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ABSTRACT

A procedure for using Guilford's structure of the intellect as the theoretical basis for a task analysis model is presented. It is reasoned that such a model would furnish a bridge between task analysis and test selection, and also a bridge between test selection and test validation. Such a mechanism might answer some of the Equal Employment Opportunity Commission (EEOC) criticisms of psychological testing because of the inherent content validity of the technique. In addition, the technique could be used to produce task analyses of both a job and training for that job. A comparison of the structural task analyses of the job and job training would expose discrepancies where abilities not required on the job are required for training. It might be then possible to modify training to bring the abilities required for training more in line with those required for the job, thus ultimately providing a bridge between task analysis through selection to training. (Author/RC)

# BRIDGING TASK ANALYSIS, SELECTION, TRAINING AND JOB PERFORMANCE-- STRUCTURAL TASK ANALYSIS

James W. Dees

Task analysis, task taxonomy, personnel selection, and the study of intelligence factors are all closely related. Good job descriptions are based on good task analysis and are helpful in choosing tests for personnel selection. The study of intellectual factors has very strong implications for the design of psychological tests for personnel selection. I believe that these four areas can be unified by a single system which will allow immediate translation from a task analysis based upon task taxonomy to the choice of personnel selection tests and to the intellectual requirements of the job. It would then be possible to redesign jobs and the training for those jobs in order to make the intellectual requirements consistent with the intellectual capabilities of the population of humans available to perform the jobs. I propose that this can be done by modifying a component theory of intelligence and reversing the order in which it is used in order to produce a task analysis technique in which the task is described primarily in terms of the intellectual components which it requires rather than in terms of the actions which are taken.

Paul Fitts (1961) presaged this when he said that "...a taxonomy should identify important correlates of learning rate, performance level, and individual differences." He emphasized the need for a taxonomy of processes and activities rather than of static elements. Describing the task in terms of its intellectual components is certainly a description in terms of processes and activities. Melton (1967) emphasized the need for a unifying theory in these areas in his statement that it was not enough to know only certain empirical relationships. Isolated empirical relationships are not normally generalizeable unless they are related to a unifying theory (Melton, 1967). Similarly, Miller emphasized the system's requirement of a taxonomy. He stated that the terms used in a taxonomy must be formally related to each other by explicit principles of inclusion and exclusion (Miller, 1962). A task analysis system based upon structured intellectual components would satisfy Miller's requirements. Fleishman and Stephenson (1970) delineated three different task taxonomic approaches:

1. the ability requirement approach,

2. the task characteristic approach, and

3. the system's language approach.

A task taxonomic approach based upon structural components of intelligence would look simultaneously at all three methods.

Several task taxonomic systems have already been developed. For example, Stolurow (1964) investigated several dimensions of task classifications. These dimensions have stimulated considerable research of value, but have not led to the design of a comprehensive task classification scheme. Gagne and Paradise (1961) developed an empirically derived hierarchy of learning sets for a specific type of mathematical task. While the learning sets themselves do not compose a task taxonomic system, they hint at the possible existence of such a system based upon the intellectual requirements which the job imposes. In fact, the learning sets identified were very similar to the elements in both Guilford's structure of the intellect and Cattell's intelligence and personality factors. Gagne further refined his thinking, and by 1965 had classified all types of learning into eight general categories: signal, stimulus response, chaining, verbal associates, multiple discrimination, concept, principle, and problem solving (Gagne, 1965). This is a very useful set of descriptors for educators, and has proven itself very valuable in the design of curricula. However, its scope is inadequate for use as a task taxonomic system. Bloom's taxonomy of educational objectives is similarly useful in the design of educational curricula (Bloom, 1956). However, a task analysis based upon this taxonomy would not result in an abstraction of task which would allow a mathematically meaningful comparison across different jobs.

