A Database for a Changing Economy: Review of the Occupational Information Network (O*NET)

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A DATABASE FOR A CHANGING ECONOMY

Review of the Occupational Information Network (O*NET)

Panel to Review the Occupational Information Network (O*NET)

Nancy T. Tippins and Margaret L. Hilton, *Editors*

Committee on National Statistics

Division of Behavioral and Social Sciences and Education

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PANEL TO REVIEW THE OCCUPATIONAL INFORMATION NETWORK (O*NET)

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We are especially grateful to the experts who quickly responded to our request for presentations and written materials related to O*NET. At our first meeting, Pamela Frugoli and Gay Gilbert of ETA provided an overview of the key questions to be addressed in the study, and David Rivkin and Phil Lewis, O*NET technical officers, presented an overview of the development and current status of the O*NET database and its uses.

At our second meeting, we explored different uses of O*NET. We would like to thank Lance Anderson, ICF International; Hope Clark, Indiana Department of Workforce Development; Rada Dorman, Manpower, Inc.; Dan Erdmann, University of Oregon; Bonnie Graybill, California Employment Development Department; G. Francis Green, University of Kent, UK; P. Richard Jeanneret, Valtera Corporation; Sylvia Karman, Social Security Administration; Phil Lewis, National Center for O*NET Development; Brian O'Leary, Office of Personnel Management; Don Phillips, XAP Corporation; Douglas Reamer, New York Department of Labor; David

Rivkin, National Center for O*NET Development; Dixie Sommers, Bureau of Labor Statistics; and Jane Styer, Department of Defense.

At our third meeting, experts provided perspectives on how O*NET might be improved to increase its usefulness and the quality of the data. We thank Marcus Berzofsky, RTI International; Scott Butler, The Usability Team; Erich Dierdorff, DePaul University; Michael Handel, Northeastern University; Robert J. Harvey, Virginia Polytechnic Institute; Fred Morgeson, Michigan State University; Michael Penne, RTI International; Elizabeth Sadler, University of Virginia; Marilyn Silver, JBS Associates; and Suzanne Tsacoumis, Human Resources Research Organization.

We thank our colleagues on the panel for their enthusiasm, hard work, and collaborative spirit in writing this report.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the NRC. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We thank the following individuals for their review of this report: Lance E. Anderson, Human Capital Strategies, ICF International, Fairfax, VA; Andrew Crapuchettes, Chairman's Office, Economic Modeling Solutions, Moscow, ID; J.W. Cunningham, Department of Psychology Emeritus, North Carolina State University; Donald W. Drewes, Department of Psychology, North Carolina State University; Sigrid B. Gustafson, Health Research and Policy Analysis, American Institutes for Research, Chapel Hill, NC; Richard W. Judy, Chairman's Office, Workforce Associates, Indianapolis, IN; S. Morton McPhail, Office of the Senior Vice President, Valtera Corporation, Houston, TX; Frederick P. Morgeson, Eli Broad Graduate School of Management, Michigan State University; Ron Page, Assessment Associates International, LLC, Minnetonka, MN; Norman G. Peterson, Research Directorate, Satisfaction Performance Research Center, Inc., Minneapolis, MN; Jay J. Pfeiffer, Senior Associate, MPR Associates, Inc; and Alan R. Tupek, Chairman's Office, Arbitron, Inc., Columbia, MD.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Neal W. Schmitt, Department of Psychology and Management, Michigan State University. Appointed by the NRC, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully con-

sidered. Responsibility for the final content of this report rests entirely with the authoring panel and the institution.

We are grateful for the leadership and support of Michael Feuer, executive director of the NRC's Division of Behavioral and Social Sciences and Education, and Constance Citro, director of the Committee on National Statistics. We are particularly grateful for the work of Thomas Plewes, associate study director, who developed the study scope, assembled an excellent panel and an array of useful background materials, and provided invaluable contributions throughout the study process. Finally, we thank Renée L. Wilson Gaines, senior project assistant in the Center for Education, for her assistance in supporting the panel at every stage of its deliberations and in preparing drafts and revisions of the report.

Nancy Tippins, *Chair*
Margaret Hilton, *Study Director*
Panel to Review the Occupational
Information Network (O*NET)

Contents

Executive Summary

Information about the characteristics of jobs and the individuals who fill them is valuable for career guidance, reemployment counseling, workforce development, human resource management, and other purposes. To meet these needs, the U.S. Department of Labor (DOL) in 1998 launched the Occupational Information Network (O*NET), which consists of a content model—a framework for organizing occupational data—and an electronic database.

The O*NET content model includes hundreds of descriptors of work and workers organized into domains, such as skills, knowledge, and work activities. Data are collected using a classification system that organizes job titles into 1,102 occupations. The National Center for O*NET Development (the O*NET Center) continually collects data related to these occupations.

In 2008, DOL requested the National Academies to convene an expert panel to review O*NET and consider its future directions. The panel was asked to inventory and evaluate the uses of O*NET; to explore the linkage of O*NET with the Standard Occupational Classification System and other data sets; and to identify ways to improve O*NET, particularly in the areas of cost-effectiveness, efficiency, and currency.

Based on its review of the evidence, the panel reached the overarching conclusion that O*NET is used and useful.

Conclusion: The Department of Labor has demonstrated the value and usefulness of a publicly funded, nationally representative database of occupational information through its wide usage. An array

of individuals and organizations relies on O*NET data to inform important activities in workforce development, economic development, career development, academic and policy research, and human resource management.

The panel's other conclusions and recommendations fall into two broad categories, reflecting the two goals of O*NET: (1) developing and maintaining a high-quality database and (2) enhancing service to users. Primary conclusions and recommendations in each category are presented here; more detailed conclusions and recommendations appear in the individual chapters of the report. All recommendations are summarized and presented in order of importance in Chapter 10.

