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OCCUPATIONAL ANALYSIS FOR HUMAN RESOURCE DEVELOPMENT

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BY B. E. MOORE

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OCCUPATIONAL ANALYSIS FOR HUMAN RESOURCE DEVELOPMENT:

A Review of Utility of the Task Inventory

by

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Purpose

A review of the issues concerning the field of occupational analysis is undertaken in this paper in order to indicate the comparative strengths and weaknesses of the task inventory. Specifically, the significance of the task inventory (TI) will be assessed for:

1) reliability and validity
2) job analysis and evaluation
3) occupational restructuring and career ladder development
4) manpower planning

The organization of this report follows topic headings very closely so that the reader may quickly move to those areas of particular interest. However, the intention of the report is to provide context to the field of occupational analysis while indicating how the TI fits within this field. Thus, the history and evolution of occupational analysis is treated chronologically in order to better place the TI's significance.

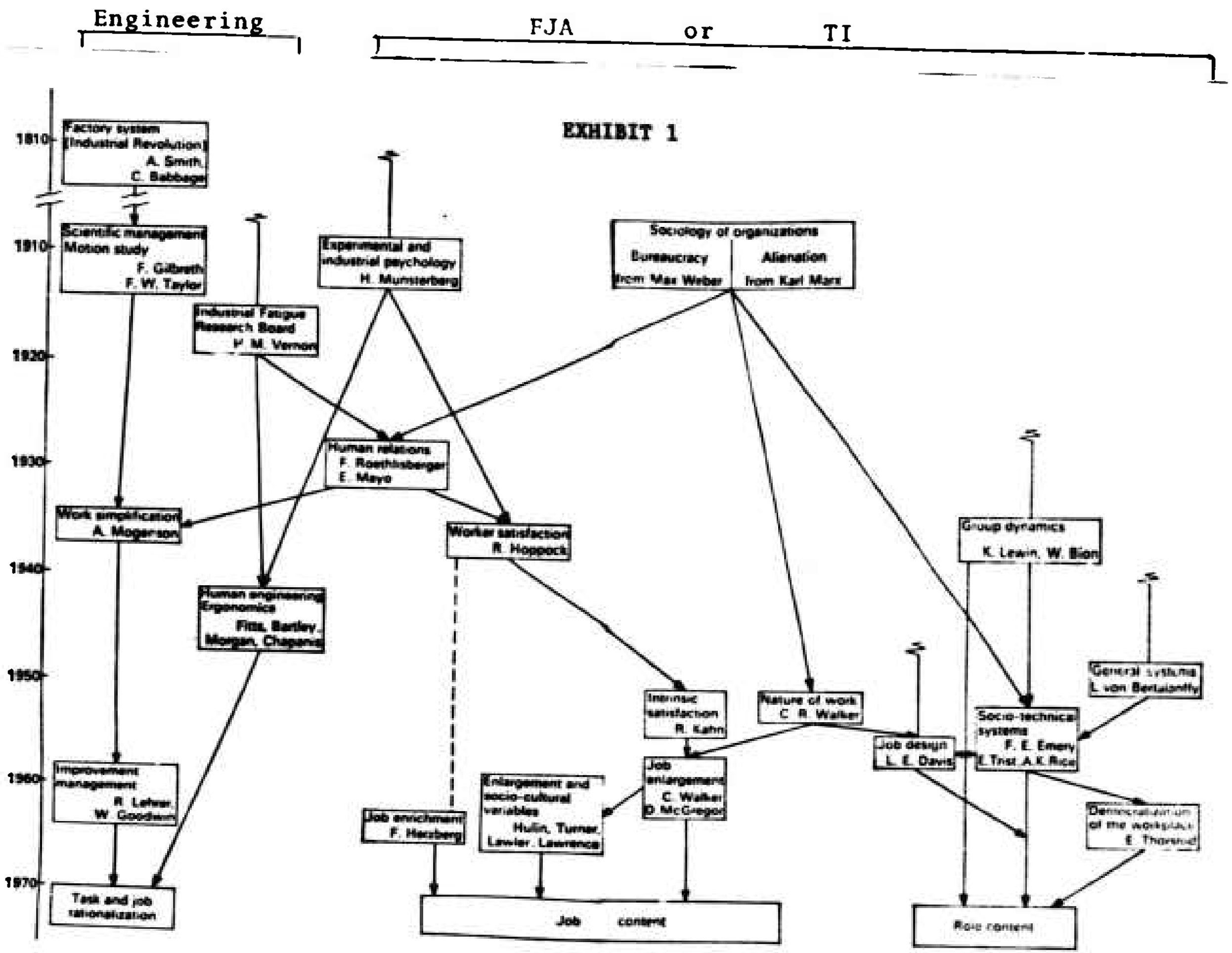
Historical Perspective

Exhibit 1 is titled the Geneology of Work Design and is found in Davis' Design of Jobs (1972). Since the Industrial Revolution, three broad areas of work design are traced. They are the engineering approach, job content, and role content approaches. As generic types, they describe the philosophies that support the various techniques of occupational analysis. Interestingly, these three approaches all focus on task definition and measurement.

(Exhibit 1, about here)

Most systems now used for describing men and work reflect diverse purposes for which they primarily were developed. One generic category reflected in Exhibit 1 is engineering methods, e.g., time and motion study and industrial production analyses principally devised to improve efficiency. Engineering methods have brought to bear precise techniques for lay-out and measuremeht of work stations and for the development of standards of human performance. By and large, engineering systems were designed for detailed analysis of job segments or fixed processes in a highly replicative context. By contrast, most ongoing manpower planning requires full job coverage in changing environments with periodic updating over time. Why? There is a chemistry that occurs in the interaction between the worker and the job that continues to influence both. Also, after work has been described, one or more employees leave or are promoted. At that time, tasks which make up the work position go

EXHIBIT 1



Genealogy of work design

Source: Davis, Louis and Taylor, James C., Editors, <u>Design of Jobs</u>, selected readings: Penguin, 1972 through a redistribution process with the remaining job incumbents. Both the vacant position and those still manned may be materially changed. Extensive re-analysis, in manufacturing environments, is rarely possible with engineering methods. While they have a long history, engineering techniques are time consuming and costly.

A second broader and less precise category of occupational analysis can be collectively defined as Functional Job Analysis (FJA). This system can support either job content or role content schools reflected in Exhibit 1. FJA systems have a common methodology; usually requiring an observer called a position analyst. The resultant FJA work description is designed to cover the full scope of the job, but at a level of relatively less detail. The amount of detail lost in FJA depends on the particular system used. The U. S. Department of Labor uses the Dictionary of Occupational Titles (DOT), a highly aggregated system. The Canadians use the Canadian Classification Dictionary of Occupations (CCDO), a similar system. Other systems, such as E. J. McCormick's Position Analysis Questionnaire (PAQ), may be quite detailed, particularly respecting environment and supplementary factors--but still does not approach the performance detail of engineering/efficiency techniques. There are many examples of FJA. Regardless of the FJA variant employed, no two position analysts classify the same job the same way. Also, as with the engineering techniques, standardization or quantification to permit comparisons at definitive levels of man/position interaction are virtually impossible. The most broadly based FJA system is the DOT in the U. S. and the CCDO in Canada.

A relatively new system has emerged over the past decade. It merits high confidence from 15 years of U. S. and Canadian Armed Forces testing across a very large range of skills distributed. This is the time-ordered, task inventory, survey system. To begin with, a task inventory is constructed. It lists all significant tasks performed by workers in a given occupational area--the job family or career ladder. A career field is a grouping of occupational specialities involving basically similar knowledge and skills. A career field ladder (or career ladder) is a vertical arrangement of occupational specialities within a career field subdivision to indicate skill distinction and progression. The terms career field, job family, and occupation express the same generic concept of closely related skills and tasks. These tasks are compiled from every available source of occupational information. Specific resource material may include previous position descriptions, expert opinion, trade manuals, training programs, school curricula, etc. The structure of task statements is carefully worded to be readily intelligible to workers at the operational level. This structuring of task statements permits economic, standardized, self-reporting by direct survey of all workers or large samples of workers. These surveys further include simple but definitive measures of <u>relative time spent</u> performed on each task in comparison to total time spent on all other tasks. Each worker and each position thus becomes identified by a unique subset of work task behaviors which are weighted by relative time spent on each task. All occurences, and any combinations, of like tasks can readily be identified across all workers and positions in the same occupation.

Computer analysis based on the above cited properties can explicitly identify and systematically relate task level behavioral work requirements for all workers and all work within a given occupation. The analyses lead to comprehensive assessments covering selection, training, assignment, upgrading, evaluation transfers, and job structuring and certification. Such quantifiable data can be collected, stored, manipulated, analyzed, and reported by automated systems. These capabilities--lacking in previous systems of occupational analysis--make possible a new order of magnitude of manpower analysis planning and management. The standard software is currently available to anyone and is designated <u>C</u>omprehensive Occupational Data Analysis Programs (CODAP). Structuring of data and of computational logic in CODAP will be schematically illustrated later. Representative surveys are attached. Also, representative analyses are enclosed. Actual field data collection would include individual social security numbers permitting correlation with all background data in regular personnel files. Individual attitudinal data and other special responses can be included to meet specific research requirements, e.g., job satisfactions and perceived utilization of ability.

State-of-the-Art Methods

Given the historical background of job analysis, what is the current state of the art of occupational analysis?

(Exhibit 2, about here)

A recent survey by Jones & DeCoths is excerpted in Exhibit 2 - Survey of Job Analysis. The size of their sample was 1,805. 50% responded. Their responses are broken down in Exhibit 2. The most common method of job analysis breaks into the areas interviewing - either panels of supervisors or workers. Sometimes observation and documentary information are used. Roughly 21% of the sample utilized checklists of tasks and duties. To the casual reader, there are many kinds

Exhibit 2

METHODS RESPONDENTS USE TO PERFORM JOB ANALYSIS

	Programs for Salary-Rated	Programs for Hourly-Rated
Check Lists of Tasks and Duties	19%	23%
Check Lists of Worker Behavior	2	2
Critical Incidents	3	2
Daily Diary by Employee	3	4
Employee Written Narrative	41	22
Interviews	85	84
Of Groups	11	9
Of Supervisors	79	78
Of Workers	69	61
Job Training Standards Review	2	3
Key Question Interview	26	20
Observations	57	72
Observation-Interview	34	39
Old Job Descriptions	59	58
Questionnaires	43	30
Recall from Analyst's Experience	18	17
Supervisor-Written Narrative	54	42
Technical or Supervisory Conference	20	17
Time and Motion Studies	4	13
Work Participation by Analyst	8	7
Other	1	1

Source: Jones & Decoths, "Job Analysis: National Survey Findings," Personnel Journal 49 (10), 805-809, 1969 of methods of job analysis. Also, it is apparent that many systems of occupational analysis prevail, often in combination with each other. It is informative to review Jones & DeCoths' "Conclusions":

> Three important conclusions may be drawn from information provided by this survey. First, there is widespread dissatisfaction with present job analysis programs, particularly with respect to currency of job information and versatility for diverse purposes. The reasons for this dissatisfaction may be attributed to lack of standardized, quantifiable techniques for gathering, recording, and presenting job information, and limited use of EDP. Second, most job analysis programs are characterized by relatively little emphasis on human relations type job variables. Third, due to the rapidly growing work force, the current emphasis on upgrading the unemployed and underemployed and the impact of technological change on the natu:. of work, the traditional techniques of job analysis may no longer be adequate to meet the needs of the economy.
>
> These conclusions suggest the need for a two-pronged research effort in job analysis. One aspect of the research should attempt to develop a comprehensive model for improving job analysis procedures. The objective of this research should center around quantifying job information, increasing its validity, eliminating its subjectiveness, and reducing the costs of its collection. In addition to standardizing job job analysis methods, the successful implementation of such a model will greatly facilitate updating of job information. The other aspect of the research should examine ways to help job analysis practitioners define and measure psychological and sociological job related variables. Increased availability and validity of human relations type job data will enable manpower managers and planners to more effectively deal with the human aspects of technological change.