In order to be maximally useful, the task taxonomic system must not only be a classification scheme, but must also bridge the boundary between the requirements of the job and the description of the man. In short, the task taxonomic system should be expressed in the language of the human ability system. Therefore, the current efforts in the field of intelligence testing are directly relevant to task taxonomy and task analysis. At present, there is a significant debate in the literature as to the validity of intellectual component systems as opposed to single factor systems. There is also debate among multifactor proponents as to the number of factors involved. I personally am not sure as to how this conflict will be resolved. However, the primary virtue of a theory is not whether or not it is true, but whether or not it is useful and produces valid results. The structure of the intellect as defined by J. P. Guilford has been attacked from many quarters as being an overextrapolation and an improper use of factor analysis. For example, Eysenck (1973) says "Guilford's scheme has been widely accepted because of its neatness and because of the tremendous amount of empirical work that has gone into it. It is unfortunate that it is not really acceptable on psychometric grounds." Eysenck's criticism of Guilford's work may ultimately prove correct. However, the complexity and diversity of Guilford's system offers the best available base for beginning the development of a structural task analysis system. It may be that much of Guilford's system is modified in the process. However, in the development of a new applied system, it is probably easier to eliminate and consolidate erroneous and duplicating categories than it is to hypothesize and validate new categories. For this reason, I propose to use Guilford's structure of the intellect as the starting basis for the development of a structural task analysis system.

AN OUTLINE OF THE STRUCTURAL TASK ANALYSIS SYSTEM

Slide 1 in Appendix 2 of the handout presents the familiar Guilford model of the structure of the intellect. Here you see the three dimensions: operations, products, and content. Each of these divisions is further divided into subdivisions. The combination of various subdivisions from each of the three dimensions produces a total of 120 separate elements within the design. Not all of these elements have been identified empirically (Guilford, 1968). In addition, the tests developed in attempts to measure individual elements of the structure have failed to achieve a zero correlation with one another (Dees, 1972). Nonetheless, where the structure may have failed in theory, it has succeeded in practice. In a study by Dees (1972), 36 separate Guilford elements were tested and correlated against three different criteria. The three criteria were:

1. ability to shoot the M-16 rifle,

2. the peer rankings of students in Infantry Officer Candidate School (OCS), and

3. whether or not an OCS student completed the course.

In each case, the contribution of each of the individual tests was quite small, but the intercorrelations between the tests were also low and the resulting multiple correlations with the three criteria were relatively high: .44, .41, and .86, respectively, after correction for shrinkage. This is the sort of situation which would be expected using a large number of fairly independent measures, each of which makes a small but relatively independent contribution to the prediction of a complex skill. In short, although Guilford's theory may not be all that Guilford claims it to be, it can be used to insure heterogeneity of test material in a multivariate format. This approach to structural task analysis assumes only that Guilford's work has provided a panoramic presentation of intellectual skills and tests for those skills. While I am not assuming that Guilford's system is theoretically correct, I am saying that the Guilford system may ultimately be of more practical usefulness because of its heterogeneity and comprehensiveness than another theory which might more closely parallel the abstract qualities of man's intellect.

Guilford and Hoepfner (1963) have defined each of the subdivisions of his structure of the intellect. Many of these definitions require modification in order to be applicable to a task analysis situation. A first cut at these redefinitions is furnished in Appendix 1 to the handout of this paper. Structural task analysis then differs from traditional task analysis in the nature of its descriptors. In traditional task analysis, it is the job itself that is being described. In structural task analysis, the job will be described traditionally for identification purposes, but the heart of the system will be a description of the intellectual requirements for each job component based upon a modification of Guilford's structure of the intellect.

## USES OF THE SYSTEM

There are two ways in which the results of a structural task analysis can be used. First, separate tests can be constructed for a wide variety of jobs. The tests would contain items representing the intellectual elements identified in the structural task analysis, and would contain them in proportion to their relative importance. Second, a single massive testing program could be developed which would identify an individual's entire spectrum of capabilities and would enable that individual to be provided with a listing of all of the jobs for which he has untrained capability. Furthermore, the listing could provide this information in the order of descending capabilities. The individual would then be selected according to his capabilities in all of the ability areas important for a job with the weighting of those areas identical to the weighting of the importance of the job itself. In short, this would be an improved version of the classification battery where the tests administered should have predictive capabilities for virtually every imaginable job.