MAINTAINING A HIGH-QUALITY DATABASE

Conclusion: Over the past 10 years, DOL has achieved its initial goal of populating O*NET with information from job incumbents and occupational analysts, replacing earlier data based on the Dictionary of Occupational Titles. However, short-term policy agendas related to workforce development have at times reduced focus on the core activities of developing, maintaining, and updating a high-quality database.

Recommendation: The Department of Labor should focus O*NET resources on the core functions of collecting, maintaining, and publishing high-quality data, leaving development of most new applications and tools to the private sector, state and local governments, and educational institutions.

This focus on data quality will involve complex trade-offs between costs and benefits now and in the future. Maintaining continuity in the content model has supported the growing use of O*NET data for many valuable purposes. Nevertheless, weaknesses in the content model and other O*NET elements warrant targeted research investments that may lead to modifications with potential to reduce data collection costs, improve data quality, and enhance service to users.

Conclusion: The construct validity of the taxonomies of descriptors varies across the different domains included in the content model. In the abilities domain, the descriptors reflect a long history of psychological research on the nature and measurement of human abilities, but many of the descriptors in the skills domain lack such an extensive research base.

Conclusion: To gather information for most content model domains, the O*NET Center employs a multimethod sampling approach, in which respondents for approximately 75 percent of the occupations are identified through probability-based sampling, and respondents for 25 percent of the occupations are identified by other, less scientifically rigorous methodologies. Trained occupational analysts provide information for the abilities and skills domains. Taken together, these methods yield O*NET data derived from different types of data providers (occupational analysts, job incumbents, occupational experts) who may or may not represent the work performed in that occupation. The impact this has on measurement error is unclear, because each type of respondent introduces a different source of error.

Recommendation: The Department of Labor should establish and support an external technical advisory board, comprised of senior scientists, to develop a research agenda for O*NET that will prioritize research suggestions from its members, the department, the O*NET Center, the user advisory board recommended below, and other sources. At a minimum, it should meet twice yearly, once to establish research priorities for the coming year and develop requests for proposals reflecting these priorities and once to review and rank proposals submitted by academic researchers or contractors.

ENHANCING SERVICE TO O*NET USERS

Conclusion: The full potential of O*NET has not been realized, partly because of a lack of effective, ongoing communication and feedback between the O*NET Center and current and potential users. As a result, the O*NET Center has an incomplete understanding of user needs, resulting in development of an O*NET that is not fully aligned with these needs and marketing activities that do not explain all its potential uses.

Recommendation: The Department of Labor should establish and staff an ongoing, external user advisory board, including at least one representative of each major user group, as well as representatives of potential users in the U.S. military and in K-12 and higher education. The board should meet regularly to provide advice and recommendations to the Department of Labor regarding processes for identifying users' evolving needs and communicating information about O*NET and its uses. New marketing and educational strategies must be aligned with the reality that, for many users, O*NET provides building blocks

(rather than ready-made solutions or final answers) toward more complete solutions.

The Department of Labor should not wait to initiate the research and development recommendations of this report until the technical advisory board and user advisory boards have been constituted and are fully functioning, but should proceed with continuous improvement initiatives using its traditional advisers until these boards can be established. The department should also establish mechanisms for ongoing communication between the user advisory board and the technical advisory board we recommend.

1

Introduction

In today's uncertain economic environment, standardized information about the characteristics of jobs is helpful to match job-seekers with vacancies, provide a foundation of basic information about occupations, and create the means for tracking changes in occupations over time, as well as for other purposes. The Occupational Information Network, called O*NET, which replaced the earlier printed *Dictionary of Occupational Titles* (DOT), provides such information in the form of an electronic database and related tools.

The first edition of the DOT appeared in 1939, when millions of American were out of work. Congress approved the Wagner-Peyser Act in 1933, creating the U.S. Employment Service in the U.S. Department of Labor (DOL). As called for in the law, DOL provided funds and assistance to the states to create a national network of public employment offices and also initiated a program of occupational research in order to help the new employment offices classify and match job seekers with jobs (National Research Council, 1980). This research program led to publication of the 1939 volume, which included concise definitions of approximately 17,500 jobs, presented alphabetically by job title; jobs were classified into one of 550 occupational clusters and were also defined as skilled, semiskilled, or unskilled.

GOALS AND PROGRAM MANAGEMENT

Although no formal mission statement for O*NET with specific goals has been published, the DOL Strategic Plan for 2006-2011 includes this goal (U.S. Department of Labor, 2006, strategic goal 2):

> Meet the competitive labor demands of the worldwide economy by enhancing the effectiveness and efficiency of the workforce development and regulatory systems that assist workers and employers in meeting the challenges of global competition.

This overarching goal includes a more specific one: "Build a demand-driven workforce system by increasing the accessibility of workforce information through the National Electronic Tools" (performance goal 2E). The strategic plan lists the web interface used to access the O*NET database, O*NET OnLine, as one of these electronic tools, stating that it is to be used for two main purposes:

1. To support individuals in making education and training decisions and investments, and
2. To support business and community needs for a prepared and globally competitive workforce.

Another indication of the O*NET mission is its funding source. DOL provides funding for O*NET under the Wagner-Peyser Act, as part of a stream of funding dedicated to employment services. This funding stream includes a budget earmarked for workforce information, which in turn includes a line item for O*NET.

