

Methodologies, Objectives, and Issues Involved in Identifying Occupational Clusters Using Skills-Based Data

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20 April, 1994

Submitted to:

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The author accepts all responsibility for the accuracy of the contents of this paper, and for all opinions that are expressed. There should be no presumption that these views are shared by anyone affiliated with the sponsoring agency, the US Department of Labor.

Table of Contents

	Page
Executive Summary	ii
A. Purpose and Background	1
B. Findings and Implications	3
C. References	16

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Executive Summary

1. Objectives

The stated goal to be addressed in this paper was to answer two main questions: (a) what kind of “occupational/skill clusters” would be expected to result when such clusters are formed by clustering occupations or job families using a criterion of *commonality of worker skills* required to perform each occupation; and (b) what kinds of statistical and data-collection methodologies might be useful in constructing such occupation/skill clusters? These questions are of fundamental importance to efforts that are being funded by the Departments of Labor and Education in order to develop voluntary national skills standards that can be used when selecting, placing, training, and otherwise managing the high-performance workforce of the future.

2. Methodology

The two major questions described above were addressed by responding to each of the 17 specific questions that were posed by the January 1994 *Developing Occupational/Skill Clusters* document. These questions were addressed individually, and summary recommendations and conclusions were then drawn.

3. Findings and Implications

The two major questions described above were addressed by responding to each of the 17 specific questions that were posed by the January 1994 *Developing Occupational/Skill Clusters* document. In the interests of conciseness, these have been summarized into a smaller number of questions.

- (a) Regarding any attempts to develop skills-based occupational clusters, definitional issues were a concern. The following points were made:
 - (i) The task of clearly defining terms like “skills,” “competencies,” “abilities,” “cross-functional skills,” and “occupation-specific skills” is not a trivial one, and problems similar to those seen in recent efforts to revise the *Dictionary of Occupational Titles* (DOT) will likely be encountered.
 - (ii) The most serious definitional issue concerns the difference between “skills” defined at a relatively specific level (e.g., the capacity of the worker to perform

individual job tasks/duties) versus a more behaviorally abstract level (e.g., the cognitive, psychomotor, and physical *abilities* required for successful job performance). It is fundamentally important to distinguish between specific skills (and their associated knowledge requirements) versus abstract ability traits, as this distinction has important implications for the ways in which data on such characteristics are measured, validated, and used.

- (iii) Should knowledge-based requirements of occupations be included in the data used to derive skills-based occupational clusters? Clearly, it would be difficult -- and probably highly undesirable -- to attempt to separate knowledge-based requirements from skills-based requirements of occupations. If knowledge-based requirements are to be used when deriving occupational/skill clusters -- and I recommend that they should be -- it is fundamentally important to distinguish between specific- (e.g., knowledge required to balance a checking account) versus abstract knowledge requirements (e.g., general knowledge of accounting principles and theories), for the same reasons described above.
- (b) Regarding the conceptual and practical issues involved in developing skills-based occupational clusters, the following points, issues, recommendations, and conclusions were offered:
- (i) Very different kinds of occupational/skill clusters will be produced when specific versus abstract skill/knowledge data are used to form the groupings, and it is impossible to say in the abstract which kind of clustering scheme would be preferred. In short, different kinds of clusters would be preferred in different kinds of situations.
 - (ii) In general, as the degree of abstraction of the skill/knowledge data used to describe the jobs/occupations increases, we would expect increasingly abstract and heterogeneous (i.e., at the level of specific job behaviors) clusters to result. Using highly abstract skill/ability data as input to the clustering procedures would also be expected to produce a smaller number of occupational/skill clusters, all other factors being held constant.
 - (iii) Conversely, using more specific skill/knowledge data as input to the occupational clustering analyses should yield more specific, less behaviorally heterogeneous occupational/skill clusters. Likewise, as skills specificity increases, a larger number of occupational clusters would be expected to result.
 - (iv) Although developing a clustering system that contains only a relatively small number of highly abstract occupational/skill clusters might be desirable for some purposes (e.g., generalizing selection-test validities for abstract worker-ability tests), they would be highly undesirable for other functions (e.g., developing and validating work-sample based selection tests, developing curricula for specific worker retraining programs). Data describing both the abstract and specific skill, ability, and knowledge requirements of occupations will be needed when forming a new system of skills-based occupational clusters; additionally, users of such information should have the choice of specifying which *kind* of information (i.e., abstract abilities versus specific work skills/knowledge) would be used in each specific situation when forming clusters.

