# *Appendix D*

## *The Development of the Occupational Information (O*NET™) Analyst Database*

**Addendum**

*Appendix D - The Development of the Occupational Information (O*NET™) Analyst Database*

June 12, 2002

Below is information regarding important updates to the project described in *Appendix D - The Development of the Occupational Information (O*NET™) Analyst Database*, as previously published *O*NET 98 Data Dictionary*.

The appendix contains information based on O*NET 98 and refers to information presented in O*NET 98. Since the publication of the *O*NET 98 Data Dictionary*, the current O*NET 3.1 database has been developed. The major difference between this database and the O*NET 98 database is its compatibility with the 2000 SOC system. [1] By making O*NET 3.1 compatible with the SOC system, the O*NET 3.1 database contains 974 occupations. O*NET 98 contains 1,122 occupations (referred to as OUs or occupational units in O*NET 98). Note: The Office of Management and Budget has mandated that all federal agencies' occupational classifications systems be compatible with the SOC system.

The information in the O*NET 3.1 database, like the O*NET 98 database, contains information based largely on data supplied by occupational analysts from sources such as the Dictionary of Occupational Titles (DOT). As such, it is known as the *Analyst Database*. To develop data for the O*NET Analyst Database, analysts evaluated and refined existing occupational data, then extrapolated these data to the O*NET content model.

Data collection is currently underway with job incumbents to update the O*NET database. Questionnaires are being used to collect data for 4 Content Model Domains: Skills, Generalized Work Activities, Work Context and Knowledge. A 5th (fifth) Content Domain, Abilities, will be updated through a new analyst rating project. The data collection project call for gathering data on 200-300 occupations per year, with the goal of replenishing the database every 5 years.

[1] United States Department of Labor, Bureau of Labor Statistics. (2000). Standard Occupational Classification Manual 2000: Washington, DC: Author

# *Appendix D*

# *The Development of the Occupational Information (O*NET™) Analyst Database*

## Transition from the Dictionary of Occupational Titles (DOT) to the O*NET System

### Overview

The database for O*NET 98 is based largely on data supplied by occupational analysts. Thus, it is known as the *Analyst Database.* To develop data for the O*NET Analyst Database, analysts evaluated and refined existing occupational data, then extrapolated these data to the O*NET content model. Development of the database involved four phases:

***Phase I: Developing Homogeneous Occupations for O*NET***. First, the 11.761 *Dictionary of Occupational Titles* (DOT) occupations were grouped into categories based on Occupational Employment Statistics (OES) occupations. Because some of the 852 OES occupations were too broad, however, statistical clustering was used to divide some of them into two or more new categories that were more homogeneous in terms of required skills. Review and modification of the preliminary categories resulted in 1,122 defined O*NET Occupational Units (OUs).

***Phase II: Developing Task Statements to Describe the OUs***. To develop descriptive task statements for each OU, analysts began by examining the task statements for the DOT occupations that were grouped under the OU. The analysts combined and condensed the DOT statements, extracting a list of more general task statements to describe the OU.

***Phase III: Rating OUs in Terms of O*NET Content Model Descriptors.*** In order to relate the OUs to the content model that forms the conceptual framework for O*NET, analysts rated each OU in terms of selected descriptors drawn from the content model. Ratings were based on examination of the OU task statements developed in Phase II. A particular descriptor was included *only* if non-incumbents would be able to determine a rating based solely on the task statements.

***Phase IV: Evaluating the OU Task Statements.*** To evaluate the currency, relevance, and face validity of the OU task statements, analysts compared OU task statements to task data from existing occupational databases. The results suggested that the OU task statements are consistent with task content from widely used sources of occupational information.

This appendix describes these phases in more detail.

## Phase I: Developing Homogeneous Occupations for O*NET

The first phase of database development required analysts to group over 11,000 very specific DOT occupations into broader occupational categories that could be used for O*NET. The purpose of this regrouping of occupations was to make the O*NET more manageable and useful than the DOT by placing greater emphasis on the meaningful differences between occupations. Thus, it was essential to accurately group the DOT occupations and to ensure that the categories themselves were meaningful. In particular, each grouping of DOT occupations needed to display

- ***Belongingness*—**the work activities of each DOT occupation had to match the definition of the occupational category under which it was grouped; and

- ***Homogeneity*—**differences within a single category had to be less than differences between categories and all the DOT occupations within a single category had to show consistency of skill transferability.

## Initial Crosswalking of DOT and OES Occupations

To ensure that the new O*NET System could be linked to current labor market information, a common taxonomy of occupations was needed as its developmental foundation. The OES provided the most feasible taxonomy for this purpose. Then, by linking, or "crosswalking" the OES taxonomy to other taxonomies, the O*NET System could have increased application.