These statements and the funding source suggest that a primary goal of O*NET is to help state workforce development offices carry out their dual mission of assisting individuals in gaining challenging, rewarding work (and any required education and training) and assisting employers in recruiting, hiring, and developing skilled workers. In addition, O*NET is intended to be useful to other audiences, including human resource managers, students planning their future education and career paths, community-based organizations, and colleges and technical schools (e.g., National Center for O*NET Development, 2009a).

Program Management

DOL's Employment and Training Administration (ETA) manages the O*NET program through an annual grant to the North Carolina Employment Security Commission, which oversees the National Center for O*NET Development (the O*NET Center). The O*NET Center employs core staff

and, under ETA direction, manages projects to collect, evaluate, and disseminate O*NET information and related products and tools and provides technical support and customer service to O*NET users. The O*NET Center works in partnership with several other organizations (National Center for O*NET Development, no date):

- RTI International (RTI) designs, implements, and supervises the survey data collection designed to populate the O*NET database.
- The Human Resources Research Organization provides technical expertise on the O*NET content model and in the areas of data collection, job analysis, assessment, and training.
- North Carolina State University (NCSU) conducts research to support O*NET initiatives, such as identification of new and emerging occupations.
- MCNC, a nonprofit organization that uses advanced networking technologies to support learning and collaboration in North Carolina's education community, houses the O*NET database and provides Internet access and dissemination and strategic advice on technology.
- Maher & Maher provides web-based training services and products through the O*NET Training Academy to support the use of O*NET information.

COMPONENTS OF O*NET

At the heart of the O*NET program is a database of information on the characteristics of occupations (which are clusters of similar jobs) and their requirements of workers. The program consists of a content model, which is used to describe the characteristics of occupations, an ongoing data collection program to update information on these characteristics, and a program for the publication and maintenance of the database. To facilitate use of the database, the O*NET Center has also developed several related tools.

The Content Model

The content model organizes information on many different characteristics of occupations into a taxonomy that is structured hierarchically. At the highest or most general level, the content model organizes information into six categories, designed to provide multiple "windows" into the world of work (see Figure 1-1). These broad categories are referred to as *domains*.

At the next level of the taxonomy, each of these six domains includes subcategories of occupational information, also structured hierarchically

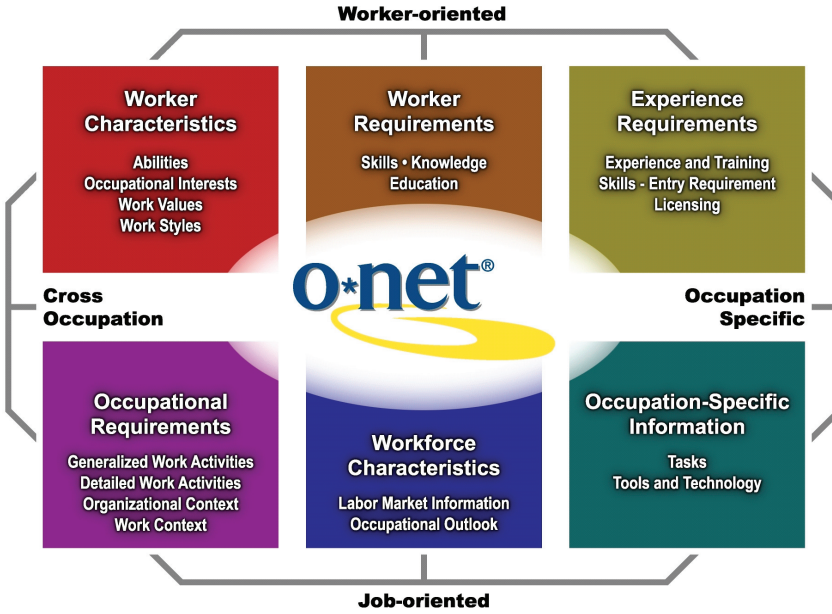

FIGURE 1-1 Overview of the O*NET content model.
SOURCE: National Center for O*NET Development (no date, a). Reprinted with permission.

and also known as domains.[1] Each domain, such as Abilities, Generalized Work Activities, and Tasks, is made up of the most specific information items in the taxonomy, called *descriptors*. Because these domains are also taxonomies, they are also referred to as *descriptor taxonomies*.

Each domain is organized hierarchically. For example, the Abilities domain includes three levels. The highest or most general level is comprised of four categories: cognitive, psychomotor, physical, and sensory (U.S. Department of Labor, 2008). Each of these four groups of abilities includes two levels of more specific descriptors (see Appendix B for the full hierarchy of domains and detailed descriptors). The six broad domains and the detailed domains they contain are described briefly below (some detailed domains are discussed more thoroughly in Chapter 2).

[1]In biology, the word "domain" is reserved for the highest or most general level of the taxonomy, but in this report, "domain" refers to both the highest level and also to the second highest level of the O*NET content model.

1. **Worker Characteristics:** These are enduring characteristics of workers that may influence both performance and the capacity to acquire knowledge and skills required for effective work performance. This broad domain includes four more specific domains: Abilities, Occupational Interests, Work Values, and Work Styles.
2. **Worker Requirements:** These are work-related attributes that are acquired or developed through experience and education. This broad domain includes three more specific domains: Skills, Knowledge, and Education.
3. **Experience Requirements:** These are requirements that are explicitly linked to certain types of work activities, such as experience, training, licenses, and skills required for entry into the occupation.
4. **Occupational Requirements:** These are specific occupational requirements, including the following domains: Generalized Work Activities, Work Context, Detailed Work Activities, and Organizational Context.
5. **Workforce Characteristics:** This category includes variables describing the general characteristics of occupations that may influence occupational requirements. It includes labor market information (such as wage levels and employment levels) and occupational outlook information (such as projected future employment levels).
6. **Occupation-Specific Information:** This category of information describes characteristics that apply either to a single occupation or to a more narrowly defined job family. Currently, the database includes two descriptor taxonomies, Tasks and Tools and Technology.