The state-of-the-art methods, as this survey shows, reflect dissatisfaction with methods of the past. Up to date, accurate job information is needed by these organizations. Currently, they do not get this. Standardizable, quantifiable techniques which adapt to the computer are needed. Currently, they are not in use. Higher standards of reliability and validity are required, and a call for research is issued. Fortunately, this review only points out that diffusion of technology is slow because most of the problems raised have been solved. A comparative evaluation of the new state-of-the-art argues this case.

Comparative Analysis

In order to analytically place into perspective these various methods of occupational analysis, Exhibit 3 was created.

(Exhibit 3, about here)

Exhibit 3 cross tabulates common attributes of occupational analysis systems with three of the most common generic systems. That is, Exhibit 2 may reflect many diverse methods of occupational analysis, but they are organized into three gross categories. Of these three categories, two are now hybrids as computer assisted systems.

Exhibit 3

COMPARATIVE ATTRIBUTES OF OCCUPATIONAL ANALYSIS SYSTEMS

Attribute of System	Manual Systems: Engineering Job Analysis	Manual Systems: Functional Job Analysis	Manual Systems: Check List Job Analysis	Computer Assisted Systems: JAV - DECAL FJA	Computer Assisted Systems: CODAP Task Based, Time Ordered
Measurement: Specificity & accuracy	VG	F - G	F - VG	P	VG
Generalizability	P	P	F - VG	P	VG
Relative Cost	Very costly	Costly	Economical	Relatively Economical	Economical
Relative Speed & capacity	Very slow & very limited	Slow & limited	Slow & high capacity	Slow to Fast (a) & high capacity	Fast & high capacity
Exhaustiveness	P	F	P - VG	P	G
Utilization of Product					
Qualification standards development	G (limited)	P	P	P	EX
Job engineering	EX	P	P - G	P	EX
Manpower Planning	P	F	F - G	F	EX
Career ladder design	P	F	P - F	F	EX
Performance evaluation	P - G	P - F	F - G	P - F	EX
Curriculum development	G - VG	P	P - F	P - F	EX
Job Pricing, Evaluation	G	P	P	P	EX
Overall Utility	Average utility	Limited utility	Limited utility	Limited utility	High potential Needs testing in all applications

(a) Both JAV and DECAL are experimental

A general discussion of the attributes of any occupational analysis system is in order.

Measurement: information or data collected must be in form that is understandable to others. It should be specific, discrete, and accurate.

Generalizability: since data collection is expensive, we would like to get the maximum mileage out of our efforts. Therefore, accuracy of measurement combines with the amount of information collected to give us a basis for generalization: naturally, we would wish to be confident about our generalizations.

Relative Cost: any occupational analysis system costs time and money. What are the goals? How many dollars are needed to achieve this objective? Some systems are extremely costly because so much high salary is tied to these systems, e.g., the engineering approach. Cost can never be overlooked. At times, it is the one deciding factor when totaling up the strengths and weaknesses of the other attributes.

Relative Speed and Capacity: many occupational analysis systems are slow to produce meaningful data. In fact, the layman often confuses the method of collecting job data with the type of analysis because the method is visibly slow, e.g., observation, interview, daily diary, critical incidents, etc. So much time is taken in collecting data that this time is only exceeded

<u>by the time necessary to analyze it</u>. Thus, relative speed is slow with most manual information systems. This slow relative speed interacts with capacity because the slower the speed with which job information can be collected and analyzed, the lesser the capacity of the system to store up to date, comprehensive job analyses.

<u>Exhaustiveness</u>: the completeness of occupational measurement is always in question - especially in large manpower applications. For example, certification of a given trade across regions of the country requires an occupational analysis which is sufficiently comprehensive across all regions. Not only that, it should be comprehensive enough to describe cyclical or seasonal variations in occupational content. Therefore, a good measurement of occupational content is only as good as it is exhaustive. And clearly, this increases generalizability while increasing costs! Some optimal combination of these attributes reflected in Exhibit 3 is clearly preferred.

<u>Utilization of Product</u>: each possible product of occupational analysis is assessed against the type of analysis system. This judgment is aggregated at the bottom of the table.

The attributes of Exhibit 3 are explained above and a discussion follows in the next section based on the comparative evaluation of each generic occupational analysis system with each of these attributes.

Engineering Approach

The aggregate assessment of the engineering approach to occupational analysis indicates average utility. Specifically, measurement can be very good. Generalizability is clearly poor as job samples are always small, though based on work sampling. Cost is usually high since industrial engineering is a costly staff function. Relative speed of the engineering approach is slow. It is a one-on-one observational technique. The capacity of the technique is limited because of the requirement for observation. Exhaustiveness is poor because the technique is limited to idealized work factors - usually in an industrial environment. There are other considerations that make the engineering approach less useful for qualification standards, manpower planning, and performance evaluation. However, job engineering and some training applications are well handled by this method.

Per Gilpatrick (1973), industrial engineers, in dealing with staffing problems and efficiency, use job analysis. They evaluate the workers' relationships to machines and work flows. By definition, the unit of work is tied to existing technology. These approaches do not require reliable task definitions. Concerning this lack of scientific rigor:

> ...heuristic descriptions may aspire to the rigorous characteristics of scientific description (but)...may be satisfied with much less.... Task analysis at present is a heuristic description of activities at the functional interface of the human operator and the objects and environments with which he interacts. As such, its value is proportional to its utility and economy in the design, evaluation, and operation of systems....
> (Miller, 1966; p. 188)

Miller's definition of a task is:

> A group of unitary human operations having a common purpose, directed towards the same specific output(s), and usually occurring at about the same time or in close sequence...
> (Op.cit., p. 13)

The use of the term "operator" by engineers, rather than "performer" in the definition presented below reflects this lack.

1. The task contains an explicit goal which identifies for the operator the state or condition to be achieved as a result of task performance.

2. The task contains input stimuli representing sources of information external to the operator but to which he must attend if the goal is to be achieved.

3. The task contains a set of procedures which specify particular responses to be made to the input stimuli during task performance. (Op.cit, p. 44)

Perhaps, the most sophisticated engineering definition may be that of Verdier (1960). However, it also shows the inherent problems, Verdier defines a task as:

> A limited and orderly grouping of individual human activities applied methodically to things or equipment for the purpose of satiffying some problem or need.
>
> To clarify the definition; human activities in tasks are generally, but not always, limited to those performed by one individual within a convenient period of time, usually less than one day. These activities are orderly, in that they are grouped in a homogenous manner with an observable start and completion stop. The task is comprised of elements; these are simple, discrete responses which are carried out in a cumulative and progressive sequence. Task activities, or elements, are usually applied to, or concern, specific things or equipment. The things that task activities are applied to should be mentioned in the description of the task; as example: calibrate a voltage meter, adjust a carburetor, ship a container, counterbore a support bracket, etc. The purpose and activity of the task should also be inferred as a verb in the task description; this clarifies the problem or need for which the task is performed. In the case of the short tasks we have just mentioned, these verbs are: calibrate, adjust, ship, and counterbore, respectively. (p. 37).

In relating the task to its component elements, Verdier expands on the definition; the orientation to blue collar work is quite apparent:

> a. The element whould be the most simple form of discrete activity within the task, a single stimulus-response act, if possible.
>
> b. An element should contain the smallest observable, continuous, integrated, activity within the confines of one central idea, as example; "Remove container cover."
>
> c. Elements are reflective of the smallest coherent action relationship between the human and the equipment.
>
> d. The element should have an observable start and a completion stop.

e. The central idea of what is to be done within the task element should not only be clear, but should be defined on the worksheet as concisely as possible by some commonly understood verb. As example; "Remove the cover," "Read the gauge," "Insert the gasket."

f. If a single element accomplishes a task, the element may then be the task.

g. Elements are best presented on the task analysis worksheet in a logical, numbered sequence, in exactly the same order that these are carried out in the best performance of the task.

h. There should be a minimum of overlapping of the same elements within the total task breakdown.

i. Elements are best worded in the present tense, second person, and should start with an action verb; there may be exceptions, however.

j. Each element should contain some actual, observable activity; something the performer does.

Examples: thinking about what to do is not an observable activity. Looking, inspecting, or perceiving, by itself is not an observable activity. Observing meter reading 275 lbs. is an observable activity. Waiting by itself is not an observable activity; however, waiting until the gauge reads 275 lbs. is an observable activity, as it contains a start and completion stop. (p. 41).

This excerpt gives a flavor of the engineering approach and its concern with task as a unit of measurement in job analysis. In practice, however, the engineering approach is used primarily to derive work factors and standard costs in manufacturing. Thus, the aggregate assessment of the engineering approach is that it has average utility. This is based on the lack of utility and extension of this method to other products of occupational analysis.

Functional Job Analysis

Functional job analysis (FJA) is the major, generic form of occupational analysis. Generally defined, FJA describes what gets done and what the job incumbent does. How these two processes are the be logically captured depends upon the particular system of FJA employed. Thus, what gets done refers to technology that can be categorized into work fields. What the worker does refer to the worker's physical/mental activities that can be categorized into worker functions.

As Exhibit 3 indicates, however, its measurement properties are fair to good - depending on its application. This is due to FJA requiring training in some system of classification and semantics. That is, if Fine's FJA (the DOT and CCDO system) is employed, his definitions of keywords are essential. Also, like all taxonomies, the classification systems that support FJA's smooth over real differences within and across occupations. Thus, measurement suffers.

Generalizability is poor because of the measurement properties of FJA. The true variation in occupational content is always difficult to capture, but superimposing categories on this variation is illogical because the categories equalize this variation.

Users of the DOT have been aware of this deficit for sometime.[1]

Relative cost of FJA is high - if the system is to be maintained. Sometimes the cost is low because FJA is attempted in cycles. That is, a job family is described and years pass before this effort is mounted again. Here, of course, low cost is associated with stale occupational data. Conversely, if FJA is maintained, the cost is high since full time occupational analysts are required to apply FJA techniques.

Relative speed and capacity; the techniques are faster, in some cases, than engineering techniques, but still rely heavily on observation and interview (see Exhibit 2, as a reminder of the various methods of data collection employed). The capacity, of course, is linked to the method of classification found in the DOT. Over 30,000 jobs are listed! Users must be trained in the logic of the classification system <u>and</u> be wary of constantly changing job descriptions which <u>cannot be found</u> in the DOT.

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[1] A useful exercise to test this assertion is to look up carpenter (construction) 860.381 on page 101 of DOT (1965, 3rd ed.) All general carpenters may be able to perform the tasks listed, but none do all of them in their jobs. The mix of tasks, their frequency, skill level, etc. do not exist in DOT descriptions - which are overly general.

As to exhaustiveness, some FJA methods are exhaustive (e.g., the Position Analysis Questionnaire of E. McCormick). The PAQ has six dimensions for describing work and is unique among the FJA systems. Usually, however, FJA systems employ some variation of Fine's three dimensions which are illustrated in Exhibit 4.

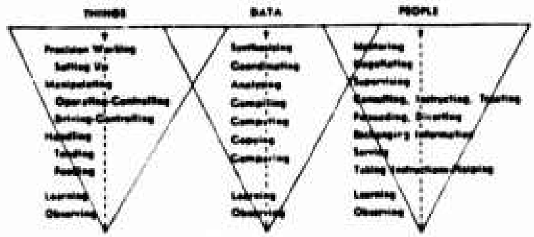
(Exhibit 4, about here)

This scheme of data, people, and things is well known since it is one of the bases of classification used in the DOT. These three dimensions are scaled into functional levels and have precise definitions for each functional level. For example, statistical clerk interacts with data, but the functional level may only be comparing and checking. This carries a medium code level as depicted in Exhibit 4. Conversely, a professional statistician may interact with data by synthesizing data arrangements. Therefore, this functional level carries the highest code level in this scheme. The same occupation is classified by its functional level on the other two dimensions. In fact, the six digit code for the two occupations are 216.388 (clerk) and 020.188 (statistician). The difference in functional level of interaction is designated by the fourth digits in each code (3 and 1, respectively). These levels require careful definition. The training of the occupational analyst must be uniform to guarantee that they are applied consistently. For example, here are the definitions which support just one dimension of the data, people, things scheme:

Exhibit 4

Scales for Controlling the Language of Task Statements

Summary Chart of Worker Function Scales



LEVEL	DESCRIPTION
1	COMPARING Selects, sorts, or arranges data, people, or things, judging whether their readily observable functional, structural, or compositional characteristics are similar to or different from prescribed standards.
2	COPYING Transcribes, enters, and/or posts data, following a schema or plan to assemble or make things and using a variety of work aids.
3A	COMPUTING Performs arithmetic operations and makes reports and/or carries out a prescribed action in relation to them.
3B	COMPILING Gathers, collates, or classifies information about data, people, or things, following a schema or system but using discretion in application.
4	ANALYZING Examines and evaluates data (about things, data, or people) with reference to the criteria, standards, and/or requirements of a particular discipline, art, technique, or craft to determine interaction effects (consequences) and to consider alternatives.
5A	INNOVATING Modifies, alters, and/or adapts existing designs, procedures, or methods to meet unique specifications, unusual conditions, or specific standards of effectiveness within the overall framework of operating theories, principles, and/or organizational contexts.
5B	COORDINATING Decides time, place, and sequence of operations of a process, system, or organization, and/or the need for revision of goals, policies (boundary conditions), or procedures on the basis of analysis of data and of performance review of pertinent objectives and requirements. Includes overseeing and/or executing decisions and/or reporting on events.
6	SYNTHESIZING Takes off in new directions on the basis of personal intuitions, feelings, and ideas (with or without regard for tradition, experience, and existing parameters) to conceive new approaches to or statements of problems and the development of system, operational, or aesthetic "resolutions" or "solutions" of them, typically outside of existing theoretical, stylistic, or organizational context.