To initiate the O*NET development process, job analysts evaluated the National Occupational Information Coordinating Committee (NOICC) Master Crosswalk. The NOICC crosswalk, which was created by the Bureau of Labor Statistics (BLS), identifies the relationships among individual DOT occupations and OES occupational categories and establishes direct links between the two classification systems.

In some cases, the DOT occupations linked to an OES occupation were not sufficiently similar, with regard to skill requirements or work activities, to develop homogeneous occupations for O*NET. For many potential O*NET users, these broad OES occupations were too diverse to be meaningful or functional. Therefore, it was anticipated that some modification of the OES occupations would be needed. In general, however, the analysts agreed that the OES and the corresponding NOICC crosswalk could be used as a starting point to develop an occupation structure for O*NET.

To ensure that the linkages established between the DOT occupations and the OES occupations were sound, job analysts used a two-stage process: In the first stage, analysts evaluated OES occupations that were linked to four or fewer DOT occupations. In the second stage, they evaluated OES occupations that were linked to more than four DOT occupations.

## Direct Analysis of Relatively Narrow OES Occupations

Analysts selected 220 OES occupations that they determined were accurately matched with DOT occupations and were linked to four or fewer DOT occupations. Of the 220, 140 of the OES occupations were crossed with only one DOT occupation. The remaining 80 OESs were crossed with two to four DOT occupations.

To confirm this crosswalk evaluation, the list of the OES and the associated DOT occupations was distributed to four additional job analysts. In this stage of the evaluation, analysts were provided with the OES and DOT codes, titles, and definitions, as well as supplemental information from the DOT for each occupation. This information included codes for General Educational Development (GED) and Specific Vocational Preparation (SVP), as well as the date when the occupational information was last updated. The analysts were asked to read the OES definition and DOT definitions and indicate the degree of match between the OES and DOT definition (where there was a 1:1 correspondence) or the degree of match between the OES title and group of DOT titles (where there were multiple DOT occupations matched to an OES occupation). Analysts rated these using the following rating scale: 1= "Very poor"; 2= "Poor"; 3= "Moderate"; 4= "Good"; 5= "Very Good."

Out of the 220 linkages, 207 were found to be classified appropriately, yielding either "Good" or "Very Good" match ratings. The remaining 13 OES occupations were not represented in O*NET because the available DOT information was not sufficient to adequately represent the OES category.

### Generation of Subclusters within Broad OES Occupations

Because of the complexity of the information involved, instances where more than four DOT occupations were linked with an OES occupation required a different method of evaluation. Thus, statistical clustering was performed to generate subclusters for each OES occupation that had more than four DOT occupations associated with it. Once the cluster analysis was conducted, three teams of three job analysts assessed the homogeneity and belongingness of the DOT occupations within each subcluster. The analysts then compared the subclusters and made final decisions on occupational structure. A detailed description of the methodology follows.

**Selecting the variables**. Table 1 shows the 28 variables used in the clustering procedure. These variables were based on job analysis components commonly used in the DOT to describe the dimensions of jobs. Specific variables were selected because of their relationships to specific parts of the O*NET content model as well as their usefulness in classifying occupations.

**Table 1. Variables Used in Cluster Analysis[1]**

| Variable | DOT Job Component |
|---|---|
| Reasoning | General Educational Development (GED) |
| Mathematical | |
| Language | |
| Specific Vocational Preparation | Specific Vocational Preparation (SVP) |
| Data | Worker Function |
| People | |
| Things | |
| General Learning Ability | Aptitude |
| Verbal Aptitude | |
| Numerical Aptitude | |
| Spatial Aptitude | |
| Form Perception | |
| Clerical Perception | |
| Motor Coordination | |
| Finger Dexterity | |
| Manual Dexterity | |
| Eye-Hand-Foot Coordination | |
| Color Discrimination | |
| Materials, Products, Subject Matter, and Services (3 Codes) | Materials, Products, Subject Matter, And Services |
| Work Fields | Work Fields |
| Directing | Temperament |
| People | |
| Influencing | |

1. Scales for each variable are explained in detail in the Occupational Outlook Handbook (DOL, 1990).

Expressing

Some variables (i.e., the GED dimensions, the SVP measure, the Worker Functions, and the Aptitudes) were selected because they were most closely related to skills. Others (i.e., the Materials, Products, Subject Matter, and Services [MPSMS] codes, the Work Field codes, and the Temperament variables) were selected because they provided necessary information about work context. Temperament variables most closely related to interpersonal skills, as defined in the content model, were actually included in the cluster analysis. These were Directing, People, Influencing, and Expressing. Data for all the cluster variables came directly from the DOT.

**Selecting the proximity measure.** To indicate the amount of similarity between individual occupations, a proximity or distance measure was used. Any one of several different types of similarity measures could have been used. The Euclidean distance measure was chosen because it tends to be less affected by potential anomalies often associated with categorical variables.