The entire content model can be found at **http://www.onetcenter.org/** content.html.

Data Collection, Publication, and Expenditures

The National Center for O*NET Development and its partners collect data related to five of the six broad domains included in the content model, excluding the workforce characteristics category (see Figure 1-1). Workforce characteristics data are provided through links to the employment, wage, and long-term employment projections databases produced by the U.S. Bureau of Labor Statistics and state and local employment agencies (U.S. Department of Labor, 2008). To populate the other five, the O*NET Center collects some data, and its partners collect others.

The O*NET Center and its partners, RTI and NCSU, use multiple methods to collect data related to these domains and the more detailed descriptors within them. These methods include surveying a national sample

of establishments and their workers, supplemented by additional samples when necessary; surveying samples of occupational experts; and collecting data from occupational analysts, who are provided with updated data from the worker surveys.

In addition to these primary data collection activities, the O*NET Center collects data to populate two descriptor taxonomies, Tools and Technology and Detailed Work Activities, as well as data on lay job titles. After collection, the data are cleaned, nonresponse to surveys is analyzed at multiple levels, and weighting and estimation procedures are applied to account for nonresponse (U.S. Department of Labor, 2008). Finally, updated data are incorporated into, and maintained within, the O*NET database.

The first O*NET database, published in 1998, is known as the "analyst database" because it is comprised of data provided by trained occupational analysts (see Box 1-1). Over the next few years, the O*NET Center focused on developing data collection methods. In 2000, the O*NET Center launched a major data collection program aimed at populating the database with updated data by 2008, one decade after publication of the analyst database. To advance this goal, spending on data collection rose, reaching a peak of $10.15 million in fiscal year 2003, as the O*NET Center conducted many waves of sampling (see Table 1-1). From 2002 to 2006, the O*NET Center collected updated information on approximately 200 occupations each year, publishing an updated database every six months (see Box 1-1).

In recent years, the pace of data collection has slowed. The O*NET Center has spent $6.5 to $6.8 million annually to collect and publish updated data on approximately 100 occupations each year. The current database, O*NET 14.0, released in June 2009, includes updated information on 833 of the 965 occupations for which data are gathered,[2] or 86 percent of these occupations. The 132 occupations that have not yet been updated are among the new and emerging occupations added to the O*NET-SOC (Standard Occupational Classification) taxonomy in 2009. The O*NET Center has largely achieved the goal of populating the database with updated information.

O*NET Tools and Websites

In addition to developing, updating, and publishing the database that is the heart of O*NET, the National Center for O*NET Development has created several tools to facilitate its use:

[2]The O*NET occupational classification system includes 1,102 occupations, but data are not collected for all of these occupations.

- A website for public viewing and searching the database, O*NET OnLine (http://online.onetcenter.org/; see Chapter 5 for discussion of the website).
- A website with more detailed technical information that allows the database to be downloaded, the O*NET Resource Center (http://www.onetcenter.org/).
- A web-based application to assist workforce development professions in matching lay job titles with O*NET occupations, the O*NET Code Connector, available through a website, the O*NET Code Connector (http://www.onetcodeconnector.org/) and for download from the O*NET Resource Center website.
- A website providing a forum for users and developers to share knowledge, the O*NET Knowledge site (http://www.onetknowledgesite.com/onet_ks_home.cfm).
- A website providing education and tutorials on how to use O*NET, the O*NET Academy (http://www.onetacademy.com/).
- A suite of career exploration tools, including
  —the O*NET Ability Profiler
  —the O*NET Interest Profiler
  —the O*NET Computerized Interest Profiler
  —the O*NET Work Importance Locator
  —O*NET Work Importance Profiler.

These career exploration tools are designed to help individuals assess their work-related interests, what they consider important on the job, and their abilities in order to explore the occupations that relate most closely to those attributes. Printed versions of the Ability Profiler, the Interest Profiler, and the Work Importance Locator tools and their supporting documents are available for download from the O*NET Resource Center website and for purchase in quantity from the U.S. Government Printing Office. Electronic components of the Ability Profiler, the Computerized Interest Profiler, the Work Importance Locator, and the Work Importance Profiler are available for download from the O*NET Resource Center website.

A BRIEF HISTORY OF O*NET

In 1977, when the U.S. Employment Service published the fourth edition of DOT, the agency decided it would be timely to evaluate both the uses of this catalogue of job-related information and the research program underlying it. The agency called on the National Research Council (NRC) to conduct a critical review of DOT (National Research Council, 1980).

The NRC committee raised concerns about the extent to which the entire realm of civilian jobs was covered and the accuracy of the information.

BOX 1-1
Publication of O*NET Databases

O*NET 98 (October 1998):	Release of the original "analyst database" based on the Occupational Employment Statistical (OES) classification
O*NET 3.0/3.1 (August 2000/June 2001):	Database classification converted to conform to the new Standard Occupational Classification (SOC) system
O*NET 4.0 (June 2002):	Release of the final analyst database with a revised database structure consistent with the Data Collection Program approved by the Office of Management and Budget
O*NET 5.0 (April 2003):	First update of the database from the Data Collection Program with a comprehensive update of 54 occupations
O*NET 5.1 (November 2003):	Occupational-level and item-level metadata added to the O*NET database
O*NET 6.0 (July 2004):	Second update of the database from the Data Collection Program with a comprehensive update of 126 occupations
O*NET 7.0 (December 2004):	Third update of the database from the Data Collection Program with a comprehensive update of 100 occupations