SOURCE: Fine, S. and Wiley, W., "An Introduction to Functional Job Analysis," The W.E. Upjohn Institute for Employment Research, No. 4, 1971.

These definitions appear clear, but in practice there is much variance in their application.

Therefore, when we sum up the attributes of the FJA system per Exhibit 3, we evaluate FJA as having limited utility. It is probably best as a manpower labor exchange system. There appear to be better methods available currently, however, and FJA offers little help for other products of occupational analysis - especially job pricing or evaluation.

Nevertheless, as this paper has maintained, the task is a common unit of measurement spanning all of the generic systems reflected in Exhibit 3. For that reason, it is helpful to review how Sidney Fine (Fine et al, 1974) views task:

> Conceptualization and Definition of Tasks
>
> In FJA a basic distinction is made between what workers do and what gets done - between behavior and end results. This distinction is carried into the methods of analysis (data gathering) and the formulation of the Task Statements. The distinction has been essential since, historically, most job descriptions dwelt primarily on what got done. Another key concept or assumption of FJA is that Task Statements, while certainly not the reality of work activity, are as close to that reality as you can get to carry out personnel operations. Task Statements are verbal formulations of activities that make it possible to describe what workers do and what gets done so that recruitment, selection, assignment, training, performance evaluation, and payment can be efficiently and equitably carried out. Therefore, the focus of our attention must be on the formulation - the words and the organization of words in the Task Statement used to express the task. The formulation must stimulate reality; that is,

those performing the task must agree that, insofar as the task can be communicated, the Task Statement does so. Furthermore, since a task is part of a context; namely, a work situation, it is essential that the language of one Task Statement be compatible with that of other Task Statements in that context and that together they can describe the technology of a work situation. For practical purposes, then, the Task Statement is the task.

In FJA a task is defined in terms of a controlled language, a controlled method of formulation, and in relation to a systems context. The definition is as follows:

> A task is an action or action sequence grouped through time designed to contribute a specified end result to the accomplishment of an objective and for which functional levels and orientation can be reliably assigned. The task action or action sequence may be primarily physical, such as operating an electric typewriter; or primarily mental, such as analyzing data; and/or primarily interpersonal, such as consulting with another person. (Fine & Wiley; 1971:10)

Tasks conceived and formulated according to this definition have permanence that jobs and assignments of everyday parlance do not have. Although mutable, tasks can and will become building blocks in personnel practice and manpower planning. Hence, it is important to formulate and edit Task Statements carefully.

A task formulated according to FJA methodology becomes the most fundamental unit of a work-doing system. From it, it is possible to make reliable and valid inferences about the worker, the work organization, and the work.

The Worker. The worker's functional level and orientation are indicative of his experience, education, and capability to perform the task.

The Work Organization. The methodology provided for and the output of the Worker Actions must contribute to the Objectives of the organization.

> The Work. The action, object of the action, equipment provided, and output are indicative of the Performance Standards and Training Content (both Functional and Specific), as well as the basic skills in reasoning, math, and language required.

The logic of Dr. Fine's words is clear and precise, but, again, application depends on trained personnelists understanding and applying this logic in a standard, uniform way.

An extension of this discussion on FJA is to review how the U.S. Department of Labor (1973) views this same unit of measurement (the task) within the FJA framework:

> U.S. Department of Labor
>
> (Tasks are the) distinct major activities that constitute logical and necessary steps in the performance of a job. (BIPP 152-35: p.11)
>
> (A task or duty is) made up of one or more elements.... It is the work unit that deals with the methods, procedures, and techniques (the "what," "how," and "why") by which parts of a job are carried out. A task or duty is created whenever human effort, in terms of one or more elements, must be exerted for a specific purpose. The effort may be physical, as pulling and lifting, or mental, as planning and explaining. The effort may be exerted to change a material. The material may be tangible, as boards and nails, or intangible, as numbers and words. Each task or duty has certain distinguishing characteristics.
>
> (a) It is recognized, usually, as being one of the worker's principle responsibilities.
>
> (b) It occupies a significant portion of the worker's work time.
>
> (c) It involves work operations which utilize closely related skills, knowledges, and abilities.

> (d) It is performed for some purpose, by some method, according to some standard with respect to speed, accuracy, quality, or quantity. This standard may be provided by the worker himself through trial and error or as a result of experience; it may be furnished to the worker by his supervisor in the form of oral, written, or graphic instruction; or it may exist in the form of directives, published operating procedures, or similar media.
>
> (An element is) the smallest step into which it is practicable to subdivide any work activity without analyzing separate motions, movements, and mental processes involved. It is a work unit that describes in detail the methods, procedures, and techniques involved in a portion of a job. (p. 6)

However, the investment decision tends to rationalize itself to the point that newer (perhaps more parsimonious and efficient) systems are available.

Summing up the comparative attributes of FJA, its primary purpose was for man/job matching and it does that adequately. Overall, however, it is judged to have limited utility for the other uses of occupational analysis even though it is probably the prevailing method.

Checklist Approach

As the Jones & DeCoths survey shows (Exhibit 2), the checklist was employed by some 20% of the organizations surveyed. Per Beach (1975), the checklist method is of value in large organizations wherein large numbers of people are assigned to similar jobs. Some staff group, or panel of experts must prepare the checklist for each of the various job families in a given organization.

The usual methods of preparation are employed (observation, interview, previous documentation, etc.). After the checklist is constructed, it is administered to the job holders. They merely check off whether they perform the task. They may be asked to indicate their proficiency, training, and experience also. They may be asked to write in additional tasks not seen on the checklist.

According to Morsh, Madden, and Christal (1968):

> A number of problems are inherent in the checklist method. Information about the sequence in which tasks are performed by an incumbent or the relationships among tasks is not obtained. It is also sometimes difficult to write task statements to which an unequivocal response can be given. For instance, in the case of tasks which are shared as a two-man or crew tasks, incumbents' responses may be ambiguous with respect to the performance of specific work activities within the task. Task statements are not always mutually exclusive. Some statements overlap or are included in other statements. Tasks are not homogeneous. Several activities that are invariably performed together by one man may at times be legitimately combined as a single task statement. On the other hand, a relatively small segment of behavior may appear as a separate task if it is performed independently of other work activities. The scope of the task statement depends upon the judgment of the checklist constructor. Although it is structured, if the checklist is lengthy, the tedium of completing it may arouse disinterest and low motivation with consequent unreliable responses. Unless the items are grouped into meaningful categories, such as duties, it is virtually impossible to gain an overall perspective of the job from checklist information alone.
>
> Nevertheless, the checklist has many decided advantages. The checklist requires recognition on the part of the incumbent rather than the less de-

> pendable recall which is essential to some of the other methods. The checklist makes possible group administration to large samples of incumbents, thus making occupational data available rapidly and economically from widely representative populations. The responses are adaptable to machine tabulation.....

Measurement: the checklist approach always had appeal because of its survey characteristics. Nevertheless, measurement is fair to very good depending on the specificity of the task statement construction. Indeed, some checklists check of knowledges, job elements, or just duties.

Generalizability: due to its survey characteristics again, the generalizability of the checklist method can be very good. But, for the deficiencies cited above generalizability depends greatly on the technique and care of checklist construction.

Relative cost of the checklist; even before machine tabulation was invented the checklist was economical for the amount of data acquired. Whereas the same amount of time for an occupational analyst is required to produce a checklist, this is usually offset by the large number of job incumbents that can be reached with this method.

Relative speed and capacity; the checklist method is unusually different from the engineering and FJA approaches (see Exhibit 3). That is, relative speed of checklist development is as slow as the other two approaches are, yet the checklist has high capacity. This high capacity is again due the exhaustiveness that can be built into a checklist plus the surveying of large numbers of jobs.

Exhaustiveness, as mentioned, can be very good. As we shall see, the craft of constructing a comprehensive checklist requires careful attention to technique. Thus, the checklist approach has the capability of exhaustively describing many job families if care in its construction is manifested.

Unfortunately, the aggregate assessment of the checklist method is judged to have only limited utility overall. Primarily, this judgment is based on the very wide range of measurement and technique that has gone into this approach. There have been no standards for the checklist approach. However, through the years it has had a steady attraction for the more systems-oriented personnel researchers. The U.S. Air Force pioneered in this area and has contributed over 100 studies on various facets of this approach. Some of these, and the work of others in the field, will be reviewed below. It is important to cite why the checklist evolved at this point, however. A breakthrough in statistical analyses and methodology took advantage of the better properties of the checklist. The properties claimed are:

1) simplicity
2) standardizability
3) quality work information (for many types of occupations)
4) currency of job information (due to low cost, survey techniques)
5) broad sampling
6) economical
7) product of survey has many uses
8) procedure is flexible

These are broad claims. The remaining portion of this paper reviews the evidence for task based, time ordered occupational analysis.

The JAV and DECAL computer assisted FJA approaches will not be dealt with. These two systems are still experimental. They are both examples of a wedding of computer speed with faulty measurements. That is, FJA, as a system, has inherently poor measurement and reliability problems when compared to the checklist approach. Therefore, computerization of FJA increases some of its uses and speed, but does not overcome the inherent problems of FJA.

Our discussion prefers, instead, to review the empirical research of the past 15 years on the task based, time ordered system of occupational analysis - the TI.

The Task Inventory and CODAP

The carefully constructed TI produces data that can be analyzed with correlation, cluster analysis, and crosstabulational techniques. How? The great step forward was to attach a variable to the task statements which had meaning to the job incumbents and was scalable for statistical analyses. After considerable testing of absolute time (via time diaries) percent guesstimates (via reconstructions of proportions of time spent in functional areas), a simple rating scale which assesses relative time spent became the best candidate.

Relative Time Spent

Research considerations into proportional time estimates tied to task led U.S. Air Force researchers through many tests. Here is a partial recounting of their empirical experience from Morsh, et al:

> The incumbent may make a direct estimate on an absolute scale which expresses the proportion of total working time spent on each task, or he may make a judgment of time spent on each task relative to the other tasks he performs.
>
> In a series of limited pilot studies, some absurd results were obtained when absolute estimates of proportion of time spent on each task were required. As an illustration, in one sample of ten incumbents, the total proportion of time estimates ranged from 400 per cent to 2300 per cent. The difficulty seems to be in breaking up 100 per cent or total time spent into individual percentage estimates for all the tasks on the inventory. One alternative is to obtain relative estimates such as average, more than average, less

than average, and the like. Whether this method merely obscures the difficulty or allows the incumbent to make judgments of which he is more capable is difficult to determine.