- (v) From a measurement standpoint, it is increasingly difficult to collect reliable and valid data as the degree of abstraction of the rated occupational skill/knowledge items increases. As research experience with the abstract worker-trait rating scales used to collect data for the existing DOT has indicated, it is very difficult to collect adequately *reliable* ratings of highly abstract worker skill/ability requirements, and there is very little evidence to support the *validity* or *accuracy* of such ratings. Although in some situations it will certainly be desirable to be able to cluster occupations using highly abstract worker-trait requirements, the methodologies that have in the past been used to collect such data (e.g., single-item holistic rating scales) are extremely suspect. In short, if abstract worker ability-trait data are to be used to form occupational/skill clusters, I strongly recommend developing alternative means for collecting such data (e.g., using synthetic validation methods to estimate the abstract worker-trait requirements of occupations based on ratings of more easily verifiable work activities, skills, and other characteristics).
- (vi) It is critical that a *comprehensive* taxonomy of skills-based occupational clusters be derived that will be applicable to the entire US economy. Ideally, this new classification system should be *flexible*, allowing users of such information to adapt it to suit their needs (especially, with respect to the issue of whether they prefer to use occupational clusters based on abstract ability-based versus more specific skills-based data). For precisely the same reason that the new DOT should allow users to generate flexible occupational classification structures, the skills/ability/knowledge database to be used to generate occupational/skill clusters must allow similar flexibility. Clearly, a single, highly abstract, rigid skills-based taxonomy of occupations will not be adequate to the task.
- (vii) Regarding the suitability of the ACT's Worker Activities Survey (WAS) -- developed as part of the National Job Analysis Study (NJAS) -- to serve as the database "engine" that drives the development of skills-based occupational clusters, it is my assessment that it suffers from a number of serious limitations, including (a) it is composed of very few items, which questions its content-coverage adequacy; (b) its items represent an unusual mixture of work- and worker-oriented content, and (c) it was developed in a "bottom up" fashion that does not appear to build upon the extensive measurement literature regarding the underlying *dimensions* of work activity measured by existing occupational analysis inventories. It is my assessment that using the ACT's instrument as the basis for deriving skill-based occupational clusters for the US economy would actually be counterproductive in the short and long run.
- (viii) Efforts to implement the concept of occupational/skills clusters should be closely integrated with the planned revision of the DOT, and linked closely to the new DOT database. The *Content Model* proposed for the new DOT (e.g., APDOT *Final Report*, 1993) calls for it to contain precisely the kinds of abstract and specific skill/ability/knowledge requirements that will be required to produce skills-based occupational clusters. The data-collection methodologies that have been used in the various projects (e.g., the ACT's NJAS) that are attempting to set voluntary skills-standards in different industries will likely *not* produce the kind of coherent, comprehensive, and psychometrically defensible database of skill/ability/knowledge information that will be needed to implement the

occupational/skill clusters concept. The new DOT database should be an integral part of any efforts to develop skills-based occupational clusters.

- (ix) From a legal-defensibility standpoint, the distinction between *occupational level* versus *job level* information is critical. As the APDOT *Final Report* regarding the planned revision of the DOT made clear, aggregate information collected at the level of *occupations* or *occupational clusters* cannot automatically be presumed to be valid and accurate with respect to describing the requirements of a specific *job* in a specific organization. Unavoidably, given the differences in unit-of-analysis, each organization that attempts to use occupation- or occupational cluster-level data will need to verify (e.g., via on-site job analysis) that the economy-wide aggregate data are indeed an accurate description of the work performed in their jobs in their organization. This poses an obvious -- and significant -- potential limitation on the usefulness of such information to individual employers.
- (x) Regarding the taxonomic/computational procedures to be used to form the new occupation/skill clusters, the most fundamental question concerns the choice of *overlapping* versus *nonoverlapping* cluster structures. Although arguments in support of the traditional nonoverlapping clusters view can be made, the major drawback of all such systems is that they are not *flexible* or sensitive to the *purpose* for which the occupations are being grouped. It is suggested that the feasibility of adopting an overlapping cluster model should be investigated.

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A. Purpose and Background

1. Report Objectives

Recently, various branches of the US Government -- in particular, the Departments of Labor and Education -- have expended a great deal of time and effort toward the goal of improving the ways in which occupational information may be collected and used to improve the performance of the US workforce. One focus of these efforts has been to revise the *Dictionary of Occupational Titles* (DOT) in order to form an on-line *Database of Occupational Titles* that would make the collection, management, and dissemination of occupational information much more efficient and useful than is possible using the current paper-based DOT and its complex DOT-code occupational classification system.

Pursuant to the objectives contained in the Goals 2000: Educate America Act, a second general focus has been the identification of broad, skills-based clusters of major occupations and the development of procedures for setting voluntary skills standards for such occupational clusters. This desire to focus on more broadly based occupational clusters has been driven by the fact that (a) the number of discrete occupational titles present in the US economy is quite large (over 12,000 are contained in the current DOT), and (b) many occupations are changing technologically at a very fast rate. These two factors combine to make it economically unfeasible to attempt to develop and maintain skills standards (e.g., for education, training, and certification purposes) for each of the thousands of individual occupational titles in the economy.

The objective of this paper was to address two questions that have arisen with respect to the goal of identifying abstract clusters of occupations for skills-related purposes. Specifically, (a) what kinds of "occupational/skill clusters" would be expected to result when occupations are clustered using a criterion of *commonality of worker skills* required to perform each occupation; and (b) what kinds of issues and problems might arise when constructing such occupational/skill clusters?

Regarding the first question, the goal of producing clusters of occupations based on their similarity in required worker-skill requirements -- instead of the more traditional method of clustering occupations based on their similarity in overt work tasks/duties or work products -- might be expected to produce qualitatively different kinds of occupational clusters. Whether or not these clusters would be optimal for the purpose of setting occupational skills-standards that could be used in training, education, selection, and placement is an important question that must be addressed before investing resources in the actual process of forming such clusters.

Regarding the second question, a variety of practical, technical, and legal issues must be considered before adopting a skills-based occupational clustering system. That is, depending on how broadly the term “skills-based” clustering is defined, a number of the same difficulties and pitfalls that have been experienced in other occupational analysis programs (e.g., the DOT) might apply equally strongly to such efforts.