**Selecting the method of analysis.** Proximity measures for the 28 profile variables were cluster analyzed using Ward's Minimum Variance procedure. Twelve clustering trials, using a sample DOT data set, were conducted to select the most appropriate method. Observational analyses and comparisons of the results revealed that the Ward's procedures best represented the data. This algorithm also supported the primary objectives of the project. Ward's emphasizes clusters with small, roughly equal numbers of observations (SAS, 1989, pp. 56, 536) but minimizes the tendency to create single member clusters. A large number of single member clusters within an OES category would pose problems for this study, so a clustering procedure that minimized single member clusters was preferred. Further, Ward's has been widely used in the clustering literature, has been shown to be superior for recovering known spherical clusters (SAS, 1989, p. 56), and accepts a wide variety of similarity measures.

**Determining whether to use raw or standardized profile variables.** Additionally, analysts needed to determine whether raw (i.e., unstandardized) or standardized profile variables should be used in the computation of the Euclidean distance measure. To determine which method provided the most meaningful cluster structures, cluster analyses were conducted for a subset of 31 OES units using both methods. While

the results for both methods were similar, some differences were apparent. A set of five analysts examined the solutions and determined that the use of raw unstandardized profiles yielded the most meaningful information.

**Generating the subclusters.** The clustering procedure described above (i.e., Ward's Minimum Variance, using Euclidean distance and unstandardized profile variables) was used to generate subclusters for each OES occupation with more than four associated DOT occupations. For each OES occupation, results were organized by DOT codes and titles under each resulting cluster number. These results were given to job analysts for subclustering review.

## Review and Modification of the Subclusters

A group of three job analysts was presented with the OES code and definition, the DOT codes and titles, arranged by cluster results, and the DOT occupational definitions. Initially, the analysts reviewed the DOT definitions, familiarizing themselves with the definitions for all job titles within each subcluster. They focused on occupation-specific skills and knowledges (e.g., tasks performed, equipment used, subject-matter, etc.), noting the differences between the occupations. The *Occupational Outlook Handbook* (1990) was consulted, as needed, for information regarding training requirements.

**Evaluating belongingness.** After reviewing the DOT definitions, each analyst evaluated the belongingness of the DOT occupations, noting any DOT occupations that did not match the OES definition. These titles were discussed with the group and a consensus was reached as to whether or not to remove the DOT from the OES. If recommended for removal, a rationale for removal was included on a group worksheet along with a recommendation of the OES occupation to which the DOT title should be linked.

**Evaluating homogeneity.** After removing the mismatched DOT occupational titles from the list, the analysts then selected a seed DOT occupation (i.e., the most representative DOT occupation) for each subcluster. This occupational title was the one that most closely represented the OES definition. If more than one DOT title reflected the OES, then skill level was used as a second criterion. In these cases, the occupational title representing the highest appropriate skill level (based

on GED and SVP rating) for all DOT occupations in the subcluster was selected. After recording their individual responses, the group discussed their selections until they reached a consensus on the seed DOT designation. This selection was then recorded on the group worksheet.

Next, each analyst estimated the amount of retraining time required to make a career move from each DOT within the subcluster to the seed DOT. Retraining time was defined as the amount of time required by a worker to acquire—through either vocational or on-the-job training—the additional occupation-specific skills and knowledges needed to perform proficiently in the seed DOT. Retraining time estimates were used to assess the relative similarity of groups of DOTs within each subcluster. These estimates were not considered predictors of actual retraining time.

Analysts estimated retraining times using task statements and ratings from the DOT and training requirement information from the *Occupational Outlook Handbook.* Analysts were asked to: 1) identify the overlap of occupation-specific skills and knowledges; 2) identify the additional occupation-specific skills and knowledges required to perform proficiently in the seed DOT; and 3) estimate how much retraining time is required to gain these additional occupation-specific skills and knowledges. Retraining time was rated using the following scale: 1= “1 day up to 1 week”; 2= “1 week up to 1 month”; 3= “1 month up to 3 months”; 4= “3 months up to 6 months”; 5= “6 months up to 1 year”; 6= “1 year up to 2 years”; 7= “more than 2 years.”

Individual estimates of retraining time were recorded on the individual worksheets. After group members made individual estimates, the group discussed the individual estimates until they reached a consensus on a retraining time estimate, which they recorded on the group worksheet.

The group then compared retraining times of the DOT occupations within each subcluster to determine if the occupations had similar retraining time estimates. If a given DOT occupation differed significantly in terms of retraining time from the other occupations in the subcluster, the group estimated the time required to retrain to the seed occupation in each of the remaining subclusters of that OES occupation. The analysts then determined if the retraining time for the discrepant DOT occupation was closer to the retraining times of the occupational titles within any of the remaining subclusters. The DOT occupation was moved to the subcluster in which the retraining time to the seed occupation was the lowest.