In order to develop and prove this system, it must be used and validated traditionally on a complex and well-defined job. The job must be complex so that a wide variety of intellectual elements can be examined. It must be well defined in order to reduce error variation due to disagreement as to the nature of the job. It must be validated traditionally in order to demonstrate its consistency with conservative statistical methodology. However, once validated using traditional methodology, this technique would be applicable to jobs which heretofore have defied traditional criterion validation. It should be possible to identify the intellectual elements required by a given job whether or not the criteria of good job performance can be measured quantitatively. Thus, it should be possible to apply this technique to management positions where criteria of performance are qualitative, and to combat positions where the obtaining of criteria of performance can be dangerous. In most systems, the analysis of the task, the selection of the test instrument, and the validation of the test instrument are separate steps. Once structural task analysis has been validated, all three of these steps will then be woven into one process.

## PERSONNEL POLICY CONSIDERATIONS

No treatment of intelligence testing or personnel selection is complete without a consideration of the interaction of those issues with the current personnel policy decisions of the Federal Government and its courts. The Equal Employment Opportunity Act of 1972 is the legal basis for court requirements that businesses across the nation validate their selection instruments. All military services are currently under the scrutiny of Congress to observe personnel selection and allocation programs at least as equitable as those observed by civilian organizations. The Equal Employment Opportunity Commission (EEOC) created by the 1964 Civil Rights Act is charged with the responsibility of administering the law. In order to do this, it has developed a series of informal publications known as guidelines. While these guidelines do not have the force of the law, they are an interpretation of the law which the courts and Congress have in the past tended to uphold. The publications most pertinent to employment are:

1. *Guidelines on Employment Testing Procedures* published in 1966,

2. *Guidelines on Employee Selection Procedures* published in 1970,

3. *Guidelines on Discrimination Because of Sex* published in 1972.

Of these, the most important is the *Guidelines on Employee Selection Procedures*.

Section 1607.2 of the selection procedures guidelines defines what is meant by a test. This definition includes any paper and pencil or performance measure used as a basis for any employment decision. Thus, according to the EEOC there is no employment selection device of any sort which is exempt from the law. Any personnel selection program developed by the proposed program would eventually be examined to determine its conformance with the requirements of the law.

In Section 1607.4 the employer is required to have available for inspection evidence that the tests do not discriminate in violation of Section 1607.3. Where differential rejection rates for minority and nonminority candidates are in evidence, the employer must: (1) provide evidence of the test's validity, and (2) provide differential validity for the minority groups where it is possible.

The requirement for differential validity has led to a great deal of discussion. One set of research indicates that there is no such thing as differential validity. This view holds that while there may be differences in the mean predicted performance of various racio/ethnic groups, these differences in predicted performance are borne out by differences in actual job performance. Another group of researchers have found contradictory evidence indicating that racio/ethnic group differences in actual job performance are not validly indicated by racio/ethnic group differences in test prediction of that job performance.

Differential validity is a sticky question for two reasons. First, it is extremely expensive. Second, many people have an emotional negative reaction to any system that would allow members of one racio/ethnic group to be hired with a given selection test score, while requiring a higher selection test score for members of another racio/ethnic group.

The test selection technique proposed for this effort will not eliminate all of the cross cultural differences in test sophistication which in part account for the requirement for differential validity. However, if successful, this system will define objectively and systematically what the job requirements are. Further, these job requirements will be defined in a language which will permit their mathematical manipulation and comparison across very different jobs. This in itself is not a cure for the current alleged discriminatory practice in personnel selection testing. However, it is an avenue of approach to the problem.

## IMPLICATIONS FOR TRAINING

Structural task analysis defines the job in terms of its intellectual requirements rather than the task per se. The descriptors used in structural task analysis also translate immediately into requirements for tests for that job. At the same time, the manner in which the analysis is conducted and the manner in which the tests are selected is intrinsically a form of content and construct validation. Thus, structural task analysis is simultaneously a bridge between task analysis and test selection, and a bridge between test selection and validity.