2. Methodology to be Used

The two major questions described above were addressed by answering each of the 17 questions that were posed by the January 1994 *Developing Occupational/Skill Clusters* document. In answering these questions, I focused on the following general issues: (a) the terminology that is used (outlining potential problems that may be caused by imprecision in this area), (b) the ways in which the goal of developing occupational clusters based on skill requirements differs at a *conceptual* level from the more traditional method of developing clusters based on behavioral similarity, and (c) the technological, methodological, and legal issues that might arise when skill-based occupational clusters are formed.

B. Findings and Implications

The January 1994 *Developing Occupational/Skill Clusters* document that was supplied to us to guide the selection of issues addressed in this report contained a number of specific questions that have arisen regarding the proposal to develop skill-based occupational clusters. Each of those questions are addressed below; to identify each, the page number from the *Developing Occupational/Skill Clusters* document on which the question occurred is listed as well. Before addressing these questions, however, I must first define the terminology that will be used in this report. Wherever possible, the terminology used in the APDOT (1993) *Final Report* on the revision of the DOT will be used; this is based on the DOL "Content Model" used to structure the planned DOT revision.

My primary point of terminological clarification concerns the definition of the terms "skills," "knowledge," "abilities," and "skills-based occupational clusters." Specifically, the Worker Attributes section of the Content Model correctly differentiates between a number of different kinds of worker characteristics, ranging from very specific and behavioral (e.g., "occupation-specific skills and knowledges") to the very abstract (e.g., "aptitudes and abilities"). Unfortunately, there is a strong tendency to simply lump all of these different kinds of worker attributes into a single category termed "skills," which causes potentially very serious problems. In this report, I will attempt to distinguish between *specific skill/knowledge* requirements versus *abstract worker attribute* requirements; the former are what I/O psychologists have traditionally termed "knowledge and skill" (KS) requirements, whereas the latter are termed "ability and other" (AO) requirements (see Harvey, 1991a, pp. 73-78).

It is similarly important to distinguish between the different kinds of *work activity* that might be rated and used to form occupational/skill clusters; the critical distinction here being between (a) *task/duty* content (i.e., very behaviorally specific work activities, such as those included in task inventories and the narratives in the current DOT); (b) *general work activities and "other" characteristics* (GWAOs), which are more abstract than tasks but still descriptive of observable/verifiable work activity (e.g., the "generalized work activities" discussed in the Content Model, and the "worker-oriented" items contained in standardized job analysis questionnaires like the Common Metric Questionnaire [CMQ] of Harvey, 1991b); and (c) *work dimensions*, which are the most highly abstract kinds of descriptors used (these are typically obtained by combining a large number of GWAO-level items to form a scale score; e.g., "Skilled Machine Operation," "Managerial Decision Making," "External Contacts").

The primary importance of clearly differentiating between abstract versus specific worker attributes, and between abstract versus specific work activities, is that very different *measurement* and *inference* processes are required to collect such data. Figure 1 summarizes these various kinds of information, and shows the ways in which such data may be interrelated. The critical point is one of *accuracy* and *verifiability*: that is, which kinds of information can be reliably and validly rated *directly* by occupational analysts or job incumbents? As I have argued in a number of other documents (e.g., Harvey, 1991a), the more specific, observable kinds of activities (e.g., GWAOs, tasks/duties) can be rated directly, whereas the more abstract, non-observable constructs (e.g., worker abilities, work dimension scores) must be *inferred* based on ratings of more observable entities.

For example, as Figure 1 illustrates, based on knowledge of an occupation's GWAO profile, task and duty statements can be written to more specifically describe the work activities,

outcomes, and working conditions involved. Once this information is available, specific skill and knowledge requirements can be inferred with little or no difficulty based on the knowledge of the tasks, duties, and GWAOs performed. Conversely, highly abstract worker-ability requirements of occupations or occupational clusters can be inferred (using either statistical or “rational” methods) based on knowledge of the abstract work dimensions that characterize the occupation. Because of these fundamental differences in measurement technology and behavioral abstraction/observability, in this report I will use the term “specific skills” to refer to the specific knowledge and skill requirements that can be directly linked to job analysis data (i.e., tasks, duties, and GWAOs); the term “abstract skills” will be used to describe the more general worker traits, abilities, temperaments, and other qualities that cannot be directly linked to specific occupational behaviors.

1. What should be the relation between the occupational/skill clusters and the occupational analysis system that will replace the DOT (p. 3)?

Based on even a casual inspection of the very comprehensive kinds of information described in the Content Model -- most if not all of which will be included in the upcoming revised DOT -- it is immediately clear that there must be a very close linkage between the new DOT and efforts to develop skill-based occupational clusters. That is, regardless of whether one decides to derive occupational/skill clusters by clustering occupations based on their similarity in specific skills versus abstract abilities, *all of those data will already be contained in the new DOT*, and therefore there is no need to “reinvent the wheel” and develop a parallel -- and likely incompatible -- system for describing occupations and occupational clusters based on their skill/knowledge/ability requirements.

