self-addressing techniques
Source-destination files
Truth tables
Variable

GENERAL SECRETARY CONCEPTS

Business law terms
Elementary data processing
Getting jobs in 1st place (application techniques)
Human relations (dealing with others)
Income tax information
Word processing

Figure 2

Listing of possible new concepts for each occupation

U S Government Printing Office. 1975 659-760/02 Region 5-11