O*NET 8.0 (June 2005):	Fourth update of the database from the Data Collection Program with a comprehensive update of 100 occupations
O*NET 9.0 (December 2005):	Fifth update of the database from the Data Collection Program with a comprehensive update of 100 occupations
O*NET 10.0 (June 2006):	Sixth update of the database from the Data Collection Program with a comprehensive update of 100 occupations; release of the updated O*NET taxonomy, O*NET-SOC 2006
O*NET 11.0 (December 2006):	Seventh update of the database from the Data Collection Program with a comprehensive update of 101 occupations
O*NET 12.0 (June 2007):	Eighth update of the database from the Data Collection Program with a comprehensive update of 100 occupations
O*NET 13.0 (June 2008):	Ninth update of the database from the Data Collection Program with a comprehensive update of 108 occupations
O*NET 14.0 (June 2009):	Tenth update of the database from the Data Collection Program with a comprehensive update of 117 occupations; release of the updated O*NET taxonomy, O*NET-SOC 2009

SOURCE: National Center for O*NET Development (2009b). Reprinted with permission.

TABLE 1-1 Expenditures by the National Center for O*NET Development

Fiscal Year	Expenditures ($ millions)
1998	1.0
1999	3.2
2000	4.35
2001	5.46
2002	6.0
2003	10.15
2004	9.5
2005	8.5
2006	7.0
2007	6.5
2008	6.8
2009	6.5

SOURCE: Personal communication, Pam Frugoli, O*NET/Competency Assessment Team Leader, U.S. Department of Labor, August 3, 2009.

For example, the committee found that the occupational titles included were disproportionately concentrated in manufacturing; that nearly two-thirds of the occupational descriptions were based on observation of fewer than two jobs; that the number of occupational titles identified in some job families (e.g., processing, machine trades) was disproportionate to the representation of these job families in the labor force; and that three-fourths of the job analysis schedules (forms) used by occupational analysts to compile the dictionary did not meet the standards specified for a complete occupational analysis. In addition, the committee criticized the ratings of worker functions and traits made by job analysts (National Research Council, 1980).

The committee recommended not only improvements to the existing system of cataloging and describing jobs, but also substantial changes to the overall approach to organizing occupational information and the process for maintaining a robust database. Among its recommendations (National Research Council, 1980, pp. 13-14):

1. The occupational analysis program should concentrate its efforts on the fundamental activity of job analysis and on research and development strategies—for improving procedures, monitoring changes in job content, and identifying new occupations—that are associated with the production and continuous updating of the *Dictionary of Occupational Titles*.
2. A permanent, professional research unit of high quality should be established to conduct technical studies designed to improve the quality of the *Dictionary of Occupational Titles* as well as basic research designed

to improve understanding of the organization of work in the United States.
3. An outside advisory committee to the occupational analysis program should be established.

In addition, the committee recommended that DOL explore cross-occupational linkages of occupational information to identify possible areas of skills transferability; possibilities for increased alignment with federal job classification systems; and research on criteria for aggregating specific job titles into an occupation.

In 1990, DOL, following the NRC committee's recommendation to create an outside advisory panel to guide revisions to the DOT, established the Advisory Panel for the Dictionary of Occupational Titles (Advisory Panel for the Dictionary of Occupational Titles, 1993). As recommended by this panel, DOL sponsored a research and development project that led to creation of the prototype O*NET content model (Peterson et al., 1995, 1999). After pilot testing and revision of the initial content model, the prototype was revised slightly to create the current content model.

CHARGE TO THE PANEL

The Panel to Review the Occupational Information Network (O*NET) was charged to:

Conduct a top-level review of the O*NET program and the electronic database access program that supports it; to document the important current and potential future uses of O*NET in business, labor market functions, job matching systems, and human resource management; and to consider future directions for the program. The panel's investigation will be aided by the conduct of a workshop. The product of the study will be a final report with recommendations that will focus on means of strengthening the program and future directions for O*NET.

The panel will develop an inventory and evaluation of the uses of O*NET, in order to gain an understanding of the extent to which O*NET has become embedded in business, labor market functions, human resource practices, job matching systems such as Monster, human resource management information systems, and in international applications.

The linkage of the O*NET system with the SOC system, a key tenet of the program since its inception, will be documented and explored. The expert panel will use this information to assess the extent to which the opportunities for linking O*NET with employment, wage, demographic, and other occupational data have been realized.

Based on its assessment of the state of the system, the panel will seek

to identify opportunities to take O*NET to a new level. This will involve mapping out a system for the future that builds on O*NET successes and seeking ways to improve it, while maintaining the high quality standards and level of validity it has attained.

Some of the areas for which the panel will consider opportunities for enhanced functionality and improvement will be currency (how to capture changing and emerging skill needs in the economy and labor market with certainty and speed); efficiency; cost-effectiveness; use of new technology and collaborative approaches (to include Web 2.0 or "wiki" type processes in which those who provide input into the system are able to add to and update some items interactively online); means of capturing/documenting emerging skill changes and new and emerging occupations; and ways to foster seamless integration with the development and updating of industry competency models. It is expected that this review will lead to recommendations for potential cost savings and increased speed in turnaround time from identifying an occupation to being able to use the data in applications and in the field.

HOW THE PANEL APPROACHED THE CHARGE

The panel approached its charge through an iterative process of gathering information, deliberating on what was learned, identifying gaps, and seeking new information to fill the gaps. The panel obtained information on O*NET and key study issues from DOL and the O*NET Center, in both formal presentations and meetings and in ongoing information exchanges. The panel reviewed published literature in the fields of industrial/organizational psychology, human resource management, economics, and cognitive psychology, as well as unpublished "gray literature," including business and trade documents.