If an occupation did not fit any subcluster, the group re-evaluated belongingness to the OES occupational category. If the DOT occupation matched the OES occupational category (i.e., “belonged”), but did not fit any of the subclusters, it formed a cluster by itself. In contrast, if the DOT occupation did not match the OES category, the DOT occupation was moved to a more suitable OES category.

Finally, the group evaluated the subclusters once more. They compared the retraining times within subclusters of the OES units to retraining times across subclusters. The criteria for comparison was that there should be lower retraining time estimates within OES subclusters than between OES subclusters. The group determined if there was sufficient justification to maintain occupational subclusters or if the OES should form only one cluster. For cases in which there were no retraining time differences between and within OES subclusters, the subclusters were collapsed back into single clusters. On the group worksheet provided, the group stated the rationale for the formation of final subclusters, including estimates of retraining times within and across subclusters.

**Defining the preliminary Occupational Units (OUs).** The group was asked to name and provide a short definition for the subclusters. Each resulting subcluster was defined as an Occupational Unit (OU). These OUs, formed to maintain consistent levels of within group skills transferability between the DOT occupations, were homogeneous groupings of DOT occupations. Figure 1, on the next page, shows an example of an OES category that was subclustered.

**Conducting a final review of the OU structure.** As a result of the initial subcluster reviews described above, about one-third of the original OES categories were subclustered, yielding 1,350 OUs. One final review of the new OU structure was then conducted. Based on expected relevance and usage level, several single-member OUs were placed on a low priority list for inclusion in O*NET. These OUs were evaluated and 1) reassigned to a related OU, 2) reassigned to an “All Other” residual OU, or 3) targeted for further review. For example, the OU “Mule Team Driver” was expected to have relatively low employment and to be slightly dated. OUs such as this are now pending additional study before future inclusion in O*NET.

**Assigning titles and definitions to the final OUs.** The final version of the new OU structure included a total of 1,122 OUs, each with DOT occupations linked to it. Some of these OUs are identical to the OES occupation. If this process determined that an original OES occupation was homogeneous, the 5-digit code, title and definition were adopted as the OU code, title, and definition. If the clustering process resulted in a subclustered OES, then each subcluster became a separate OU. These OUs were assigned the original OES 5-digit code with an alphabetical suffix. This created a 6-character OU code for all subclustered OUs. The titles and definitions of these OUs were then developed in a manner consistent with the 1995 OES occupational titles and definitions. This naming convention made it easy to identify subclusters of the OES and show the relationship of OESs to OUs.

## Figure 1. Example of a Subclustered OES Occupational Unit

**Original OES Occupational Unit**

OES 15026 FOOD SERVICE AND LODGING MANAGERS: Plan, organize, direct, control, or coordinate activities of an organization or department that serves food and beverages and/or provides lodging and other accommodations. Include Food and Beverage Directors.

185.137-010 MANAGER, FAST FOOD SERVICES
187.117-038 MANAGER, HOTEL OR MOTEL
187.137-018 MANAGER, FRONT OFFICE
187.161-010 EXECUTIVE CHEF
187.167-026 DIRECTOR, FOOD SERVICES
187.167-050 MANAGER, AGRICULTURAL-LABOR CAMP
187.167-066 MANAGER, CAMP
187.167-106 MANAGER, FOOD SERVICE
187.167-126 MANAGER, LIQUOR ESTABLISHMENT
187.167-206 DIETARY MANAGER
187.167-210 DIRECTOR, FOOD AND BEVERAGE
319.137-014 MANAGER, FLIGHT KITCHEN
319.137-018 MANAGER, INDUSTRIAL CAFETERIA
320.137-010 MANAGER, BOARDING HOUSE
320.137-014 MANAGER, LODGING FACILITIES

**Subclusters Created From Evaluation of OES Occupational Unit**

Cluster I: Lodging Managers: Plan, organize, direct, control, or coordinate activities of an organization or department that provides lodging and other accommodations.

187.117-038 MANAGER, HOTEL OR MOTEL
187.137-018 MANAGER, FRONT OFFICE
320.137-014 MANAGER, LODGING FACILITIES

Cluster II: Food Service Managers: Plan, organize, direct, control, or coordinate activities of an organization or department that serves food and beverages.

185.137-010 MANAGER, FAST FOOD SERVICES
187.161-010 EXECUTIVE CHEF
187.167-026 DIRECTOR, FOOD SERVICES
187.167-050 MANAGER, AGRICULTURAL-LABOR CAMP
187.167-066 MANAGER, CAMP
187.167-106 MANAGER, FOOD SERVICE
187.167-126 MANAGER, LIQUOR ESTABLISHMENT
187.167-206 DIETARY MANAGER
187.167-210 DIRECTOR, FOOD AND BEVERAGE
319.137-014 MANAGER, FLIGHT KITCHEN
319.137-018 MANAGER, INDUSTRIAL CAFETERIA
320.137-010 MANAGER, BOARDING HOUSE

### The Resulting OU Structure

A total of 1,122 OUs were developed and crosswalked to the original DOT occupations.[2] In general, these OUs are more homogenous, and thus, are more meaningful groupings for presentation of occupational information than the original OES structure.