Another method for obtaining measures of proportion of time spent on each task is to require the incumbent to estimate the frequency with which he performs each task and the length of time which he takes to perform each task. These ratings are then cross-multiplied to provide proportion of time estimates. In a series of exploratory studies, when absolute scales were used to obtain judgments such as times per day and minutes required, results were rather erratic. There is some evidence that incumbents in the higher aptitude brackets are able to make these responses accurately and consistently, especially if few tasks are performed. On the other hand, incumbents in the lower aptitude levels tend to produce extremely variable results. If relative scales are used to obtain both frequency and time-to-do judgments, satisfactory results appear to be attainable from incumbents in all specialties.

....a relative proportion-of-time-per-task scale was used by Ammerman. His five-interval scale required incumbents to judge each task from "least" to "most" amount of time needed for task performance in relation to all other tasks done. He also obtained proportion of time estimates by combining frequency and absolute time scales. In this case, the relative scale was less consistent and failed to duplicate the combination of the absolute time and frequency scales. However, whether or not tasks were performed was reported more reliably with the relative scale.

Using an Inflight Refueling specialty task inventory and a sample of 31 incumbents, Madden attempted to evaluate three relative type rating scales in terms of the number and kinds of errors made and the distribution of responses. The relative proportion of time for each task was computed by combining responses to frequency and time-to-do scales, each with five categories.

> He found that with these scales incumbents in this sample exhibited almost no tendency to make omissions, off-scale entries, or other mechanical errors. He consequently judged all the scales to be highly satisfactory in this respect. Madden found also that incumbents' mean ratings were located approximately in the middle of the scales and that the means for each scale were symmetrically distributed across the entire scale. The standard deviations tended to be small which indicated a rather infrequent use of the extremes of the scales.

These early Air Force studies are also indicative of efforts other researchers were doing. Stogdill and Shortle (1955), Mahoney, et al (1963), and Hinrichs (1964), pursued proportional time measures of job content. Results were mixed, depending on specificity of job content measurements. However, Carroll and Taylor report an average correlation of .88 of all respondents between time allocations of estimates and absolute work measurements (via job sampling).

At the same time, Air Force research was testing experimental scales for obtaining estimates of time spent on each task. Ammerman tried "time" scales providing for open-ended responses. It was reported that these responses clustered on certain values - perhaps caused by a rounding tendency. A revision of this research was attempted and Madden reported that:

> Revised scales were then constructed in which frequently used values represented points along a continuum. For example, the resulting "time-to-perform-a-task" scale listed less than 1 minute, 1, 2, 5, 10, 20, 30, 45, 60, and 90 or more minutes. This method of determining scale values seemed to have some advantage over the logically constructed scale which includes class intervals with specified mutually exclusive limits. On another scale incum-

> bents were asked to report "amount of time spent" to the nearest percentage value, (i.e., less than 1%, 2%, 3%, 5%, 10%, 15%, 25%, more than 25%). As might be expected, over half of all responses were in the category, "less than 1%," giving little discrimination among tasks. (1961)

Since reporting "amount of time spent" to nearest percentage value produced not enough discrimination for the Air Force, they tested "length-of-time-of-task-performance." Scales assessing this variable were categorized into two absolute modes. That is, 10 and 20 minute categories were provided for in the scales, e.g.,

1) scale values = -1, 2,...., 10, 15,...., 30, 40, 45, 50, 60, 90 plus
2) scale value = -1, 1, 2, 5, 10, 20, 30, 45, 60, 90 plus

The longer absolute time scale gave greater reliability in the results (r=.74). The 10 category scale covering the same range of values produce an r. of .65. This result coincides with the known finding that increased reliability is associated with greater range of response categories.

This research of the Human Resources Laboratory of the U.S. Air Force led to a test of the relative-time-to-do scale that had five intervals. These were:

1 = very short

2 = short

3 = average

4 = long

5 = very long

This finding showed that the computed mean of each respondent's scores was distributed over the entire scale. The mean of the means was 2.9 and standard deviation .38. The interpretation of the results is that job incumbents can respond accurately to a relative scale.

This finding is crucial because the relative time spent scale was later expanded to a 7 point scale of which is presented in Exhibit 5.

(Exhibit 5, about here)

Step 2 demonstrates how the scale is presented. The explanation of the scale is psychologically real to most respondents. Test-retest studies (McCormick & Tombrink, 1960; Moore, et al, 1974) reveal reliability coefficients in the high .70's. Validation of these time spent measures has been pursued with a variety of techniques - all suggest valid use of the relative time spent rating. Consider the following evidence from Morsh, et al:

> Interviews with incumbents and with supervisors were compared with inventory responses by Strayer, Harris, & Buckner as a measure of the validity of task inventory information obtained from incumbents. In general, they found only minor discrepancies between inventory responses and interview findings.
>
> Results of self-administered performance reports filled out daily by bomb-navigation systems mechanics over a period of four and one-half months were compared with task inventory data in an attempt to appraise the validity of task-inventory information. The particular tasks each mechanic reported on the daily work record as performed depended to some extent upon normal rotational assignments and the shifts which he worked. Consequently, the comparison between data provided by the automatic data collection plan and data obtained from the completed task inventories

EXHIBIT 5

Each step should be performed for the full list of tasks

before proceeding to next numbered step.

STEP 2.

Indicate relative time on each task in present job. Only enter time for tasks you checked on Step 1. (Time does not necessarily = importance)

1. Very much below average time on this task
2. Below average time
3. Slightly below average time
4. Average time
5. Slightly above average time
6. Above average time
7. Very much above average time on this task

1. Check tasks performed (✓). Add tasks you do which are not listed.

2. Rate checked (✓) tasks on time spent.

STEP 1.

Check own job tasks

A. DIRECT PATIENT CARE		
1. Administer bladder irrigations		
2. Apply cervical traction		
3. Assist patients to turn, cough and deep breathe		
4. Brief family on condition of patients		
5. Catherize patients		
Write in any additional tasks you perform.		

> was not directly comparable, since inventory responses were single estimates covering a fixed time period. The average frequency of task performance for each task was derived from daily performance reports completed by 49 incumbents and from task inventories completed by 162 incumbents. The resulting product-moment correlation across 129 tasks was .66. The fact that the self-administered data collection plan totals agree to this extent with the task inventory frequency ratings is encouraging, considering the differences in samples and data collection techniques, as well as the changes in work assignment which took place during the four and one-half month period.

Both reliability and validity will be dealt with more comprehensively below. However, the relative time spent variable is crucial to statistical analysis. For this reason, this paper attempts to specify its research development. Careful search for a variable that is real to job incumbents yet lends itself to statistical routines marks this Air Force research. The high speed of the computer means nothing if job content cannot be comprehensively measured and quantifiably manipulated. Why? The TI relies on the job incumbent being the best source of job information since he is closest to the work. However, job incumbents write poor job descriptions. But, the TI is the product of the occupational analyst and permits the job incumbent to provide job content through the structure of the TI by providing valid, reliable data for computer analysis.

Thus, there are four important reasons why the TI, as computer analyzed, is so useful for qualification standards development, training program development, occupational restructuring, and job evaluation:

1. Accuracy of Measurement -
The smaller the unit of description (i.e., task), the more stable the description tends to be. Thus, the measurement is better than that for many other forms of job analysis.

2. Comprehensiveness -
This technique is comprehensive and yet economical. Data are collected from all employees, if need be, and not the few "sampled" by position analysts. Still, the cost is less than for engineering techniques.

3. Quantifiability -
Data collected are quantifiable, unlike functional job analysis.

4. Manipulability -
Manipulation of quantified data is simple via computer. Data retrieval, analysis, and reporting are all handled by computer, which is an advantage not shared by functional job description techniques.

Comprehensive Occupational Data Analysis Programs - CODAP

CODAP is the acronym for a computer software package which analyses task data. Currently, there are over 30 statistical routines. The most useful will be discussed briefly, however, a greater description is available from either the National Technical Information Service or the Air Force Human Resources Laboratory, Lackland Air Force Base, Texas, where CODAP was developed.

One of the most important CODAP routines is the hierarchical clustering routine (called GROUP). Indivividuals or groups of individuals can be clustered by computing a similarity matrix. The relative time spent data are summed for each individual, then estimated percents are computed. Thus, the values of each relative time spent variable range from 0 - 100 for tasks performed. Therefore, the similarity matrix uses a hierarchical grouping which involves repeated searching for those individuals or partially formed clusters which have the highest degree of similarity.

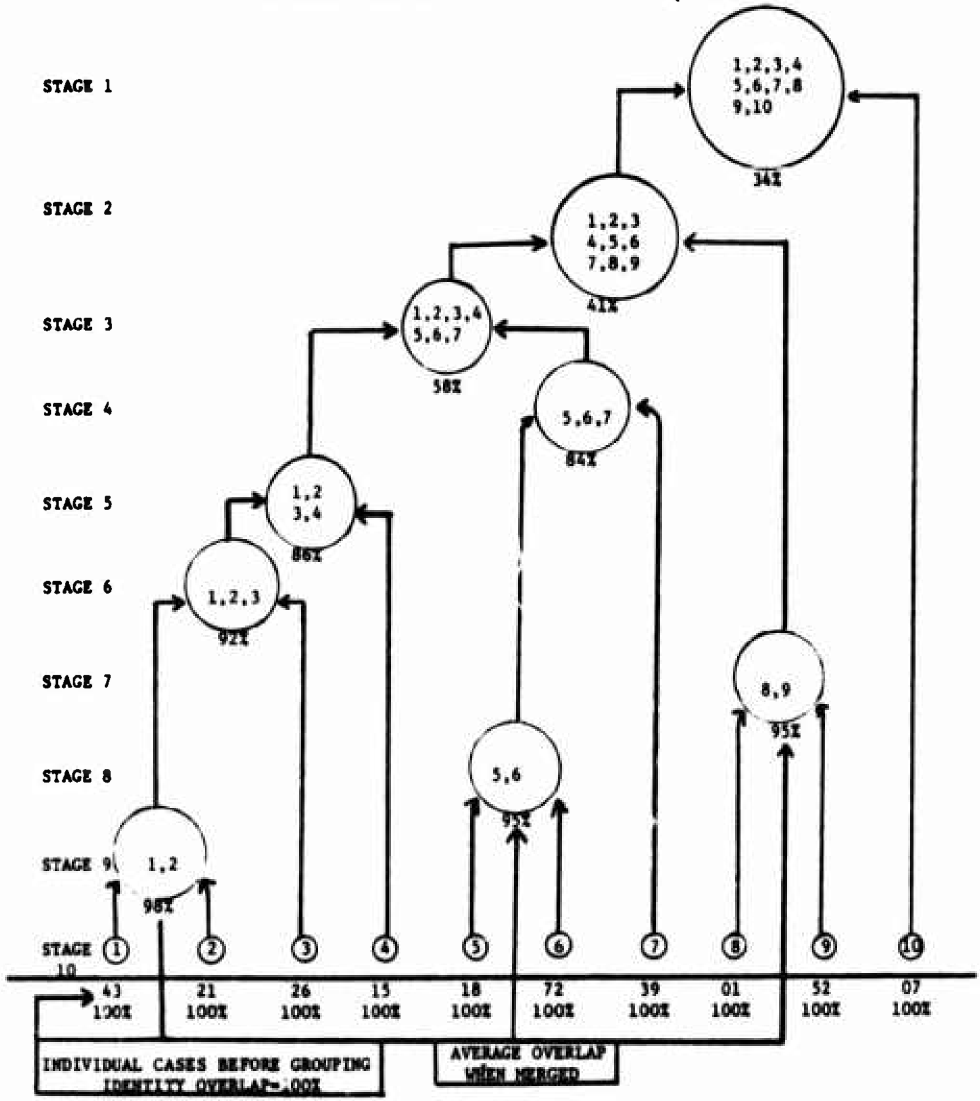
Each cluster is actually called a "stage." Exhibit 6 diagrammatically shows this statistical process. Clustering continues until a single group has formed. This group will contain all individuals in a survey. Therefore, when looking at Exhibit 6, keep in mind that Stage 1 is the last stage since the matrix compared all individuals on all tasks according to the estimated percent of time they performed the tasks. At this stage there is only 34% overlap among all ten surveys.

(Exhibit 6, about here)

From the Exhibit, each stage shows the degree of overlap by the percentage figure. For example, Stage 6 shows individuals 43, 21, and 26 as being arrayed in 1, 2, 3 order. The time spent on similar tasks overlaps by 92%. The order that individuals 43, 21, and 26 were clustered becomes valuable because the sequence of 1. 2, 3, etc., indicates how close each person's work is to another's.