The selection of the best available people for a given job is itself a significant contribution to training. However, structural task analysis can ultimately be of much greater value in training. How often have you heard someone say that a given student would be an excellent pilot if he could just get through training, or that "This fellow may have graduated with honors from college but he doesn't know anything about the business." One of the implications of such statements is that the requirements for the completion of the training program are not consistent with the requirements for the job. This is not unusual, and in some cases it is unavoidable. The learning of material often places ability requirements on an individual which the application of that material in a job setting does not. However, the learning requirements placed upon the student are often a function not so much of the material which must be learned, but of the method of material presentation. Ideally, the training for a job should require abilities as close to the ability requirements of the job as possible. To the extent t aining deviates from this, students will be failed who could do the job well and will be passed who will fail on the job. Structural task analysis of the job can delineate the ability requirements of the job. Structural task analysis of the training program can delineate the ability requirements for the program. Discrepancies between the two analyses can be noted, and the training program can be changed in order to reduce these discrepancies.

## SUMMARY

Structural task analysis, by furnishing bridges between task analysis, test selection, test validation, and training can furnish a unifying theory with which many improvements in all of these areas can be achieved. Such improvements should reduce the inequity in job assignments among different ethnic groups. It should also provide a means for developing selection batteries for jobs whose criteria of performance are qualitative, dangerous, or otherwise difficult to measure. In addition, it should provide a means for improving the training for various jobs by decreasing the discrepancy between the ability requirements of training and the ability requirements of the job.

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APPENDIX 1

## REDEFINITIONS OF GUILFORD'S ELEMENTS OF THE INTELLECT FOR TASK ANALYSIS

### Operations

Cognition: A cognition is a discovery, a rediscovery, or a recognition. In short, it is the perception of the existence of something. Quite often a cognition is the first intellectual step in a series required for problem solution. As such, it is a "perception" as compared to a "sensation." The important point is not that a stimulus impinges upon the individual, but rather that the individual perceives the stimulus even though it may be camouflaged by many other stimuli and recognizes its importance.

Memory: The memory classification is used for the commission of memory only. It is not used for the retrieval of information from memory even though the success or failure of the commission is not known until retrieval is required.

Divergent Production: Divergent production is tantamount to inductive logic. Whenever one generalizes from the specific case to the general rule, divergent production or inductive reasoning is taking place.

Convergent Production: Convergent production is tantamount to deductive logic. That is, whenever one is reasoning from the general rule to the specific application, convergent production or deductive reasoning is occurring.

Evaluation: Evaluation is the qualitative or quantitative judgment as to the suitability, goodness, correctness, or adequacy of what we know, remember, or produce intellectually.

### Content

Figural: Figural content is concrete material such as is perceived through the senses. It does not represent anything except itself. Visual material has properties such as size, form, color, location, or texture. Things we hear or feel provide other examples of figural material.

Symbolic: Symbolic content is composed of letters, digits, and other conventional signs usually organized in general systems such as the alphabet or the number system.

Semantic: Semantic content is in the form of verbal meanings or ideas.

### Products

Unit: A unit is an isolated element of information which has importance in and of itself. It may or may not be associated with a higher order system or class or relation. The important point is that in the intellectual process it is the unit that is created not a class of units or a relationship between units or a system of units.

Class: The production of a class occurs when two or more concepts are identified as belonging in the same category because of shared characteristics. For example, a baseball, a football, and basketball might all be classed as game equipment.