## Phase II: Developing Task Statements to Describe the OUs

In the second phase of database development, job analysts integrated narrative DOT occupational information into the new OU structure. Specifically, the analysts revised and aggregated DOT task statements to form task descriptions for the new OUs.

### Training and Guidelines for Analysts

To maintain consistency across the OU task lists, all analysts participated in a half-day workshop. This workshop familiarized analysts with the process of extracting key tasks from DOT task statements and gave them practice writing aggregated task statements for the OUs. To develop OU task lists, the job analysts used the following guidelines: 1) each OU should be described by less than 20 tasks to keep the OU descriptions at a reasonable length; 2) each task statement should contain 20 or fewer words to keep them from being too complex; 3) where possible, task statements should be written to reflect modern technology; 4) task statements should be ordered roughly by perceived importance to the OU; and 5) task statements should follow the general writing guidelines found in the U.S. Department of Labor's *Revised Handbook for Analyzing Jobs* (1991) to ensure standardization.

2. The final list of DOT occupations crosswalked to the new OUs was slightly different than the list published in the 4th edition (1991) DOT. A series of unpublished DOT revisions had been compiled for release at a later date. These revisions were incorporated into the development of O*NET. The current OU-DOT crosswalk contains 12,761 unique DOT occupations with 12,797 individual linkages to OUs. There are more linkages than DOTs because some DOT occupations are linked to multiple OUs. Any OES Codes (the first five positions of the OU Code) which do not appear in this crosswalk do not have any DOT occupations linked to them and thus, were excluded from O*NET.

## Extraction of OU Tasks from DOT Task Statements

To derive the tasks for the OUs, all DOT task statements were placed into a database. Task statements that described the DOT occupations grouped into each OU were compiled and provided to assigned analysts. For the OUs that were crossed with many DOT occupations, the task statements were placed into a data file that could be accessed using the database software ALPHA4. ALPHA4 software was used by analysts to sort task statements based on common or similar action verbs. To further facilitate the aggregation and extraction of information, job analysts were also given a list and count of the action verbs that were found within all task statements. From these comprehensive lists, analysts extracted the most commonly cited DOT tasks for each OU. These task statements were deemed to be the most representative of the OU. In addition, they reviewed each set of task statements for redundancy. Tasks with nearly the same meaning were combined and re-written into an aggregated task statement. The result was a condensed list of more general task statements describing each OU. Figure 2 shows an example of an aggregated task.

**Figure 2. Example of a Task Extracted for an OU**

**Tasks from Four DOT Occupations Classified Under One Occupational Unit**

1. Advises customer on selection of apparel and on coordination of accessories, such as handbags, belts, and boots.

2. Suggests furniture size, period style, color, fabric, and wood that will complement customer's home and other furnishings.

3. Suggests trees and shrubbery suitable for specified growing conditions.

4. Advises customer on style of organ or piano to harmonize with other furniture.

**Resulting O*NET Occupational Unit Task**

Selects and recommends merchandise based on customer needs and desires.

## Quality Control

After task extraction, each OU task list was submitted to two levels of quality control. First, other O*NET team analysts reviewed the OU tasks.

Second, a quality control analyst conducted a final review of the comprehensiveness and quality of the OU description and tasks. In both stages of quality control, reviewers had access to original task extraction information as well as all subsequent OU revisions and modifications.

### The Resulting OU Task Statements

This effort resulted in the development of a complete set of task statements, derived from the DOT, to describe each OU. These tasks provided qualitative information about each OU from which ratings, in terms of O*NET descriptors, could be generated.

## Phase III: Rating OUs in Terms of O*NET Descriptors

In the final phase of the development effort, analysts drew direct connections between the OUs and the O*NET content model, which forms the structural base of O*NET. Specifically, DOT narratives had been used as the foundation for developing OU tasks and definitions. Now analysts expanded upon that task information by rating the OUs in terms of selected content model descriptors.

### Feasibility Study

Job analysts began this phase by estimating the ease of describing the OUs in terms of various content model descriptors and by prioritizing the domains of the content model. Occupation-specific tasks and duties could, of course, be easily derived from the OU task lists. An examination of the content model suggested that the following domains could be rated by analysts based on the tasks: Generalized Work Activities (GWAs), Abilities, Knowledges, Skills, and Work Context.