Exhibit 6

BRANCH DIAGRAM OF JOB GROUPING SEQUENCE



Source: Archer, Wayne B., Computation of Group Job Description from Occupational Survey Data. PRL-TR-66-12. Lackland AFB, Texas: Personnel Research Laboratory Aerospace Medical Division Air Force Systems Command, December 1966.

At Stage 10, conversely, all individuals are overlapped at 100% since they themselves are being overlapped on their own time spent. Each person's uniqueness produces an identity overlap with himself.

These stages are really task clusters which can be broken down in a variety of ways - such as by pay groups, education, length of service. The products of CODAP analyses are numerous. Here are some examples cited by Dr. Raymond Christal:

> Example CODAP Programs
>
> One program produces a consolidated description of the work performed by any specified group of individuals. Such a description can be produced for workers at a particular base; or for those who have been in their jobs less than one year; or those who claim their talents are not being utilized; or those who work on a particular type of equipment--indeed, for any group of workers which can be defined in terms of information in the background section of the job inventory. A consolidated job description indicates the percent of group members performing each task, the average percent of work time spent on the task by those who perform it, and the percent of group time spent on each task. A CODAP program prints the task statements and associated computed values, arranged in terms of percent members performed, or in terms of group time-spent values. A consolidated description of the work performed by individuals during their first year or two on the job is particularly useful in validating or designing the curricula for entry-level vocational training.
>
> Normally, when analyzing an occupation a series of job descriptions for groups at various experience levels is produced. That is, consolidated descriptions are computed for individuals who have been in the occupation for less than one year; from one to two years; from two to four years; four to eight years; and so on. Then the CODAP system is used to gather this information into a table which indicates the percent of individuals at each experience level that perform each task in the inventory. In this way, we find when tasks tend to be assigned, and when training should be given in order to be timely.

Another CODAP program enables managers to study the differences in work being performed by any two specified groups of individuals. For example, one might wish to know the differences in work performed by individuals at one grade level and those at another grade level; or in the work performed by individuals working on two types of equipment. The CODAP system analyzes the two defined groups and prints a report summarizing the major differences in work performed.

Perhaps the most powerful CODAP program is one which identifies and describes all the types of jobs which exist in an occupational area. Beginning with 2,000 individual job descriptions, this program will compute a 4,000,000-element input matrix reflecting the similarity of each job with every other job. Then it proceeds to group similar jobs into clusters and prints out a description of work performed by individuals in each cluster. The program is iterative and may evaluate well over a billion alternative solutions in arriving at the best definition of job types and clusters in a particular occupation. Still another CODAP program can be used to determine the characteristics and locations of individuals working in each job type and cluster. The results of job typing analyses are extremely valuable in identifying changes needed in defining occupational categories in an organization or military service.

Other CODAP programs can be used compute job descriptions for individuals, or for each individual in a specified group, or to compute the amount of work time each worker spends on a given set of tasks. Using factor ratings in conjunction with task data, CODAP can be used to compute the difficulty level or the grade requirement for each job. Programs are available within the CODAP which will produce two-way frequency distributions between background variables; compute the difficulty level of each task; compute intercorrelations among background variables; determine the reliability of task factor ratings; compute the average grade level or the average experience level of workers performing each task; compute regression equations;

> print task lists, or print a dictionary of background variables. The CODAP system is also a general occupational information retrieval system. All reports, descriptions, and analysis results computed by CODAP are stored and identified. Any subset of descriptions or reports can be extracted, ordered, and printed. CODAP even numbers the pages in an extracted report and automatically prints a table of contents. In general, there is a CODAP program available to organize and analyze occupational data to answer any question asked by managers of a personnel system.

Dr. Christal's remarks provide the reader with a sampling of some very useful applications of CODAP. The consolidated job descriptions referred to are shown in Exhibit 7. A brief discussion of the task job description is in order as it serves a primary purpose for the goals of this paper.

(Exhibit 7, about here)

Exhibit 7 lists all the tasks currently performed in a survey of 394 journeymen medical laboratory specialists. The tasks are arranged by the percent of individuals performing a given task. Thus, "collect blood specimens directly from patients" is common to 93.40% of all those surveyed or 368 of this job family perform this task.

The average percent time spent by members performing this task is 1.7%. That is, we know that "collecting blood," task #18, is not only the most common task to the group, but is one of the most time consuming. That is, a quick scan of the value 1.7% down the second column shows no other task taking as much time.

Exhibit 7

TASK JOB DESCRIPTION FOR JOURNEYMEN MEDICAL LABORATORY SPECIALISTS (N=394)

D-TSK	TASK TITLE	PERCENT OF MEMBERS PERFORMING	AVERAGE PERCENT TIME SPENT BY MEMBERS PERFORMING	AVERAGE PERCENT TIME SPENT BY ALL MEMBERS	CUMULATIVE SUM OF AVERAGE PERCENT TIME SPENT BY ALL MEMBERS
F 18	Collect Blood Specimens Directly from Patients	93.40	1.70	1.58	1.58
J 3	Perform Blood Count	89.09	1.56	1.39	2.98
J 24	Perform Hematology Procedures for Hematocrit Tests	89.09	1.45	1.30	5.60
J 5	Prepare Blood Smears	89.85	1.39	1.25	8.10
N 9	Perform Urinalyses for Glucose Tests	87.82	1.38	1.21	10.53
N 6	Perform Urinalyses for Albumin Tests	87.06	1.36	1.19	12.92
J 6	Separate Serum from Blood	87.31	1.30	1.14	16.40
M 4	Operate Spectro-Photometer	77.66	1.34	1.04	19.62
G 1	Examine Specimens Microscopically	86.04	1.18	1.01	22.69
F 12	Prepare Solutions and Standards	86.55	1.09	0.94	25.62
G 11	Stain Bacteriological Smears	85.28	1.08	0.92	28.41
J 1	Identify Immature Blood Cells	86.29	1.04	0.89	31.09
F 14	Prepare Specimens for Shipment	84.26	1.03	0.87	33.72
L 18	Type Blood of Donors and Recipients	74.87	1.10	0.83	35.38
L 17	Test Blood for RHO or DU Factors	76.14	1.04	0.79	37.78
M 5	Prepare Reagents and Standards	75.38	1.01	0.76	39.32
I 6	Identify Protozoans, Cestodes, Nematodes, or Trematodes	74.62	0.95	0.71	42.26
N 8	Perform Urinalyses for Bile Tests	85.28	0.80	0.68	44.34
N 3	Perform Kidney Function Tests	76.14	0.89	0.68	47.05
M 17	Perform Biochemical Procedures for Chlorides Tests	71.07	0.89	0.63	50.95

Exhibit 7, Cont'd.

D-TSK	TASK TITLE	PERCENT OF MEMBERS PERFORMING	AVERAGE PERCENT TIME SPENT BY MEMBERS PERFORMING	AVERAGE PERCENT TIME SPENT BY ALL MEMBERS	CUMULATIVE SUM OF AVERAGE PERCENT TIME SPENT BY ALL MEMBERS
M 38	Utilize Methods for Electrolyte Determinations	61.68	1.00	0.61	53.43
E 7	Maintain Files of Laboratory Records or Reports	51.27	1.14	0.59	55.20
J 18	Perform Hematology Procedures for Eosinophile Count	80.46	0.71	0.57	57.51
J 29	Perform Hematology Procedures for Sickle Cell Preps	82.74	0.68	0.56	59.21
F 20	Collect Pus Specimens Directly from Patients	65.99	0.80	0.53	61.37
H 4	Perform KOH Preparation for Dermatophyte	68.02	0.72	0.49	63.35
I 6	Maintain Donor Files	58.63	0.79	0.47	65.74
A 5	Assure the Availability of Equipment and Supplies	42.64	1.06	0.45	67.57
M 42	Utilize Methods for Titrimetric Procedure	55.33	0.80	0.44	69.79
H 1	Cultivate Mycology Specimens for Primary Isolation	56.09	0.77	0.43	71.10
N 4	Perform Pregnancy Tests	48.48	0.84	0.41	73.57
L 7	Maintain Files of Blood Banking Forms	53.30	0.74	0.39	75.16
L 14	Screen and Schedule Donors	50.51	0.72	0.36	77.04
A 21	Plan Reports for the Section	32.99	0.99	0.33	79.45
H 6	Stain Mycology Specimens	48.22	0.62	0.30	81.34
A 14	Establish Procedures for Special Tests	36.29	0.74	0.27	83.36
F 15	Prepare Specimens for Training or Reference	36.29	0.67	0.24	85.42
D 8	Indoctrinate Newly Assigned Personnel	35.28	0.67	0.23	87.09
M 29	Perform Biochemical Procedures for Salibylate Level	32.49	0.61	0.20	89.46

The third column of Exhibit 7 shows the average percent time spent by all members. This includes all 394 of the total numbered survey. The average time for all members of the group surveyed is less than time spent by members performing in this case since not everyone performed this task. However, when we look at column four we see that the cumulative sum of average time spent by all members starts with this figure (1.58%). Then, we see that this fourth column keeps summing average time by all members on tasks until we could reach 100%.

For the job analyst a determination can be made as to the percent of tasks necessary to perform adequately in a job (such as 60%). The remaining tasks may be incidental or perhaps learned on the job. The remaining tasks are of lesser importance for qualification standards or for job evaluation.

Exhibit 7 displays the frequency of task performance for a field of work in a way not currently known to many occupational analysts. Frequency often is reported by expert judgment. Frequency reported by other survey techniques divides the total sample group into each task to produce a percentage figure. This is then taken as the frequency of task statistic. For example:

Task	No. Responding	÷	Total Surveyed (394)	=	% Performing
1	30		"		8
2	150		"		38
3	250		"		63
Kth	368		"		93

Now, for any given task the percent who perform the task does not reveal how much time they spend performing the task. For example, CODAP will show average percent time spent. More importantly, if the range of members performing is 1% average time to 100% of average time spent on that task (column two of Exhibit 7) then the frequency measure tells us very little. All we know is that many people perform the task. Interpretation of frequency is impaired without having average percent time and being unable to inspect the range of time spent. Both of these statistics are reported by CODAP.

Another important yield of CODAP mentioned by Christal is exemplified by Exhibit 8.

(Exhibit 8, about here)

This Exhibit shows the difference between two samples of workers in the same job family. One group are apprentice laboratory technicians while the other are journeymen. The first column shows percent time spent on task by the apprentices. Column two shows the percent time spent on task by the journeymen. Column three subtracts the time spent on task from the more experienced group. The difference indicates what the apprentices don't currently do, or how little of their time is spent on the task compared to the experienced population. One implication for career counseling, training, and ultimately qualification standards is to

Exhibit 8

SAMPLE DIFFERENCE DESCRIPTION

GROUP 1 = APPRENTICE DENTAL LABORATORY TECHNICIANS (N=30)
GROUP 2 = JOURNEYMAN DENTAL LABORATORY TECHNICIANS (N=272)

D-TSK	TASK TITLE	PERCENT PERFORMING, GROUP 2	PERCENT PERFORMING, GROUP 1	DIFFERENCE IN PERCENT PERFORMING GROUP 1 MINUS GROUP 2
K 14	Perform Dental Assistant Functions	12.87	33.33	20.47
M 6	Maintain Boilout Tanks	52.57	70.00	14.43
M 7	Maintain Dehydrating Equipment Ovens	11.40	26.67	15.27
H 26	Trim Casts	55.51	70.00	14.49
H 11	Eliminate Wax from Denture Molds	56.99	70.00	13.01
J 21	Soak Master Casts	29.78	40.00	10.22
	TASKS OMITTED WHERE DIFFERENCES IN PERCENT PERFORMING = 10.00 THROUGH -20.00			
K 17	Solder Units of Fixed Partial Dentures	33.46	13.33	-20.12
K 9	Fabricate Stone Dies	40.81	20.00	-20.81
K 1	Cast Gold Crown, Inlay, or Pontic Backing	38.24	16.67	-21.57
B 13	Supervise the Fabrication of Dental Prosthetic Appliances	22.06	0.00	-22.06
K 13	Grind in Porcelain or Acrylic Facings and Pontics	39.71	16.67	-23.04
K 5	Fabricate Acrylic Resin Jacket Crowns	32.72	6.67	-26.05

focus on the positive values at the top of Exhibit 8. Presumably, apprentices require experience (via occupational restructuring) or training on those tasks where the difference is great and the journeymen are performing the task. A similar example can be made for job evaluation contrasting two different groups of skill wherein the analyst wishes to construct an equitable pay scale.