As the APDOT report made clear, a great deal of difficulty has already been caused by virtue of the fact that different agencies of the government have developed different data collection methodologies and occupational classification systems (e.g., DOT, OES, SOC, Census-codes) that are not based on a “common metric” for viewing and describing work. Clearly, the new DOT will define that common-metric, and it must be used when developing occupational/skill clusters. As will be discussed later, I am quite concerned that the data collection efforts (e.g., ACT’s) that are being conducted to set voluntary skills-standards and develop occupational clusters will diverge strongly from the direction that will be taken in the new DOT; this would obviously exacerbate the already extremely complicated situation that exists when attempting to link these various ways for viewing work and occupations. As I discuss below, the solution to this problem is *not* to adopt the ACT methodology and questionnaires for the upcoming revision of the DOT; instead, current pilot efforts to develop industry skills-standards should be integrated with the new DOT, and made to conform to the more comprehensive database structure defined by the Content Model.

2. Does the purpose for which the skill standards are being developed have an impact on the occupational/skill clusters themselves? That is, will clusters differ depending on whether the skill standards are to be used for counseling, training, or placement (p. 3)?

Without doubt, the answer is an emphatic *yes* to both questions. As past job and occupational classification research has demonstrated, the kind of job analysis data used as input to job/occupational cluster grouping analyses can exert a profound effect on the resulting clusters. As might be expected, more behaviorally abstract data produce more abstract and nebulous clusters. Likewise, the practice of using more abstract data as input is likely to lead to a smaller *number* of output clusters, and to the situation in which the clusters demonstrate high levels of *within cluster* variability in actual job behaviors.

For example, the Hunter (1980) study grouped over 12,000 occupations using the highly abstract Data/People ratings from the DOT, and produced *only five occupational clusters* as output! It is self-evident that within each of these mega-clusters of occupations there is a tremendous degree of variability in actual work activities, even in terms of the more abstract skill, knowledge, and ability requirements for the occupations contained in each cluster. The critical issue to be addressed when considering methods to develop skill-based occupational clusters is matching the *degree of specificity* of the job-descriptive data to the *purpose* for deriving the occupational clusters. Different purposes for clustering occupations will demand much more specific kinds of information than others, and these more specific purposes will unavoidably require different (and more numerous) occupational clusters as a result.

For example, one purpose for developing clusters of occupations might be to identify those that share similarity in terms of specific kinds of worker skills, the goal being to define career paths for workers who are already highly trained, and *who do not desire extensive (and expensive) retraining* prior to moving to a new occupation (e.g., for outplacement or downsizing purposes). In such a case, the meta-clusters of occupations produced by using highly abstract work-descriptor profiles (e.g., Hunter, 1980) would be totally unsuitable. For such purposes, each occupation to be clustered would need to be described in terms of a much more specific profile of activities (e.g., GWAOs, specific knowledge and skill requirements). However, for other purposes (e.g., general placement of applicants based on abstract ability test scores), such meta-clusters of occupations might be very useful.

In short, the *purpose* for forming the clusters of occupations is inextricably tied to the *methods* that would be used to actually cluster occupations; the degree of behavioral specificity in the occupational descriptor items is perhaps the most critical factor that must be considered. For these reasons, it is self-evident that a *single, inflexible* system for developing occupational/skill clusters will never be able to serve the broad range of functions that will be required to develop and manage the kind of high-performance workforce that America needs to excel and remain competitive into the next century.

3. What role should existing delivery systems (training, assessment, certification, etc.) play in defining the clusters?

As was noted above, the *purpose* for clustering occupations has a one-to-one correspondence with the kind of “delivery system” involved; thus, there can be no question that the kind of delivery system (e.g., training students in general workplace skills versus certification of workers in highly specific skill areas) will exert an impact on the kinds of clusters that should be formed, and the way in which those clusters should be formed.

Again, some delivery systems will require more finely-drawn occupational/skill clusters (e.g., identifying career mobility paths for highly trained and skilled employees who get “downsized”), whereas other delivery systems (e.g., determining curricula for providing disadvantaged job applicants with basic workplace skills such as literacy and numeracy) will require much more abstract views of the “world of work.” A single, inflexible system based on a single kind of occupational descriptive information will never be able to drive this multiplicity of purposes and delivery systems.

4. What existing classification systems should be examined, and what does each have to offer (p. 3)?

As I noted earlier, the efforts to revise the DOT are clearly the most important for any efforts to develop skill-based occupational clusters. As the APDOT report noted, although each of the existing occupational classification systems has some degree of merit, they each have serious drawbacks (e.g., the DOT-code system is far too detailed and anchored in a 1930’s view of work technologies, whereas the OES matrix approach might be criticized for being far too abstract for many purposes). The strengths of the DOT and SOC approaches are that they are widely used, and fairly detailed; however, the quantitative ratings of occupations contained in the existing DOT have highly questionable measurement properties (e.g., Harvey, 1992), and would likely not be of much use for that reason.

In the final analysis, one of the most important outcomes from the process to revise the DOT will be a new occupational classification system that is flexible, less cumbersome, and directly tied to a greatly expanded database of occupational information. I see no alternative but to wait until the new DOT’s classification system is developed, and to use that system as the “common metric” to guide development of a nationwide system of skills-based occupational clusters.

5. What number of occupational/skill clusters will best foster skill transferability across occupations (e.g., 10-20, 200-300) (p. 3)?