Using the newly developed OU descriptions, a short pilot study was conducted to identify which scales and items presented rating problems for analysts. Twenty-nine of the more abstract content model descriptors were selected for the sample. Table 2, on the next page, lists the descriptors and the corresponding domains included in the sample. These descriptors were chosen because, due to the level of abstraction, rating them was expected to be more difficult and to require more interpretation. During a half-day workshop, 15 analysts were asked to complete ratings for the selected descriptors. To assess the relative ease of the rating task, analysts received only minimal instructions. After the rating exercise, analysts, led by an O*NET team facilitator, discussed the process. The

facilitator guided the discussion to concentrate on particular rating problems, such as difficulties with items, scales, or anchors.

## Survey Instrument Modifications[3]

Close examination of the domain descriptors and pilot testing by job analysts indicated that the OU tasks could be used to directly rate the OUs on the descriptors. However, there were potential problem areas. As a result of analysts' responses to the pilot, minor changes were made to some O*NET survey instruments.

The Level and Importance scales were retained for the Skills, Knowledges, and GWAs domains. The Job Entry Requirement scale was eliminated from the Skills questionnaire. The Job Specialty Requirements scale (Knowledges questionnaire) was maintained; however, analysts did not note "Other" specialty areas.

As a result of the pilot testing, which indicated that precise ratings of Frequency were too difficult to make given only the OU definition and tasks, two Frequency scales were revised: the GWA Frequency scale and the Work Context Frequency scale. The original GWA Frequency scale required precise ratings of Frequency ranging from 1= "Once per year or less" to 7= "Hourly or more often." In contrast, the revised scale was a 1-4 scale in which 1= "Almost Never" and 4= "Always." Similarly, in the Work Context domain, the Frequency rating scale originally ranged from 0= "Never (or does not apply)" to 7= "Hourly or more often (including continually)." This scale was changed to a 0-4 scale in which 0= "Never" and 4= "Always." Analyst data are reported on these revised scales.

Additionally, multiple items in the Work Context domain were dropped. An item was eliminated if it was determined that the response to the item would vary considerably as a function of organization and/or location.

3. These modifications were made when it was thought that task information would be insufficient to allow inferences to a rating on the original O*NET survey item. These modifications were made for the Analyst data collection only and thus incumbent data collections were not affected.

**Table 2. Descriptors and Corresponding Domains Selected for Direct Rating Feasibility Study**

| Content Model Domain | Construct |
|---|---|
| Skills | Science |
| | Critical Thinking |
| | Active Learning |
| | Learning Strategies |
| | Monitoring |
| | Social Perceptiveness |
| | Problem Identification |
| | Idea Generation |
| | Implementation Planning |
| | Visioning |
| | Identification of Downstream Consequences |
| | Objective Evaluation |
| Knowledges | Technical Drawing |
| | Safety and Security |
| Generalized Work Activities | Identifying Objects, Actions, and Events |
| | Compliance |
| | Analyzing Data or Information |
| | Thinking Creatively |
| | Developing and Using Job-relevant Knowledge |
| Work Context | Formality of Communication |
| | Responsibility of Work Outcomes and Failures |
| | Consequences of Error |
| | Impact of Decisions |
| | Structured vs. Unstructured Work |
| Abilities | Fluency of Ideas |
| | Originality |
| | Memorization |
| | Problem Sensitivity |
| | Inductive Reasoning |

## Rater Training

25 Occupational Analysts and 32 Industrial/Organizational Psychology graduate students were selected to participate as analysts in the rating project. A three-day rater training session was conducted to familiarize these analysts with the content model and instruct them on how to complete the occupational survey. An analyst also received information about the process of making ratings and tips to help avoid rating errors. Analysts were trained in groups of 8 to 10. Each domain of the content model comprised a separate training module or session.

As a post-training check of the rater training, all analysts rated five practice OUs. Interrater reliabilities were calculated for the mean of the analyst ratings on each descriptor. The reliabilities for each descriptor mean in this post training check were all above.60.

## Direct Rating

A strategy was then developed to rate the 1,122 OUs. These OUs were divided into groups of 130. Each group was to be rated within a 30-day time frame, termed a rating cycle. The trained raters were randomly assigned to rating groups of six raters and subsequently assigned a domain for each rating cycle. Each rater rated one domain during each cycle to minimize contrast effects across different domains. In addition, domain assignment was rotated through successive rating cycles to reduce any potential biases resulting from over-familiarity with a particular domain. To eliminate any presentation order effects, the OU order within each domain was also randomized for each rater.

Each rater received a packet of rating materials that included: 1) detailed instructions for rating the assigned domain; 2) a randomized list of that cycle's OUs, including titles, definitions, and tasks; and 3) domain-specific response sheets on which to record ratings. Figures 3 and 4, respectively, show sample rater instructions and answer sheets.

Although the first rating cycle consisted of 130 OUs and had six assigned raters per domain, subsequent cycles contained 125 OUs and only five raters. This is because evaluation of domain reliabilities revealed that teams of five raters could provide adequate rating consistency.