Panel members also conducted informal telephone and e-mail surveys of the communities they represent, including the career development community, the workforce development community, the human resource management community, and the community of recent O*NET users. However, time and resource limits prevented the panel from conducting a systematic, national survey of O*NET users.

To gather information for the study, the panel convened a public workshop on uses of O*NET on March 26, 2009, and another on approaches to improving O*NET on April 17, 2009. Experts were asked to make presentations at these two workshops, and some of them also provided papers and other written materials. All materials received by the panel are available at http://www7.nationalacademies.org/cfe/ONET_Review.html.

Based on its review of these information sources, the panel reached conclusions and developed recommendations for improvements to O*NET,

presented in the following chapters. In some cases, the evidence was sufficient to support specific recommendations designed to enhance particular strengths or remediate specific weaknesses in O*NET. In many cases, however, the evidence that could be assembled and considered with the available resources and within the time frame of the study was insufficient, leaving the panel with unanswered questions. In these cases, the panel recommended further research and evaluation to address the questions. Recognizing that DOL will need technical expertise to carry out these recommendations and that new questions about O*NET will continue to emerge as a result of changes in jobs, the science of job analysis and data collection methods, technology, and other factors, the panel also recommends that DOL create an ongoing technical advisory board to evaluate and prioritize future research.

Because of limits on time and resources, the panel was unable to fully address one element in our charge—a review of international applications of O*NET. However, our review of uses of O*NET in human resource management and labor market research indicates that O*NET has been used for cross-cultural comparisons and in research on European labor markets (see Chapter 9). In addition, the National Center for O*NET Development (2009a) has documented tools and applications of O*NET developed in other countries for use in those countries, as well as translations to other languages.

Another area that the panel did not fully explore was the potential use of O*NET data in state and national education systems. Although we document uses of O*NET data to assist middle and high school students in college and career planning (see Chapter 6), we did not explore possible uses of O*NET data to inform workforce readiness certification programs, career pathways programs, development of career and technical education programs of study, state initiatives to increase access to and completion of postsecondary education, or state longitudinal education data systems. These potential uses of O*NET lay outside the study charge. In addition, the panel did not address the use of O*NET for vocational rehabilitation counseling, another area that lay outside the study charge.

ORGANIZATION OF THE REPORT

Part I describes and evaluates the core elements of O*NET. Chapter 2 covers the O*NET content model, Chapter 3 deals with the linkage of O*NET with the SOC system, and Chapter 4 addresses the currency of the data and the accuracy and cost effectiveness of current data collection methods. Chapter 5 examines the role of technology in supporting increased use of O*NET and comments on use of technology for data collection.

Part II includes the committee's inventory and evaluation of the major

current and potential uses of O*NET. Chapter 6 deals with the use of O*NET in state workforce development and career development, including the extent to which it has become embedded in labor market functions and job matching systems. Chapter 7 is an inventory and evaluation of its uses in business and human resource practices. Chapter 8 discusses an application for which O*NET is not currently used, but might potentially be in the future—the Social Security Administration's disability determination process. Chapter 9 describes the research uses of O*NET data.

The panel's detailed conclusions and recommendations appear at the end of each chapter.

Part III (Chapter 10) presents the panel's recommendations for the future of O*NET. All recommendations are summarized and presented in order of importance, as seen by the panel.

Appendix A is a dissenting statement signed by two panel members. Appendix B presents the descriptor taxonomies included in the content model, and Appendix C presents brief biographies of panel members and staff.

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Part I

Core Elements of O*NET

2

The Content Model

The content model is the basic building block of the O*NET system and refers to the prescribed set of variables used to describe occupations (see Figure 1-1). Each of these variables—a particular aptitude, skill, or education requirement—is referred to as a *descriptor*. All uses of O*NET rely on descriptions of occupations using the descriptors specified by the content model. If important features of occupations are not included in the content model, or irrelevant features are included, or the descriptors that are included are flawed, then the applications of O*NET are suboptimal. Simply put, the importance of the validity, completeness, and usability of the content model cannot be overemphasized.

This chapter discusses the developmental history of the O*NET content model and the research literature on which the model is based. Following a brief introduction, the first section focuses on the content model of the *Dictionary of Occupational Titles* (DOT), the predecessor to O*NET. The second section discusses the content model proposed by the Advisory Panel for the Dictionary of Occupational Titles (APDOT) for a new and different DOT; this ultimately became O*NET. The third section discusses the O*NET prototype content model, focusing especially on the development of descriptors, many of which are included in the current O*NET content model. The fourth section discusses the field test of the prototype and development of the current content model. The final section presents the panel's conclusions and recommendations related to the content model.

THE CONTENT MODEL AS A TAXONOMY

The content model is intended to be a taxonomy of occupational descriptors. An important first step in developing a taxonomy is to define the unit of analysis. In O*NET, this is the occupation, rather than the job or position. An occupation is broader than a specific job or specific position, and it is not idiosyncratic to a particular organization, industry, or setting. A particular occupation could include several jobs if the general responsibilities, activities, and requirements for the various jobs are substantially similar. For example, the occupation "commercial aircraft pilot" could include many different jobs as a function of type of organization, type of aircraft, and business function (see Chapter 3 for further discussion).