Unfortunately, this question has no answer. First, as was noted above, the number of clusters that will be “best” will *depend on the purpose for clustering occupations*. More specific purposes (e.g., advanced training and certification) will demand systems with far more clusters than more abstract purposes (e.g., developing minimal levels of competency in basic work skills such as literacy, or placing minimally-qualified workers in entry-level occupations). Even focusing on the question of “skill transferability” across occupations, it can be seen that this is *not* a single “purpose” for clustering. That is, depending on the *kinds* of “skills” that one seeks to transfer (e.g., highly specific technical skills in operating computer-controlled manufacturing machines, versus highly abstract skills/traits/abilities such as “managing employees” or “resolving conflicts”), very different kinds of occupational clustering systems would be required.

Second, the number of clusters cannot be determined in advance, even if a specific purpose for clustering occupations for skills-transferability reasons is stated. Unless one

is prepared to develop a totally “rational,” non-empirically based system of occupational clusters -- which I consider to be highly inadvisable, for reasons discussed below (not the least of which being the legal and professional defensibility of the system) -- the answer to the question of “how many clusters” can only be answered by empirical means.

6. What criteria should be used for defining the clusters (p. 3)?

As was discussed above, the criteria for defining clusters will be defined by the purpose for clustering and the associated kind(s) of occupational data that will be required to drive each purpose. In general, the criteria discussed on pp. 7-8 of the *Developing Occupational/Skill Clusters* document are certainly sound: that is, occupational clusters should demonstrate internal cohesion (i.e., similarity in the kinds of GWAOs, skills, etc. used to describe each occupation) and cross-cluster isolation (i.e., lack of profile similarity between different occupational clusters). The problem is, where do the ratings of each occupation come from? In my assessment, a centralized, current, defensible, and flexible occupational database must be used for this purpose; the new DOT -- *if properly executed* -- should be ideal for this role, as the various Worker Attribute and Work Content/Outcomes/Context portions of the Content Model already contain all of the information necessary to drive virtually any purpose for clustering occupations.

7. Should occupational clusters be developed based on worker-oriented or job-oriented traits (p. 3)?

As was discussed above, the answer to this question depends on the *kind* of purpose one has for clustering occupations. In short, for more abstract purposes in which a small number of behaviorally nebulous clusters of occupations are desired (e.g., placement of workers based on general, non-occupation-specific assessment devices), the more abstract kinds of information listed in Figure 1 (e.g., Abstract Worker Attribute requirements, Work Dimension scores) should be used. For moderately specific purposes (e.g., identifying career paths based on cross-functional skills, selection and placement using more specific assessment instruments), moderate-specificity occupational information (e.g., GWAOs) should be used. Finally, for the most specific kinds of purposes (e.g., placing highly skilled and trained workers in new occupations due to downsizing, or developing training/certification programs for relatively specific skills), the most specific kind of occupational data would be required (e.g., tasks, duties, and occupation-specific skills).

Again, it must be stressed that *there is no single occupational/skill clustering system that will be optimal -- or even minimally useful -- for all situations!* Without question, both job- and worker-oriented -- as well as skill/ability-oriented -- data must be collected and used when developing occupational clusters; the *kind* of data used will be determined entirely by the purpose to which the occupational clusters will be put.

8. Which taxonomy (in Technical Approach # 1) would best provide an appropriate springboard for identifying and developing the

occupational/skill clusters that define the “tool kit” that each American should carry into a new global economy (p. 4)?

The central idea behind the method labeled Technical Approach # 1 in the *Developing Occupational/Skill Clusters* document seems to be that taxonomies or clusterings of occupations should be derived directly from the taxonomies of *skills or abilities* that underlie the various approaches that have been developed to define and assess worker skills (e.g., SCANS, V-TECS, ASTD, NALS). That is, if a given assessment system measures 15 worker/workplace skill/ability traits, the reasoning seems to be that the occupational classification/clustering system should parallel those traits and base the clusterings of occupations based on the degree to which they require each skill. Clearly, there is an appealing quality to this logic: namely, that the process of setting minimum levels of proficiency/competence on each skill/ability is made much easier if the occupational clusters were formed so as to be homogeneous (within each cluster) in terms of these skills/abilities.

Quite frankly, I am not especially positively disposed (see later questions) toward this approach of starting with an existing taxonomy of skills/abilities, and letting this taxonomy drive all subsequent attempts to form occupational clusters. First, and most directly related to the question, it is obvious that different taxonomies of skills/abilities are to some degree different from one another, which makes the question of deciding which one is “best” problematic. Perhaps the best answer would be to say that none of these existing approaches is “best,” and that what should happen is for a consensus or integration across all such systems to occur; this unified structure would have the best hope of being comprehensive and useful for the purpose of forming occupational clusters.

Second, and of perhaps greater concern, once a domain of skills/abilities is defined, it will unavoidably limit the kinds of occupational clusters that can result. As I discussed earlier, the *kind* of data used to describe each occupation will exert a very strong influence on the *number* and *makeup* of the occupational clusters that are produced. Thus, depending on the kinds of skills/abilities included, and the degree to which they tend to be abstract versus specific, very different occupational clusterings will result.

In short, I do not think that the skills taxonomies that have been developed to date are adequate to the task of driving the development of skills-based occupational clusters, nor do I think that this approach is the most productive one to follow. Only if a *hierarchical* taxonomy of skills were developed (i.e., containing a comprehensive description of all possible knowledge, skills, and ability ranging from very specific through very abstract) would this approach be reasonable; however, even if such a hierarchy were developed, it would still leave the question of *assessing* each occupation in terms of each skill unanswered. Again, there is no point in “reinventing the wheel” with respect to developing a massive assessment system to collect skill, knowledge, activity, and ability requirements of occupations; the new DOT database is supposed to contain all such information, and that should be the source that is used to drive the development of skills-based occupational clusters.