Between eight and ten cycles of ratings were conducted for each domain. The mean reliabilities across the cycles for each domain and scale type are listed in table 3.

**Table 3. Mean reliability of ratings across cycles for each domain and scale type**

| Domain, Scale Type | Mean $\underline{r}$ |
|---|---|
| Ability, Level | .74 |
| Ability, Importance | .71 |
| Generalized Work Activities, Level | .88 |
| Generalized Work Activities, Importance | .84 |
| Knowledges, Level | .83 |
| Knowledges, Importance | .83 |
| Skills, Level | .87 |
| Skills, Importance | .84 |
| Work Context | .80 |

Note: The statistic reported here is the mean of $\underline{r}_{xx}$, where $\underline{r}_{xx}$ is the reliability of the mean of analyst ratings on a given descriptor for a given occupation. This reliability coefficient is calculated using the formula $\underline{r}_{xx}$ = [BMS-WMS]/BMS (Shrout & Fleiss, 1979), where BMS and WMS are the between mean squares and within mean squares respectively, from an Analysis of Variance where the rating is modeled with a "Descriptor" main effect. BMS corresponds to the Descriptor effect and WMS corresponds to the error.

### The Resulting Database

The result of these steps was a database of occupational information (for 1,122 OUs) in terms of selected O*NET content model descriptors. This information was used as the basis for the O*NET Analyst Database.

## Phase IV: Evaluating the OU Task Statements

As part of the O*NET planning cycle, a study was designed to evaluate the OU task statements created during the development process. The goal was to evaluate the currency, relevance, and face-validity of the tasks that were extracted from DOT occupational information. The study compared the newly created OU tasks with tasks from existing data sources to determine the degree of overlap or representation in content. Task data were contributed to this study from the occupational databases of the Office of Personnel Management (OPM), the Department of Defense (DoD), and the Vocational-Education Consortium of States (V-TECS).

The majority of the source data contributed to this project had been collected within the previous three to five years. All source data were collected for various purposes—none of which included evaluation of O*NET OU tasks.

### Crosswalk Development

In order to create a crosswalk, occupations from these three databases were matched to the O*NET Occupational Units (OUs). An Occupational Analyst and an Industrial/Organizational Psychologist reviewed the occupational titles from each source and attempted to match OUs to other source occupations based on title. Then, these analysts reviewed each match and selected the 10 to 15 percent (best matches) from each OES division (Managerial and Administrative; Professional, Para-professional, and Technical; Sales and Related; Clerical and Administrative Support; Services; Agricultural, Forestry, Fishing, and Related; and Production, Construction, Operating, Maintenance, and Material Handling). One-to-one occupational matches were preferred over one-to-many or many-to-one matches to minimize the complexity of interpreting representation of source task content by OU tasks. The variance in the way occupational titles are used and developed limited precision with which occupations could be matched.

### Rater Training and Rating

Five Occupational Analysts and an Industrial /Organizational Psychology graduate student were selected as analysts and trained to evaluate the extent of coverage on task-to-task comparisons. For each source task/OU task pair, the analysts used a five-point rating scale to rate degree of coverage. Rating scale values ranged from 0= “Not at all—The source task is not at all represented by the OU task”; 1= “Minimally—The source task is minimally represented by the OU task”; 2= “Moderately—The source task is moderately represented by the OU task”; 3= “Great Extent—The source task is represented to a great extent by the OU task”; 4= “Completely—The source task is completely represented by the OU task.” In addition, analysts were instructed to rate representation of each source task in the entire OU task set for each given OU. An identical scale was used for this global rating. Thus, for each OU, each analyst provided task-to-task ratings (one for each source task/OU task combination) and global ratings (one for each source task).

As part of rater training, analysts rated a practice set of seven OU to source occupation matches. Intraclass correlation coefficients (ICCs) (Shrout & Fleiss, 1979) were calculated to indicate the reliability of the mean of analyst global ratings for each OU-to-source task match. These reliabilities were all above .70, indicating that the ratings could be made with reasonable reliability.

After completing training, six raters were assigned to one of two teams. Each team of three raters then independently rated coverage of OPM, DoD, and V-TECS task content by the OU task statements from 199 OUs over two rating cycles. Each rater received a packet containing the title, definition, and task list for each OU to be rated and similar information for the source occupation(s) it was linked to.

## Analysis

Means of analysts' global ratings of source task coverage for each OU to OPM/DoD/V-TECS match were computed. Source tasks with mean ratings greater than 2.5 were counted and divided by the total number of source tasks. An OU was determined to provide sufficient coverage of task content when 65 percent or more of the source tasks had a mean of 2.5 or above.

Intraclass correlation coefficients (ICCs) (Shrout & Fleiss, 1979) were calculated to indicate the reliability of the mean of analyst global ratings for each OU-to-source task match. Median reliability across both three-member rating groups and all OU-to-source task matches was .81.