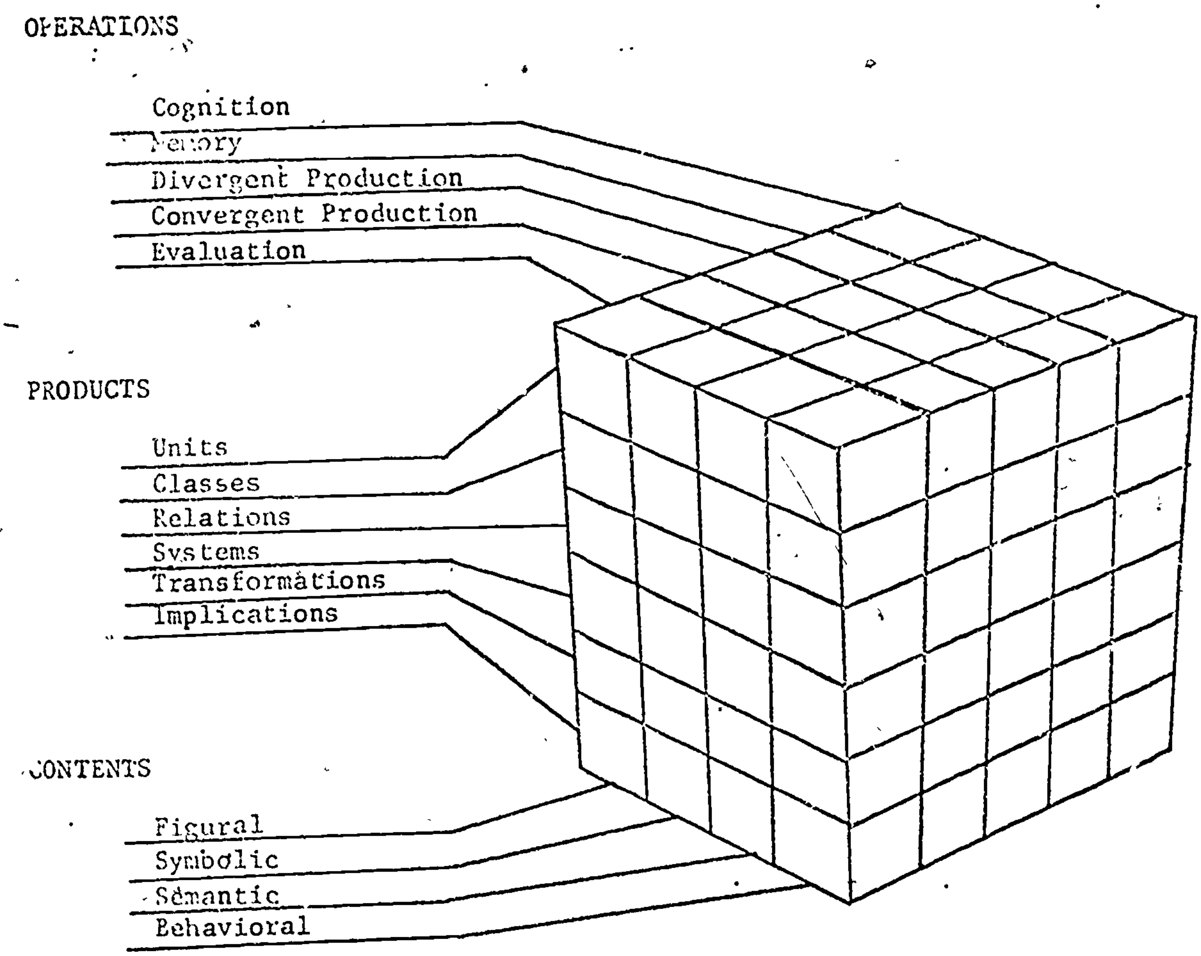
Relation: The production of a relation is similar to the production of a class in that it is based upon shared characteristics. However, the shared characteristics rather than being used to place two or more concepts in a single category are used to establish a relationship between two or more concepts. For example, it might be noted that multi-engine aircraft tend to be larger in volume and weight than single-engine aircraft. Thus, a relationship could be established between the number of engines an aircraft has and the probable size and weight of that aircraft.

System: A system is similar to a relation in that it is based upon the establishment of certain relationships. However, in a system the concepts are abstracted so that they apply to a greater population of situations. For example, instead of stopping at the relationship between the number of engines and the size of the aircraft, the relationship of these factors to the principles of lift and thrust might have been made. If this step had been taken, instead of a mere relationship between number of engines and size of aircraft, a system would have been established relating the size of the aircraft to its power requirements.

Transformation: A transformation is produced when the set or context of the information is changed. For example, a screwdriver may be used as a lever, or a double entendre is achieved with one wording.

Implication: An implication is an extrapolation of information to a probable end result or effect.

APPENDIX 2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