With occupations as the unit of analysis and the characteristics of these occupations, such as the physical and cognitive abilities they require of workers, to be included in a taxonomy of descriptors, a number of other important questions become relevant:

1. How general or specific will the descriptors of occupational requirements be? For example, when considering how to develop a taxonomy of the abilities required by occupations, previous research provides taxonomies that define abilities in terms of two groups of factors (clusters of more specific abilities), four groups of factors, eight groups of factors, or some greater number (see Carroll, 1993).
2. Given a particular level of generality/specificity, should the set of descriptors of a particular occupational requirement (e.g., knowledge, ability) be a representative sample of all possible descriptors of that requirement, or should it represent the entire universe of descriptors? Previous research-based taxonomies of human abilities (Carroll, 1993) are meant to describe the full range of human abilities, rather than a representative sample. Is this exhaustive approach to be applied when developing descriptors for all of the occupational requirements?
3. Should each descriptor of occupational requirements be applicable to every occupation (i.e., unit of analysis)? To return to the example of abilities, previous taxonomies have been designed to include descriptors that can be measured across all individuals. They do not include any descriptors of abilities that are applicable only to men or only to women.
4. Is the taxonomy to include genuine taxons, such as those in biology? In biology, a taxon is defined as a group of organisms with common characteristics, in varying degrees of distinction, such as a phylum, order, family, genus, or species. Common physical char-

acteristics among the organisms allow clear separation between groups and subgroups (Meehl and Golden, 1982). In the social sciences, where there are rarely such distinguishing variables, a taxonomy must live with classification variables that are continuous and errors of classification that cannot be reduced to zero. The boundaries between different groups and subgroups of similar occupational characteristics are always blurred, and the clarity of naming and defining different occupational characteristics must always be a function of the rules for minimizing the errors of classification given the alternative ways of describing skills.

5. Can the taxonomy be designed to serve a wide range of purposes among diverse users?

The developers of the O*NET content model addressed all these issues, if not directly, then by default. There have been four major milestones in the development of today's content model. The first was the final edition of DOT, which incorporated a content model (U.S. Department of Labor, 1991). Second, in 1993, APDOT recommended a set of specifications for a content model to be included in a new and different DOT, which they referred to as the "new DOT" (Advisory Panel for the Dictionary of Occupational Titles, 1993). Third, following the advisory panel's recommendations, the U.S. Department of Labor (DOL) funded the O*NET development project, which produced a prototype O*NET content model in 1997 (Peterson et al., 1997). Fourth, the prototype was revised in 1998-1999, leading to the current content model. Since 2000, the National Center for O*NET Development (the O*NET Center) has collected data related to the descriptors in this content model.

THE *DICTIONARY OF OCCUPATIONAL TITLES* CONTENT MODEL

The 1991 revision of the DOT contains descriptions of over 12,000 occupational titles, referred to as *DOT codes*. All information was obtained by trained occupational analysts who visited each work site, interviewed job incumbents, and observed them at work. The analysts were told to follow standardized procedures when observing and interviewing job incumbents and creating descriptions using a common format or content model. The 1991 volume included, for each DOT code:

1. A written description. The analysts followed a detailed standard protocol to describe the specific tasks, duties, responsibilities, etc., carried out by the incumbent. These occupation-specific task descriptions led to the criticism that the DOT lacked a common

language that could be used to describe a variety of different jobs (National Research Council, 1980). However, the current O*NET content model includes occupation-specific tasks as well as Detailed Work Activities (DWA) that are derived from multiple analyses of task information and are somewhat similar to the task descriptions similar to those included in the DOT.

2. Aptitude ratings. Following a prescribed procedure, the analysts rated each occupational title on the level of each of nine aptitudes that were derived from the nine constructs measured by the General Aptitude Test Battery (GATB) (Dvorak, 1947). The GATB included four cognitive ability subtests, two perceptual speed subtests, and three psychomotor subtests.
3. Temperament requirements. A temperament requirement was defined as an occupational situation to which a job incumbent must adjust. The analysts were provided with 10 situations and asked to identify the 2 most critical for each occupational title. They were not asked to equate these situational requirements with established individual personality traits.
4. Interests. The domain of work interests was represented by 10 interest factors configured as 5 bipolar preferences. The factors were derived from factor analyses of data from the Kuder Preference Record and Strong Vocational Interest Blank by Cottle (1950). These factors predate the Holland typology of work interests that is currently widely used in career guidance (i.e., Holland and Gottfredson, 1976). The analysts designated the two factors that were the most critical requirements of a particular occupational title and were not asked to rate the importance or level of the factors.
5. Physical demands. The analysts also rated each occupational title in terms of six physical demands. They rated the level of strength required by the job using a five-point scale ranging from sedentary to light, medium, heavy, or very heavy. The other five physical demands: (1) climbing/balancing, (2) stooping/crawling, (3) reaching/handling, (4) talking/hearing, and (5) seeing were designated as present or absent.
6. Job environment. The analysts indicated the presence or absence of extreme cold, extreme heat, dampness and/or humidity, noise and/or vibration, and whether the occupational title was performed primarily indoors, outdoors, or both.
7. Specific vocational preparation. The job analysts rated the level of Specific Vocational Preparation required by the occupational title, independent of general education, using a 9-point scale

ranging from 1 (receiving a short demonstration only) to 9 (over 10 years of specific preparation).

8. General educational development. Based on extensive specifications and rater training, the job analysts rated the level of reasoning, mathematics, and language skill required by the occupational title.
9. Complexity. The analysts rated the occupational title in terms of the involvement of the job tasks with data and information, interactions with people, and usage of things (such as equipment, tools, and vehicles).

In sum, DOT was based on an extensive content model that included a broad spectrum of descriptors that were used to describe occupational titles for various purposes. With the exception of the task information in the written description, all of the descriptors were cross-functional and could be used to describe all occupational titles. These descriptors constituted a common language, and a number of them have their analogs in the current O*NET content model.

THE APDOT CONTENT MODEL

The secretary of labor convened APDOT in 1990, charging it to recommend strategies for collecting, analyzing, and disseminating occupational information.