Of the 199 matches, 145, or 73 percent of the OUs provided sufficient representation (65 percent or more of the source tasks received a global rating of 2.5 or higher) of task content in matched occupations. To assist in interpreting these results, the 54 remaining matches were examined more closely. This review revealed that 43 of the OUs were initially matched inappropriately (i.e., the information provided for the matching was insufficient to make a proper match). Fore example, the OU Construction Carpenter (87102A) was initially linked to the DoD occupation Construction Specialist (6412991). However, the occupations differ greatly in terms of the tasks and skills needed. Construction Carpenters build a variety of structures directly from plans and layouts, while Construction Specialists tend to do the manual labor needed to build one type of simple structure. Considering only the 156 more appropriate occupational matches, the percentage of the OUs with sufficient representation of task content in matched occupations rises to 92 percent. The task content of the remaining 11 OUs was either inadequate or out of date.

## Discussion

Results from the study were generally positive and suggest that the tasks written for the OUs during the development process are consistent with task content from widely used sources of occupational information. This study points up the continuing need to keep task lists up to date. One way to do this is to use other existing sources for comparison and evaluation. However, it was observed that different sources maintain tasks at different levels of specificity according to the purpose of the source. This makes some sources more useful than others for updating task lists.

## Figure 3. Example of Rater Instructions

**INSTRUCTIONS FOR MAKING KNOWLEDGE RATINGS**

In this section of the survey you will be presented with a list of 33 *Knowledges. Knowledges* are sets of facts and principles needed to address problems and issues in particular parts of a job.

For each *knowledge*, please make the following three ratings:

**(1) LEVEL**

Read the definition of the *knowledge* being rated and identify the essential rating elements. Read the high and low level descriptions and the task anchors that illustrate how tasks or activities relate to the *knowledge* and various points on the scale.

Review the list of tasks and select the tasks that best typify the *knowledge*. Identify the single task or group of tasks requiring the highest level of the *knowledge.*

Using the selected task or group of tasks, make a tentative rating on the scale. If no tasks are identified, rate NR (not relevant).

Check your rating by comparing your rating with the task anchors above and/or below and adjust your rating accordingly.

**(2) IMPORTANCE**

Using all of the tasks identified above, evaluate the importance of the *knowledge* for performance in these tasks. Assign a rating on the importance scale, taking into consideration the relative importance of these tasks in overall performance in the occupational unit.

**(3) JOB SPECIALTY REQUIREMENTS**

Using all of the tasks identified above, rate whether the *Job Specialty Requirements* are relevant (R) or not relevant (NR) for performance of the occupational unit.

**Figure 4. Example of Rating Response Sheet**

RESPONSE SHEET - SKILLS

Rater:_____ OU:_____ Cycle: _____
Date:_____ Time Start:_____am/pm Time Stop:_____ am/pm

| | CONSTRUCT | LEVEL | IMP |
|---|---|---|---|
| 1 | Reading Comprehension | | |
| 2 | Active Listening | | |
| 3 | Writing | | |
| 4 | Speaking | | |
| 5 | Mathematics | | |
| 6 | Science | | |
| 7 | Critical Thinking | | |
| 8 | Active Learning | | |
| 9 | Learning Strategies | | |
| 10 | Monitoring | | |
| 11 | Social Perceptiveness | | |
| 12 | Coordination | | |
| 13 | Persuasion | | |
| 14 | Negotiation | | |
| 15 | Instructing | | |
| 16 | Service Orientation | | |
| 17 | Problem Identification | | |
| 18 | Information Gathering | | |
| 19 | Information Organization | | |
| 20 | Synthesis/Reorganization | | |
| 21 | Idea Generation | | |
| 22 | Idea Evaluation | | |
| 23 | Implementation Planning | | |
| 24 | Solution Appraisal | | |

| | | | |
|---|---|---|---|
| 25 | Operations Analysis | | |
| 26 | Technical Design | | |
| 27 | Equipment Selection | | |
| 28 | Installation | | |
| 29 | Programming | | |
| 30 | Testing | | |
| 31 | Operation Monitoring | | |
| 32 | Operation and Control | | |
| 33 | Product Inspection | | |
| 34 | Equipment Maintenance | | |
| 35 | Troubleshooting | | |
| 36 | Repairing | | |
| 37 | Visioning | | |
| 38 | Systems Perceptions | | |
| 39 | Identification of Downstream Consequences | | |
| 40 | Identification of Key Causes | | |
| 41 | Judgment and Decisionmaking | | |
| 42 | Systems Evaluation | | |
| 43 | Time Management | | |
| 44 | Management of Financial Resources | | |
| 45 | Management of Material Resources | | |
| 46 | Management of Personnel Resources | | |

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