9. Given the establishment of an appropriate taxonomy, what levels of proficiencies are needed if the US is to exceed the standards set by her principal foreign competitors (p. 4)?

This question assumes that the skill-taxonomy driven logic contained in Technical Approach # 1 would be followed; unfortunately, even if one agrees that this approach should be followed, this question does not have a single answer. In short, even if one focuses on a single occupational/skill cluster defined in terms of a given skills-taxonomic approach, it should immediately be apparent that (a) the various occupations contained within that cluster will to some degree differ in terms of the degree to which each skill is required (i.e., although within cluster similarity will to some degree be present, it will never be the case that all occupations within a cluster will have *identical* skill requirements, *especially* when more abstract skills/abilities are used to group occupations); and of even greater importance, (b) for each occupation in each cluster, the various *jobs* in individual organizations that perform that occupation will likewise differ in terms of the degree to which each skill/ability is present and required.

As the APDOT report made quite clear, the aggregate *occupation-level* descriptions contained in the DOT and similar databases are *abstractions* that apply to the US economy as a whole; they were *never* intended to function as accurate “job descriptions” or “worker specifications” that would apply to every *job* classified into each occupation, or to every *organization* that might contain such jobs. Although the APDOT report made this point with respect to the legal issues involved in using DOT descriptions to identify the “essential functions” of jobs for ADA-compliance purposes, the same point is equally telling with respect to using DOT -- or any other aggregate, *occupation-level* profile -- data to make a decision about an individual *job* in an individual *organization*. In short, the levels of analysis are fundamentally different, and the problems caused by within-occupational differences in work activities will be exacerbated when (a) occupational *clusters* are considered (i.e., they are even more abstract than *occupations*, which are already quite abstract), and (b) abstract worker trait/ability/skill requirements are used to form the occupational clusters (i.e., more abstract occupational descriptors will be expected to lead to higher within-cluster variability).

These factors, plus the fact that individual organizations may choose to be more versus less selective and stringent vis a vis the *levels* of each worker skill they set (e.g., in response to their stated competitive goals, or to the availability of those skills in their local labor market), combine to make it very difficult to set universal standards for every worker skill for the US, to say nothing of being able to determine skill requirements that are comparable to those set in the economies and workforces of our foreign competitors. Differences between jobs in each occupational title, and between occupations within each skill-based occupational cluster, will always be present, and they may be substantial, especially as the degree of abstraction in the “skills” used to cluster the occupations increases.

10. Several occupational analysis systems exist that use generalized work behaviors to define occupational/skill clusters: Are they appropriate for setting the framework for skill standards (p. 5)?

It depends on the specific occupational analysis system being considered; some systems might be very effective for this purpose, others would be quite questionable. In short, the critical issues are to what degree the instrument/system (a) facilitates the collection of data that are verifiable, accurate, and reliable; (b) contains items that comprehensively define the “content domain” of work activities seen in the diverse collection of occupations in the US economy; and (c) collects such information in a cost-effective fashion.

In my assessment (e.g., see Harvey, 1992, for further discussion), most of the existing “worker-oriented” occupational analysis questionnaires (e.g., the PAQ, PMPQ, JEI) are *not* well-suited for the task of collecting a large-scale database of occupational information on the US economy; their main problems are (a) psychometric difficulties with their rating scales that make meaningful cross-occupation comparisons problematic, (b) deficiencies in their content-coverage that cause them to not provide a “common metric” for describing all jobs (e.g., the PAQ is deficient with respect to describing supervisory, managerial, “service,” or professional occupations), and (c) items that are written at such a highly abstract level as to make independent verification of their ratings difficult or impossible

Of course, these problems can be addressed, and some instruments (e.g., the CMQ, which I was instrumental in developing) have made significant progress toward doing so. However, just as with the planned revision of the DOT, it is fundamentally important that the database that is used to develop skill-based clusters of occupations be *comprehensive*, describing all occupations using a “common metric” of work behavior and skill-based items. In my assessment, no existing occupational analysis system or questionnaire can solve this task without further modification.

The other alternative that might be proposed would draw upon the work of Fleishman and colleagues, who have attempted to develop instruments that *directly rate abstract worker ability-trait requirements* using holistic rating scales. This is also the approach that underlies the methods used to collect data for the existing DOT. However, as I have detailed elsewhere (e.g., Harvey, 1992), such methods suffer from extremely serious potential problems with respect to reliability (which has been highly variable, and often quite poor in the empirical studies reported to date) and validity (conclusive research on the question of validity is effectively nonexistent for such instruments).

In short, the only practical alternative I see with respect to collecting GWBs, GWAs, GWAOs, specific skill requirements, and similar kinds of occupational information is to develop a single, standardized questionnaire or data-collection system that will define a “common metric” of work and worker characteristics that will be applicable to *all occupations in the economy*. Although some existing instruments are closer to this goal than others, in my assessment no instrument currently available can yet accomplish this goal on the economy-wide scale required for either the DOT or skills-based occupational cluster system.