Summing up CODAP's utility, one can readily see that the TI, when matched with the power of computer assistance, produces highly usable information for occupational analysis. CODAP, as a package, produces reports in form that the user can quickly interpret. As Exhibit 3 on comparative attributes of occupational analysis argues, measurement, generalizability, low cost, speed and capacity, and exhaustiveness are deftly exploited by CODAP. Therefore, the pay-off to qualification standards development, training program development, occupational restructuring, and job evaluation is quite high.

JOB PRICING AND EVALUATION

A special application of the TI/CODAP is job pricing and evaluation. This section reviews the common methods and indicates how the TI/CODAP offers a step forward in this area.

Factor Comparison Method

Only 10% of compensation systems probably use this system of job evaluation. One notable example of this system is the Hay System. One so-called advantage of this system is that it is "custom built" for each organization. We consider this a disadvantage since comparability across organizations facilitates wage and salary surveys. Thus, job comparison scales within organizations are less sensitive to true labor market conditions. Another disadvantage of the Factor Comparison Method is that "universal" factors simply do not exist in all jobs and all organizations. Also, key jobs become critical as bench marks, but jobs change all the time. Thus, some key jobs in the scale no longer represent the bench marks they once did. The usefulness of the scale suffers. As one expert argues, it becomes a warped ruler. (Belcher, 1975).

The Point Method

Some say this is the most common and easily adapted system. Jobs are broken down in compensable factors. A numerical score on these factors produces a value of the job. Rating scales are constructed for compensable factors. A definition of this factor and degrees of this factor are outlined for each rater. Points are allocated for each degree.

Major disadvantages of this well-known system are:

1) difficult to develop

2) meanings of each factor and its degrees can be difficult to establish

3) great clerical detail is required to keep this system's "logic" intact

4) occupational analysis is definitely required and no one uniform system is employed - thus comparisons of compensable factors is always difficult

TI/CODAP Method

A newer technique is the task inventory combined with CODAP. Point Method Plans have existed with the job checklist (Bellows & Estep, 1948; Ferguson, 1948). Thus, the TI/CODAP, which is an extension of the checklist, can put clear job information into the Point Method to simplify this system. Therefore, major disadvantages are minimized because an empirically based job analysis system produces easily rated points.

Here is a list of the most commonly used job evaluation points for which the TI/CODAP can produce meaningful information:

Education at the task level

Experience at the task level

Training at the task level

Complexity of tasks by who performs task

Responsibility for:

function

procedures

data

errors

money

Contacts at the task level

Working conditions at the task level

Hazards at the task level

Supervision

In sum, the normal points are associated in a clear, meaningful form with clustering actual time spent on tasks. Qualitative weights for these task clusters can be arrayed to produce scores for proficiency at the task level, task difficulty, and level of responsibility. In this way TI/CODAP simplifies the judgments necessary for job evaluation by describing the work content at the task level in its clearest form.

Managerial discretion will not be obviated by the TI/CODAP, but the basis for job pricing will be an information system that is data based, efficient, updatable, computer reported, and more objective than contemporary systems of job evaluation.

Validity and Reliability

The TI has undergone extensive testing for validity and reliability. Validity, of course, is the correspondence between reporting task data and actual performance on the job. Some validity studies have already been reported on in this report (e.g., Carroll and Taylor, 1969; Stodgill and Shortle, 1955; Morsh, et al, 1968). Moore, et al, 1974, validated task data of subordinates with independent supervisory ratings. Across seven job families (N's of 18 to 76), agreement ranged from 63 to 88%. This is surprisingly high since supervisors must be aware of both the work process and the worker.

No one validation study answers the question of validity for any particular survey. Therefore, the TI/CODAP has techniques built into it. Inspection of the data reveals if a large proportion answers task statements the same way. This is a form of validation because consistent error is unlikely. Other techniques can include task statements that are always or never done. Isolating "false" responses into those two categories permits breaking down the pattern of responses. Curiously, research has shown that responders who say they do more tasks than responders who indicate fewer tasks tend to be more accurate (Ammerman, 1960).

The point to consider about validation is that each survey should incorporate a validation assessment. Veracity items can be included in the TI. Sub-samples, on occasion, can be drawn and a check on the correspondence between reporting task data and actual performance can be made.

Reliability is easier to assess. Test-retest correlations range from the mid .70's to the high .90's (c.f. Ammerman, 1960; McCormick and McCormick, 1960; Tombrink, 1960; Christal, 1974; Moore, et al, 1974). Perhaps the best reliability study is that of McCormick, 1960:

> Fifty-six airmen were asked to report various combinations of the following information: whether or not they performed each task, the frequency of task performance, the time required for performance of each task, and the judged mental difficulty of each task. Analysis of variance showed no systematic differences in the number of tasks reported by incumbents who were asked to report one, two, three, or all four types of information about tasks. Incumbents who were required to report more (as opposed to fewer) types of information about their tasks tended to provide more reliable information. Among the different sub-samples of incumbents there was considerable stability in the number who reported that they performed a particular task. It appears that if incumbents must read each task statement closely in order to follow instructions they will give reliable information, but if they are just required to check the statements they may not read them carefully.

3) to develop an instrument for use in the preparation of interprovincial standards examination (Red Seal), and in the preparation of curricula for instruction leading to the journeyman qualification;

4) to facilitate the mobility of a journeyman in Canada by the award of the Red Seal on a journey certificate, recognized by all provinces and territories for purposes of journeyman certification;

5) to supply employers, unions, training institutions and members of the labor force with a list of trade tasks which they can readily assess.

Point 1 above calls for the proper identification of the task. From Exhibit 3 onward, it is argued that the measurement properties of the TI are excellent. Since the job incumbent is the best source of occupational information, the survey technique of the TI permits task identification to be collected where it occurs - in the world of work.

Point 2 above asks that tasks stated in the occupational analysis be applicable to journeymen in every province. Current methods ask provincial experts to produce this judgment. The TI/CODAP provides a data base which clearly indicates the variation of task by region and gives the frequency of task performance. Since this TI is a survey technique, this information base can be updated yearly or whenever shifting labor markets demand it. Often, "experts" are surprised by the true distribution of tasks which describe a trade.

Again, each study of the past on the TI merely gives us more confidence about validity and reliability. Each application of the TI should carefully analyze the responses for truthfulness and consistency. Small sub-samples can be drawn. Test-retest coefficients can be computed. In this way, generalization and decision making are enhanced.

Relevance

This section discusses the relevance of the TI/CODAP for manpower analysis, career ladder development, and manpower modelling. Specifically, each of the objectives will be the focus of discussion as to how the TI/CODAP offers better information than current techniques.

Canadian Occupational Analysis

An occupational analysis, as developed by the Canadian federal government under the guidance of the Interprovincial Standards Program Coordinating Committee, has the following objectives:

1) to identify the tasks performed by a journeyman in a particular trade;

2) to obtain interprovincial acknowledgement that the tasks stated in the trade analysis are applicable to journeymen in every province;

Point 3's objective is to develop an examination instrument for the Red Seal program. Task based exams do exist in the form of performance examinations. However, validation of the examination as an examination must be performed. That is, item analysis must be undertaken to assess if the test instrument discriminates properly. There is no reason, per se, why task based performance tests can't be better than achievement/aptitude tests. The methodology is straightforward. Also, validation of a task-based test offers additional sources of validation since exam results can be vouchered. That is, the results of the exam are in a form that previous employers, supervisors, etc., can recognize. If their cooperation is secured, they can voucher the examinee's test performance against their knowledge of his work performance.

The second part of Point 3 asks that preparation of curricula for instruction be developed. The TI/CODAP was invented for that purpose. Task-based data that are current and accurate provide enabling and terminal objectives for curricula developers. The systems approach to training is based on occupational analysis that produces sufficient description of an occupation so that training will be optimal. That is, under and over training are to be avoided. Curricula developers need to know how much and to what standard tasks are performed.

Then, they as experts can provide the knowledge and technique suitable to perform in those tasks. Thus, the occupational analysis serves as a basis for curriculum content and a specification of goals (the terminal objectives). Many experts have cited the problems of merely letting curriculum experts build training programs in a vacuum. Some advise to keep curricula developers isolated from the occupational analysis.

Point 4 seeks to facilitate the mobility of journeymen via the Red Seal program. Given the speed at which the TI/CODAP reports out relevant occupational data, occupational analysis can be performed in months rather than years. Since certification is best made with empirical evidence rather than expert judgment alone, it seems that the TI/CODAP has much to offer Point 4.

Lastly, Point 5 seeks to supply to the labor exchange mechanism a list of tasks which are in a form that permits quick comparison of man/job matching. The TI/CODAP can print consolidated or specialized task lists in many different ways. These reports can be for entire job family surveys, as in Exhibit 7, or specialized groups, as in Exhibit 8. The lists of tasks can be for individuals, organizations, or regions. Very simple commands to CODAP produces very elaborate, yet digestible, reports.

Summing up the objectives of the Canadian Occupational Analysis, the TI/CODAP offers one incremental step over current procedures. For example, current techniques list the task at a level that is either too general or too comprehensive, i.e., it is more than one task. For instance, in the Canadian Carpentry Trades analysis task 1.1:

> <u>Examine excavations</u> to determine the sufficiency of the bearing strata to the extent that any unsatisfactory conditions are reported to the builder re: unequal bearing strength over the area of proposed building and any unsafe conditions re possible bank collapse.

Each type of excavation examination for sufficiency mentioned above may very well be at the level of measurement for the task statement. Therefore, task 1.1 may be broken into 5 or 6 tasks, but the response pattern may vary by region, industry, etc. Ultimately, TI/CODAP will tell us whether a simple statement of "Examine excavations" is all that is necessary or whether six task statements are better. In other words, the answer is derived from the data. The point here is that the current language of the task is disguising discrete tasks, or, at times, could be specifying duties rather than behavioral tasks. The significance is that if duties or multi-task embedded statements are used, respondents cannot honestly provide data. <u>If a journeyman only performs one type of examination of excavations, should he answer the entire</u>

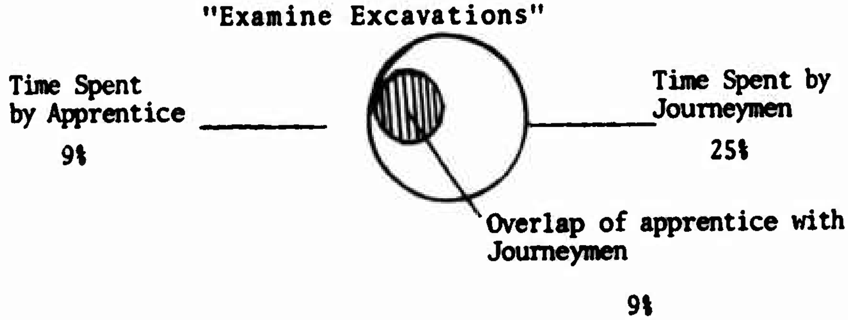
statement or not answer it at all? Of course, if the occupational analyst is answering this statement by virtue of FJA methodology, then this paper argues that good measurement has already been lost (see Exhibit 3).