11. Could the database of “core” workplace competencies and skills (i.e., collected using the ACT’s “GWB” survey) define the occupational/skill clusters analogous to the “tool kit” or “certificate of mastery” (p. 5)?

As I noted above, I do not think *any* existing instrument can solve the problem of collecting the database of occupational information that will be required to develop

economy-wide, meaningful, skills-based occupational clusters; this assessment is especially true with respect to the prototype instrument that was developed by ACT (Korte, 1993).

Although I am hesitant to criticize too strongly the ACT's work on the National Job Analysis Study (NJAS), there is simply no way around the fact that the instrument developed by ACT for this study has its share of limitations and peculiarities. First, it is *extremely* short (110 items, in the version I have examined); even the shortest existing general-purpose occupational questionnaires (e.g., the JEI, with 153 items, and the PAQ, with 194) are approximately 40-75% longer than the ACT's NJAS instrument, and even by their developers' own admissions, instruments like the PAQ and JEI suffer from potentially serious content-coverage shortages. It is difficult to imagine how an instrument only 57% the length of the PAQ could (a) solve the PAQ's serious content-coverage problems, and (b) adequately describe the work performed by some 71 million workers employed in the 151 occupations chosen for study in the NJAS.

Second, the item content in the ACT's NJAS instrument (labeled the Work Activities Survey, or WAS) is unusual, given their stated goal of collecting data on "generic skills" and "general work behaviors." That is, the items in the WAS represent a very wide range of behavioral specificity, ranging from very specific items of the sort that might be seen in a task inventory (e.g., "keep order/discipline among groups of people," "prepare food according to directions," "conduct telephone surveys of potential or current customers") to relatively abstract items of the sort seen in worker-oriented questionnaires (e.g., "use a computer to analyze information," "schedule work activities for oneself," "judge the quality of a service according to standards"). Although other standardized occupational analysis instruments contain similar items, they are typically *much* longer and more comprehensive (e.g., the OAI has over 600 items, and the CMQ contains over 2,000 items). In short, these items are not especially "skills based," especially in terms of the more abstract kinds of skills that might characterize occupations. How will this linkage between task/worker-oriented ratings and skill/ability requirements be made?

Finally, the ACT's WAS instrument seems to have been developed "from the ground up" (i.e., starting with listings of tasks/duties from the DOT for its sample of occupations, and abstracting these to form its items) rather than by building on the decades-worth of research studies and instrumentation that have been produced in the area of job and occupational analysis. As I have noted in earlier reviews (Harvey, 1991a, pp. 146-155), the dimensionality of work activities has been extensively studied, and we know quite a good deal about the "domain" of general work- and worker-oriented characteristics performed on occupations. Thus, it makes little sense to me to simply ignore this prior research and "reinvent the wheel" with respect to the measuring instruments that will be used to collect the data needed to develop skills-based clusters of occupations: (a) it is needlessly costly and time-consuming (especially if the DOL will next attempt to extend the ACT's instrument to apply to all occupations); and (b) it is quite possible that important aspects of work will be omitted (i.e., it appears as though the *archival* information on occupations currently contained in the DOT was a primary source of items, and there are reasons to seriously question the degree to which the DOT's short narrative descriptions provide a comprehensive and up-to-date description of work activities).

12. How do you define terms such as “high performance skills,” “high wage,” and “high skill demand occupations” if you are going to use them to create occupational/skill clusters or develop a questionnaire to identify “high performance organizations” (p. 5)?

This is a good question; unfortunately, it lacks an easy answer. If the first part of this question is based on the assumption that we should restrict our consideration of skills to only “high performance,” “highly paid,” or “high demand” skills when grouping occupations to derive skills-based clusters, I would disagree with this assumption. That is, if the development of a taxonomy of occupational clusters based on shared skill requirements is the goal, it is clear that *all* skills involved in the economy -- not just the scarce or highly priced ones -- should be considered.

With respect to the second part of this question -- i.e., the problem facing ACT of developing a new questionnaire to identify “high performance organizations” -- I would refer back to the earlier question (number 9 above) and note that there is no single way in which to set a standard to distinguish high versus low-level occupations, to say nothing of the question of identifying *entire organizations* as being “high performance.” Although I’m aware that such terms are commonly used, it should be obvious that all organizations are composed of some mixture of “high powered” and “low tech” jobs/occupations; where one draws the line regarding the relative number of high- versus low-performance jobs that is needed to designate an organization as being “high performance” is, by definition, arbitrary.

13. Is it possible that the ACT environmental survey could help inform the design of the major DOL/BLS Survey of Workplace Practices currently being developed (p. 5)?

Given the limitations I discussed above regarding the ACT’s WAS survey (point 11), and the problems of developing *any* instrument to identify “high performance” organizations (point 12), I remain skeptical that any “definitive results” regarding this question can be achieved by the May 1996 deadline. To be able to do so would require a comprehensive instrument -- capable of describing any job or occupation in the economy -- that defines an all-encompassing “common metric” of work- and worker-oriented activities. The ACT’s questionnaire, in my assessment, falls far short of such an ideal, and given the atheoretical, “bottom up” way in which it was developed, I hold little hope that it could be extended -- regardless of cost, which would likely be substantial -- to describe all occupations in the economy.

For that matter, given its extremely short length, I harbor similar doubts that it will even be able to comprehensively describe the GWAOs of the 151 occupations to which it was targeted. As I noted earlier (e.g., point 1), it is my very strongly held assessment that the only way in which it makes sense to attempt to develop a skills-based taxonomy of occupational clusters is to start with a comprehensive, defensible, economy-wide database of occupational information, and use that database to empirically derive those occupational clusters. The upcoming revision of the DOT is the only such database that I am aware of that is planned, and efforts like the voluntary skills-standards project -- which

are effectively charting an entirely independent course with respect to defining and measuring the “world of work” -- are, in the final analysis, *counterproductive* to such efforts. Just as it is currently counterproductive to have several largely-independent systems for classifying occupational titles (e.g., DOT, SOC, Census, OES) in existence, it will be even more counterproductive to have different occupational/skill databases in existence in the future.

14. How do you define an “occupation” when you divide the nation’s labor market into occupational/skill clusters (p. 8)?

This is a very good question, which I have touched upon earlier (e.g., point 9). In short, this is a question that also confronts the planned revision of the DOT: that is, although everyone agrees that it is desirable to reduce the number of discrete occupations contained in the DOT and other databases, the cost of reducing the number of occupations (e.g., by forming skills-based *clusters* of previously separate occupations) is that the ability to distinguish between members of these new, more abstract clusters is lost once they are collapsed into a single classification! The solution is to *not* develop a single, rigid taxonomy of occupations -- especially one with only a handful (e.g., 10-20) of “meta-occupations” -- and instead adopt a flexible approach to occupational classification that allows for both big-picture and fine-grained views of work to be taken, as the situation demands (e.g., see the 1993 APDOT report).

15. Should the skill-standards occupational clusters be occupationally based, industry based, or a combination (p. 9)?

I feel strongly that only an occupationally based approach should be taken. In short, industry-based methods have been developed by starting with general industry-level classifications of occupations (typically, rationally identified) and then subdividing each classification into subgroups (e.g., based on educational requirements). Although this may be conceptually appealing -- and it certainly is likely to lead to a relatively small number of occupational clusters -- it has serious weaknesses. In short, it is obvious that a number of effectively identical occupations will be found in different industry clusters (e.g., secretary, computer programmer, receptionist). What does one do about this: (a) develop separate occupational titles depending on the *industry* in which the occupation is performed (which causes an obvious inflation in the number of required occupational titles), or (b) *ignore* the old occupational title, and simply assign new titles that are effectively *industry-based*. Neither of these alternatives is appealing.

In contrast, developing occupations “deductively” by starting with a comprehensive occupational database (e.g., the DOT) and then analytically deriving the occupational clusters based on demonstrated empirical similarity in work performed or skills-based requirements has a number of advantages, including (a) it is empirically based and therefore much more defensible; (b) it inherently allows *flexibility* in forming occupational clusters (i.e., if a small number of abstract clusters is desired, simply use high-abstraction data from the database to form clusters; conversely, if more specific clusters are desired, use more behaviorally specific, skill- or work-based data to define occupational similarity), and (c) it is capable of identifying *cross-industry* similarities in occupations based on

similar work- or worker-requirements (in contrast, the industry-based approach effectively "locks in" artificial distinctions between similar occupations that are performed in different industries).

16. What are the advantages and disadvantages of using inductive reasoning to identify occupational/skill clusters for skill standards (p. 10)?

Clearly, at one level of analysis, the use of "inductive" methods of classifying occupations may be useful, especially when systems along the lines discussed by Secretary Reich (i.e., "routine production services," "in-person services," and "symbolic analytic services") are considered. However, once such inductively-developed taxonomies have been specified, a problem remains: namely, how do you *classify* each of the thousands of occupations in the US economy into one of these rationally developed categories?

My assessment is that inductively-derived taxonomies may be very useful, especially as a vehicle for generating hypotheses regarding the ways in which occupational clusters can/should be formed. However, when it comes time to actually *implement* such a system, I would strongly prefer to use *empirical* methods for performing the actual classification of entities (in this case, occupations or jobs) into each category in the taxonomy. By basing such classifications on numerical analysis of an empirical, defensible database of national occupational information (e.g., the revised DOT), the entire taxonomic/classification process can be made much more rigorous and systematic, while retaining the conceptual benefits of inductively developing the general taxonomic structures themselves.

17. Research suggests that the particular occupational analysis method used affects the development of resulting clusters: What is the most appropriate method to use for occupational/skill clusters (p. 11)?

As was noted in the *Developing Occupational/Skill Clusters* document, this question runs through the entirety of the above questions. To summarize, however, it all depends on the purpose one takes to the problem of clustering occupations: for "big picture" kinds of groupings of occupations, a database of relatively abstract information (e.g., general abilities, work dimensions, etc.) should be used, and for more specific purposes, the occupational database should be composed of more behaviorally specific items (e.g., GWAOs, specific skill/knowledge requirements). In no case, however, should the DOL attempt to implement a *single* occupational/skill cluster taxonomy based on analysis of a *single* kind of occupational information, no matter how technologically sound the data collection mechanism used to assemble that database might be. *Flexibility* is the key word for any new occupational classification systems to be used to describe the US economy, and this flexibility can only be achieved by (a) collecting a comprehensive occupational analysis database containing *multiple* kinds/specificities of work- and worker-descriptive data, and then (b) matching the kind of information selected from that database to the *purpose* for grouping occupations.

C. References

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