Task 1.1 also deals with frequency which is of crucial importance to the objectives of the Canadian Occupational Analysis. Currently, methodology asks for expert opinion on frequency. TI/CODAP reports it out as actual. Research experience has amply demonstrated that there are real gains in capturing frequency of task by survey methods. Unlike weaker survey methodologies, however, CODAP reveals the relative time spent on task. This is much more sensitive as a frequency measure and permits comparisons of differences to be computed (see Exhibit 8). The distinction is not a small one. For example, Task 1 could be revealed as equally frequent for both apprentices and journeymen. With CODAP, however, the following figure shows why the science of occupational analysis has been advanced:

Exhibit 9

TASK 1 - OVERLAP

"Examine Excavations"



The last facet of the Canadian Occupational Analysis is the quality factor. With TI/CODAP, many different qualitative measurements can be used. For example, task difficulty has had some merit (c.f. Mead, 1970a; 1970b; Mead & Christal, 1970). It is defined as the amount of time it takes for individuals to learn to perform a task adequately. Research has shown that supervisors, experts working in the field, can agree on relative difficulty of tasks within an occupation. This variable can be clustered by CODAP the same way that relative time spent is. Many of the quality factors in the current Canadian system are really the performance of task to a standard. As mentioned earlier, <u>the standard belongs in the task statement</u>. However, task difficulty has many uses as a way to weight emphasis for curriculum building. Because CODAP is such a flexible software package, variables such as task difficulty can be added to other variables to create hybrid variables for occupational analysis. For example, the cross products of task difficulty and time spent can be summed across all tasks for an entire inventory. Career ladders can be computed with this statistic. These ladders indicate the range of task complexity and difficulty that make up a job family. Both vocational counseling and mobility assessment can be facilitated with this type of analysis.

<u>Career Ladder Development</u>

As discussed by Christal (1974):

> ...most career ladders contain several types of jobs which may vary in difficulty. The CODAP analysis system can be used to identify these job types, and difficulty indexes can be used to determine which job types might be shredded out into new management units for performance by lower aptitude personnel. The task difficulty indexes can also be used to identify tasks which might be pulled out of existing jobs and engineered into new jobs for performance by less talented individuals. However, in order to build the most meaningful contingency plans, what is needed is a method for comparing aptitude requirement levels for jobs across all career ladders.
>
> This approach can be outlined in general terms.

<u>Step 1</u>. Select a set of career ladders requiring the same type of aptitudes, for which job inventories and recent occupational survey data are available.

<u>Step 2</u>. Collect ratings from supervisors to determine the relative difficulty levels of <u>all</u> tasks within each ladder.

<u>Step 3</u>. Select 30 to 40 tasks at various difficulty levels from each ladder. This will form the benchmark set. Reliability of final results will be enhanced if the tasks selected for the benchmark set are well known or easily observed.

<u>Step 4</u>. Obtain relative aptitude requirement ratings for tasks in the benchmark set from knowledgeable behavioral scientists.

<u>Step 5</u>. Within each ladder, compute least squares regression equations to predict task aptitude requirements from task difficulty levels.

<u>Step 6</u>. Apply the equations developed in Step 5 to re-scale all tasks in all ladders into a common aptitude requirements framework (the benchmark scale).

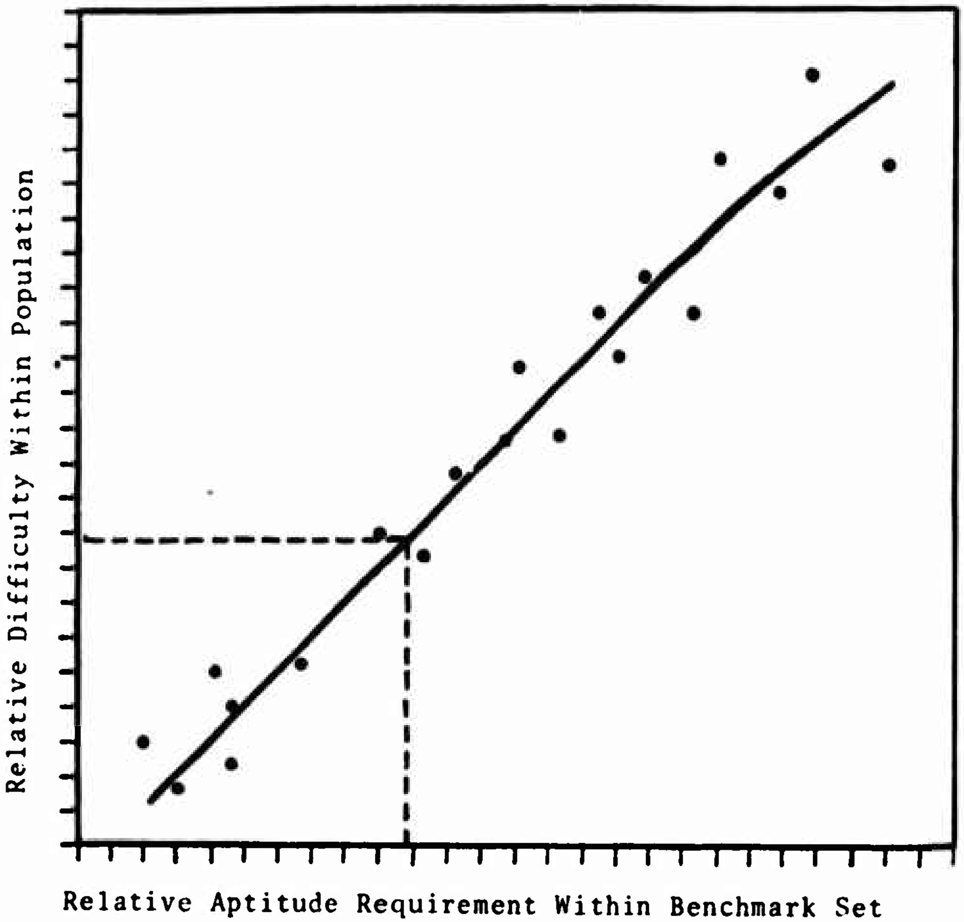
(Exhibit 9) presents 20 points representing 20 tasks on a particular career ladder which were included in the benchmark set. The position of a task on the vertical axis represents its difficulty level relative to all other tasks in its own career ladder. Its position on the horizontal axis represents its aptitude requirement level relative to other tasks in the benchmark set of tasks. A line of best fit has been drawn through the points. Using this graph, the relative difficulty index values can be converted into aptitude requirement levels for all tasks in the career ladder. If this procedure is repeated for all ladders having tasks represented in the benchmark set, the final product is a set of values indicating the relative aptitude requirement levels for all tasks in all ladders.

(Exhibit 10, about here)

Manpower Modelling in the U.S. Navy

The challenge to the Naval manpower planner is accurately to staff the technical needs of positions and to efficiently manage the human resources available to meet those needs. To accomplish this, managers have always been faced with a need for the best assignment of people to jobs. This function, of matching people to jobs so that the resulting organization makes optimal use of the personnel available, is addressed by the multi-

Exhibit 10



Resource: Christal, R. E., op cit., p. 29

attribute assignment model developed by the Office of Civilian Manpower Management (OCMM) in conjunction with the University of Texas at Austin. Long-range research plans are to construct a dynamic model, which would be able to take into account the effect of training and experience gained in each assignment. The implementation of such a model, however, is a complex undertaking, and so the first step began by working on a static model called MODS for Models for Organizational Design and Staffing (Charnes, Cooper, Niehaus & Stedry, 1968).

Overview of Model

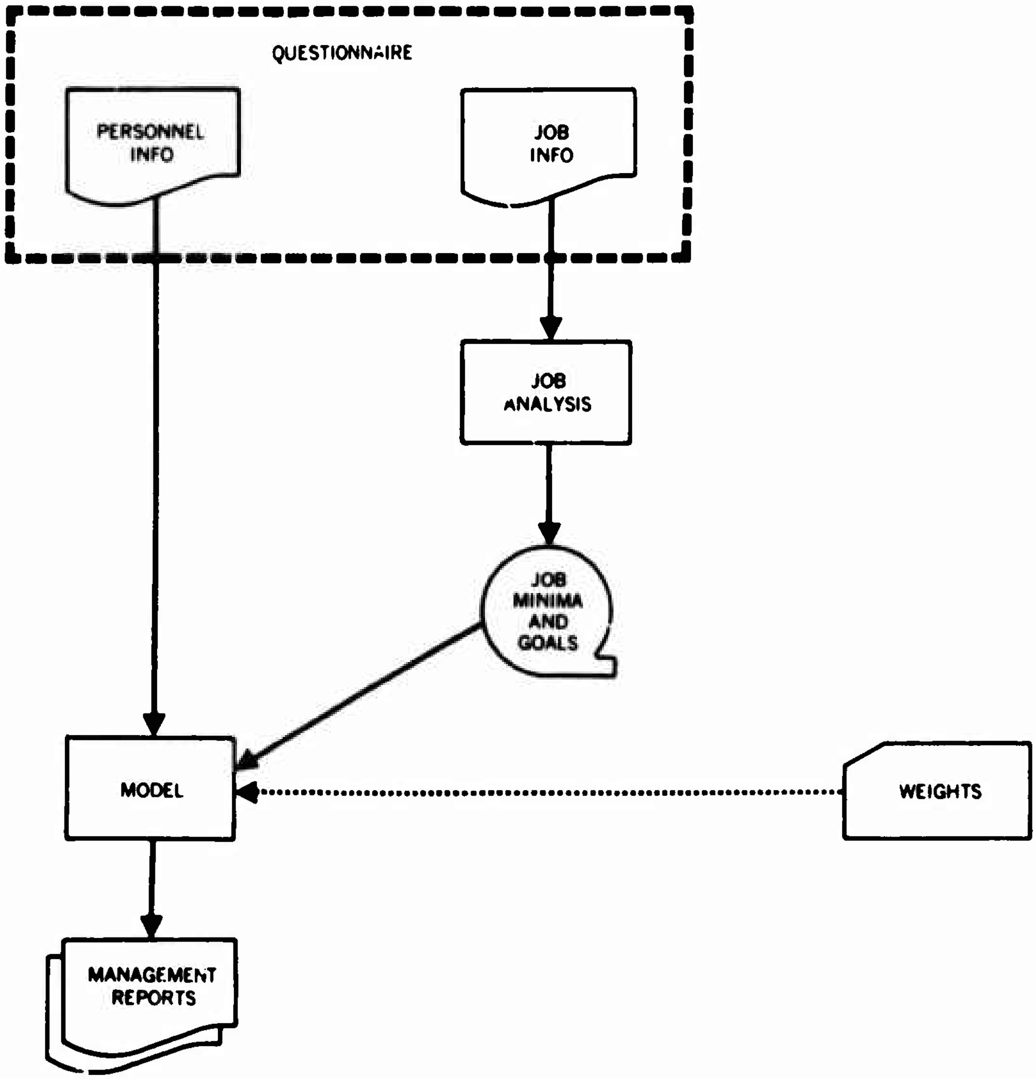
Exhibit 11 shows, in a general way, that the two principal types of input--the descriptions of the personnel and the requirements of the jobs--are derived from the TI. The personnel information is ready to be fed directly into the assignment model, but the job information must first be analyzed to produce a minimum acceptable level for each task comprised in each position, as well as the desired, or goal, level. It is also possible to specify weights to indicate that some goals are more important than others.

(Exhibit 11, about here)

For the central computer program, a preliminary pass eliminates any man-job combinations in which a

Exhibit 11

Models for Organizational Design and Staffing - MODS



Source: Moore, B.E., *et al*, "Using Task Surveys in Assigning People," *The Journal of Navy Civilian Manpower Management*, No. 4, Winter, 1974 given person cannot meet the minimum requirements for that job. The computerized model then looks simultaneously at all of the remaining personnel described and jobs to be filled, and finds that set of assignments which will result in all of the goals being met as nearly as possible. The distribution routine which actually finds the optimum match was provided by Dr. D. Klingman of the University of Texas at Austin (1972).

The management reports produced are four: a listing of the optimal assignments, a listing by person of all jobs for whic. he is minimally qualified, a register by job of all persons minimally qualified, and a training requirements report which lists the tasks and the degree of deviation from the standard required by management.

Exhibit 12 is a section of an actual task inventory. Step 1 merely asks the respondent to check whether he does the task or not. The purpose is to review the entire list before making any ratings; at this juncture, job incumbents are recognizing and recalling the tasks they perform. Additions to the list may occur at this time.

(Exhibit 12, about here)

Step 2 in Exhibit 12 asks for the now familiar relative time spent on each task performed. Once we have relative time ratings for tasks performed, the ratings can be converted into estimated percentage of

Exhibit 12

MACHINE TOOL FAMILY

3400

Each step should be performed for the full list of tasks before proceeding to next numbered step

STEP 1.

DESCRIBE YOUR PRESENT JOB BY CHECKING (✓) ONLY THOSE TASKS IN YOUR PRESENT JOB

STEP 3.

ENTER YOUR QUALIFICATION FOR ALL TASKS IN MACHINE TOOL FAMILY. USE LETTER CODE A-E, AND N AS BELOW.

A. LIMITED EXPERIENCE, NEED INITIAL TRAINING OR ASSISTANCE.
B. SOME KNOWLEDGE AND EXPERIENCE NEED OCCASIONAL ASSISTANCE.
C. CAN PERFORM ALL NORMAL WORK IN THIS TASK.
D. BROAD EXPERIENCE, CAN ASSIST OTHERS.
E. ABLE TO INSTRUCT AND DO DIFFICULT WORK.
N. NOT IN MY FIELD.

STEP 2.

INDICATE RELATIVE TIME ON EACH TASK IN PRESENT JOB. ONLY ENTER TIME FOR TASKS YOU CHECKED ON STEP 1. USE NUMBER CODE 1-7 AS BELOW. (TIME DOES NOT NECESSARILY = IMPORTANCE)

1. VERY MUCH BELOW AVERAGE TIME ON THIS TASK.
2. BELOW AVERAGE TIME.
3. SLIGHTLY BELOW AVERAGE TIME.
4. AVERAGE TIME.
5. SLIGHTLY ABOVE AVERAGE TIME.
6. ABOVE AVERAGE TIME.
7. VERY MUCH ABOVE AVERAGE TIME ON THIS TASK.

STEP 3. ENTER OWN QUALIFICATION FOR EACH TASK		STEP 1. CHECK OWN JOB TASKS	STEP 2. ENTER TIME CODE
	DUTY A. READING BLUEPRINTS, MECHANICAL DRAWINGS, AND SKETCHES		
E	1. READ SKETCHES AND SINGLE VIEW BLUEPRINTS.	✓	6
E	2. INTERPRET SIMPLE TWO OR THREE VIEW SKETCHES.	✓	7
D	3. INTERPRET ASSEMBLY DRAWINGS AND LAYOUT DETAILS WHEN NO DETAIL DRAWINGS ARE AVAILABLE.	✓	5
D	4. READ AND INTERPRET COMPLEX DRAWINGS FOR THREE VIEWS WITH CUTAWAY SECTIONS.	✓	3
C	5. READ DESIGN SYMBOLS AND SPECIFICATIONS REQUIRED TO LAY OUT SKETCH TYPE DRAWINGS, USING THREE VIEWS—TOP, FRONT, AND SIDE.	✓	2
C	6. IDENTIFY SHAPES, TOLERANCES, DIMENSIONS, FINISHES, AND TOOLING POINTS FROM COMPLEX BLUEPRINTS AND MECHANICAL DRAWINGS.		
	ADDITIONAL TASKS: ADD ANY SIGNIFICANT TASKS IN YOUR PRESENT JOB WHICH ARE NOT LISTED.		

____

____

time values. These data can then be analyzed by CODAP to find the degree of overlap of two or more jobs. The identification of similar task clusters leads to the definition of job-types--a form of job description. These job-types are behavioral job descriptions, which is to say that they do not represent what people ought to be doing, but rather just what they actually report themselves to be doing.

In Step 3 of Exhibit 12, the job incumbent indicates his proficiency in a given task, ranging from A (limited) to E (expert). In agreement with Campbell, Dunnette, and Arvey (1973), personnel assessment ought to focus on meaningful samples of work behavior rather than signs or indicators. The better predictors of proficiency (potential or actual) should be samples of the work behavior in terms reflecting the context of work, i.e., the task. Also, in the new era of equal employment opportunity (EEO), all organizations must be able to prove that personnel measures are related to satisfactory levels of productive human performance. This is equally true for promotion as well as entry level screening procedures. What the MODS is investigating as a meaningful sample of work behavior is reflected in Exhibit 12. The effectiveness of job proficiency measures is highly dependent on the accuracy and completeness of job information. Therefore, personnel proficiency is to be measured as it is related to a specific task statement of job behavior. Since a current job may not call for all the proficiencies the incumbent has, it is quite possible a largernumber of proficiencies will be scored. Retention of this information for a skills inventory is one of the by-products the assignment model offers. Notice that task 6 of Exhibit 11 is marked for proficiency, but not the job. The job doesn't currently call for this task, but the information is stored in the skills bank of MODS.

As a first test of validity of the TI, supervisors were presented with clusters of relative time spent in certain tasks and were asked to identify the men associated with these clusters. This they found easy to do within their departments.

Later, convergent validation was assessed statistically. Each supervisor vouchered all subordinates' ratings of task performance for the MODS independently. Subordinates' ratings (close to 200 tasks) were subtracted from the supervisors' independent ratings of each subordinate. Clearly, perfect agreement equals zero; e.g., low subordinate rating of 2 minus low supervisor's rating of 2 equals zero. Our data analysis for one job family shows 63% agreement (N=79). Item analysis shows that four task statements caused widespread disagreement.

By eliminating these ambiguous items, the increase in the percentage of agreement rose to 88%. In general, research shows that the smaller the unit of description the more stable descriptions tend to be. These ratings are based on discrete tasks which ranged to almost 200 significant tasks.

Assigning People to Jobs

The TI was employed by the U.S. Navy to describe people in terms of personnel proficiency. Occupational analysis by CODAP was combined with supervisory specification of minimum and ideal levels of job performance on tasks. Exhibit 11 indicates how these data were collected via the TI then merged by the MODS for person/job matching.

The MODS now looks simultaneously at all of the personnel described and all jobs to be filled. Assignments will result in all the goals of the tasks being met as nearly as possible. Exhibit 13 displays the fictionalized names of the optimal assignments for each position, i.e., those who deviated least from ideal levels of task performance. Two other reports of possible matches are also shown. These indicate people by jobs or jobs by people. That is, these are the rosters of those who meet minimal levels of task performance required in a job, but not the ideal. The implications for the manpower planner are many. For example, as job requirements change, new goals can be set by personnelists on expanding or changing positions.

(Exhibit 13, about here)

The optimal assignments in Exhibit 13 reflect a management report that is not of use in the case of a single civilian position being filled. However, the register of the minimally qualified shown in Exhibit 13 could be useful to the selection committee for single position assignments. But there are many applications in the Navy in which it is necessary to assign numbers of people at the same time. One such case is that in which a number of graduates from an apprentice program need to be placed. Another case is that of large activities which hire a number of people with similar backgrounds at the same time - for instance, at the end of a school year. Or again, across-command management intern programs might find the MODS useful.

The fourth and final management report of the MODS is the training requirements report. This displays individuals by position and lists their proficiency on that task against the goal or standard required for ideal performance. This report becomes a training plan for one individual or the same report can be aggregated to produce a group training requirements report. Other possible uses have been specified as in the Upward Mobi-

Exhibit 13
MODS Management Reports

OPTIMAL ASSIGNMENTS

JOB NUM	JOB DESCRIPTION	SSN	PERSONNEL NAME
380091001	SHEET METAL MECHANIC	666666666	SESTUS PROMMEN
380611001	SHEET METAL MECHANIC	333333333	THEO SINGER
380611002	SHEET METAL MECHANIC	111111111	ONEDA NORTH
380611003	SHEET METAL MECHANIC	222222222	TOBY LOVE
380690001	SHEET METAL MECHANIC	150000000	QUINCY MALL
380691001	WELDING BACKGROUND	130000000	THERESA WEST
388013001	MODEL MAKER-WELDING-SHT-PL	170000000	MILLIE GRAHAM
388093001	WELDING BACKGROUND	444444444	FREDERICK PIERCE
388093002	WELDING BACKGROUND	180000000	CLEE NAIR
388093003	WELDING BACKGROUND	110000000	ELIZAH BETH
388093004	WELDING BACKGROUND	555555555	PENROD STOPPER
388193001	MODEL MAKER SH AND PL METAL	999999999	NINA KNELL

POSSIBLE MATCHES BY PERSON

SSN	PERSONNEL NAME	JOB NUM	JOB DESCRIPTION
100000000	DECIUS YELLEN		
		380691000	WELDING BACKGROUND
110000000	ELIZAH BETH		
		380611000	SHEETMETAL MECHANIC
		380691000	WELDING BACKGROUND
		388093000	WELDING BACKGROUND
111111111	ONEDA NORTH		
		380611000	SHEETMETAL MECHANIC
		380691000	WELDING BACKGROUND
120000000	TWYLA KING		
		380611000	SHEETMETAL MECHANIC
130000000	THERESA WEST		
		380611000	SHEETMETAL MECHANIC
		380691000	WELDING BACKGROUND
		388093000	WELDING BACKGROUND

POSSIBLE MATCHES BY JOB

JOB NUM	JOB DESCRIPTION	SSN	PERSONNEL NAME
380690000	SHEET METAL MECHANIC		
		150000000	QUINCY MALL
		170000000	MILLIE GRAHAM
		180000000	CLEE NAIR
		333333333	THEO SINGER
		666666666	SESTUS PROMMEN
		999999999	NINA KNELL
380691000	WELDING BACKGROUND		
		100000000	DECIUS YELLEN
		110000000	ELIZAH BETH
		111111111	ONEDA NORTH
		130000000	THERESA WEST
		140000000	CORY BOTTOM
		150000000	QUINCY MALL
		170000000	MILLIE GRAHAM
		180000000	CLEE NAIR
		333333333	THEO SINGER
		444444444	FREDERICK PIERCE

lity Program where the model could be used to help in determining which people ought to be directed to what jobs. Related to this use would be that of establishing training requirements for personnel by indicating the discrepancy between current capabilities of incumbents and position requirements. Still another area is that of evaluating combinations of military-civilian assignments.

Eventually, of course, the MODS hopes to deal with multiple periods. Such a dynamic multi-attribute assignment model would be needed to address the problems of organizational redesigning, and ultimately could be used in conjunction with other OCMM manpower planning models.

Summary and Conclusions

This paper reviews the history and development of the task inventory within the general context of occupational analysis.

Three approaches to occupational analysis were evaluated against a common set of attributes. The three basic approaches are engineering methods, functional job analysis, and the task inventory. No one system is consistently better than the other on all attributes of occupational analysis. No one system satisfies all possible products for which occupational analysis is used. However, TI/CODAP (task inventory with computer assistance) comes closest to meeting the criteria of good occupational analysis. It also produces many very useful products such as job evaluation, manpower planning, and occupational restructuring. CODAP, the software package developed by the Air Force Human Resources Laboratory, was reviewed in order to indicate the kind and range of analyses possible. Task clustering via CODAP is just one of many useful applications made possible by this software package. Task job descriptions based on survey techniques are one of the basic products of CODAP. This paper attempted to demonstrate how this form of task analysis is used by the occupational analyst and manpower planner.

The relevance of the TI/CODAP was discussed and practical applications were reviewed. Whether for certification of skills, job description, career ladder development, or manpower modelling, the TI/CODAP produces accurate, reliable, and comprehensive job data.

Lastly, personnel assignment modelling was discussed as a special adaptation of the TI. The creation of a comprehensive and exhaustive person/position data file was combined with low cost, accuracy of assignment, and computerized speed. The MODS[2] (Models for Organizational Design and Staffing developed by OCMM in associated with Carnegie - Mellon University and The University of Texas at Austin) produces four management reports that indicate the optimally assigned person, all persons by all jobs, all jobs by all persons and a training requirements report. All of these reports utilize task level data. Also, this system satisfies EEO, Civil Service, and U.S. Navy regulations.

In sum, the relevance, utility, and comprehensiveness of the TI/CODAP seems to offer a significant step forward over other forms of occupational analysis. New applications of the TI/CODAP are still being developed within the Air Force, the Navy, and at major universities.

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[2] If the past fifteen years of continuous research is any measure, then the prospects for new advances in the TI/CODAP seems assured.

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A review of the issues concerning the field of occupational analysis is undertaken in this paper in order to indicate the comparative strengths and weaknesses of the task inventory. Specifically, the significance of the task inventory (TI) will be assessed for: (1) reliability and validity; (2) job analysis and evaluation; (3) occupational restructuring and career ladder development; and (4) manpower planning. Particular attention is placed on the Comprehensive Occupational Data Analysis Programs (CODAP) originally developed by the Air Force as it is applied in the Navy civilian Models for Organization Design and Staffing (MODS) system.