The advisory panel proposed a new model that specified the most important types of information about occupations and workers that should be included in what it called the "new DOT," which evolved to become O*NET (Advisory Panel for the Dictionary of Occupational Titles, 1993). At the most general level, this content model organized information into four broad domains that are similar to the most general domains in O*NET: (1) worker attributes, (2) work context, (3) labor market context, and (4) work content and outcomes (see Figure 1-1). It also included more specific domains of information, such as Occupation-Specific Knowledge and Generalized Work Activities (GWAs). The advisory panel envisioned that information related to these domains would be incorporated into a flexible electronic database, rather than being published as a printed book.

The domains and occupational descriptors included in this content model were based on extensive research, reviews of current practice, and expert testimony. However, the advisory panel did not discuss in any detail why each domain was critical, nor did it outline the specific uses of each domain (Advisory Panel for the Dictionary of Occupational Titles, 1993). Consequently, the APDOT content model is open to the criticism that it simply includes everything that occupational analysis researchers, practi-

tioners, and users of occupational data were discussing at that time, albeit in meaningful and organized ways. Overall, in comparison to the previous DOT content model, the APDOT content model was more comprehensive, systematically structured, and reflective of what had been learned about occupational analysis between 1930 and 1990. Of course, the advisory panel did not engage in the formidable data collection and measurement issues presented by implementation of the model. That was the task of the O*NET prototype development project.

Although the advisory panel criticized the DOT codes as being too job-specific, its content model included Occupation-Specific Knowledge, Occupation-Specific Skills, and Duties/Tasks Performed (Advisory Panel for the Dictionary of Occupational Titles, 1993). It appears that the advisory panel wanted to include both cross-occupation information and occupation-specific information.

The advisory panel proposed (p. 15) that the single most important capability of the new occupational information system would be to use multiple approaches to identify transferable skills. Because the advisory panel viewed several different groups of descriptors as skills (e.g., tasks, work activities, aptitudes), it created the potential for future confusion concerning the specifications for the skills taxonomy in the O*NET content model. The advisory panel made three other recommendations that informed the panel's review of the current O*NET content model and data collection methods (Advisory Panel for the Dictionary of Occupational Titles, 1993):

1. The content model should describe occupational characteristics in such a way that any person can evaluate his or her capability to perform in an occupation. Consequently, difficult to understand technical terms should be avoided.
2. The Department of Labor should commit to "an ongoing research and development agenda" and should "recruit, train, and maintain a core staff of methodologically sophisticated professionals to manage the DOT program" (1993, p. 7).
3. The content model itself should be subjected to continuous evaluation and enhancements, based on future developments in research and practice. In no sense should it be cast in concrete or viewed as unchangeable.

THE O*NET PROTOTYPE CONTENT MODEL

To carry out the advisory panel's recommendation to develop a "new DOT," the Employment and Training Administration contracted with a consortium of consulting firms with expertise in occupational analysis as

well as survey design and administration to conduct the necessary research and development. The project to develop the prototype for the new occupational information system was completed in 1996, and the research and development process has been described in several publications (Peterson et al., 1997, 1999, 2001). During the course of the project, the term "new DOT" was replaced by the Occupational Information Network (O*NET) in order to sever any direct linkage to the DOT and reflect the move to an electronic database.

As envisioned by the advisory panel, the goal of the O*NET project was to develop a prototype of a new national occupational information content model and offer evidence substantiating "proof of concept" for such a model. The advisory panel expected that the prototype would then undergo additional development and revision before becoming the basis for the principal data collections.

The prototype project team attempted to develop a content model that followed the advisory panel's recommendations, corrected the DOT's deficiencies, reflected new research and practice in occupational analysis, and incorporated the capability to adapt to a changing labor market and workforce. To advance these multiple goals, the specifications for the content taxonomies would be crucial.

The resulting prototype content model adopted the overarching framework of the APDOT content model, which divided all domains of occupational descriptors into three groups describing (1) the work itself, (2) the "worker" (i.e., job applicant or job incumbent), or (3) the context in which work takes place. Curiously, neither the advisory panel nor the prototype project team explains why these three facets of occupations should be described, except to say that the database should be a complete description of occupations and that multiple windows (i.e., domains of information) are necessary to accommodate different user needs (Peterson et al., 1999, p. 13). Compared with the APDOT content model, the O*NET prototype gave less attention to occupation-specific descriptors and concentrated to a greater extent on so-called cross-occupation descriptors, or variables that could be measured meaningfully in all occupations and along which occupations would be expected to vary. As discussed later in this chapter, it is not easy to distinguish between cross-occupation and occupation-specific descriptors.

Another objective for the O*NET prototype was to develop taxonomies of descriptor variables in each domain that are hierarchical in nature. The goal from the outset was to describe occupations at varying levels of generalizability or specificity in each domain. Consequently, the descriptors were to be nested in hierarchical levels. For example, there are 17 specific descriptors in the Work Styles taxonomy, which are in turn nested in 7 more general styles (see Appendix B). This approach implies that the

database would include "score profiles" for each occupation at each level of the hierarchy.

Because many of the taxonomies of descriptors created in the O*NET prototype project are included in the current content model, it is important to examine their development and research base. The prototype project proceeded by constituting a separate development team for each of the content domains, reflecting the goal of providing multiple windows, or domains of information, to meet the needs of different users. The teams' results are described briefly below.

Abilities

The current content model incorporates the taxonomy of Abilities descriptors developed in the prototype. The prototype team's (and current) definition of ability is consistent with the very large research literature investigating the nature of human abilities (e.g., Carroll, 1993). That is, an Ability is a relatively enduring attribute that reflects an individual's capability for performing a particular category of tasks (e.g., verbal, mathematical, physical, motor, psychomotor, sensory). This underlying capability for performing a designated category of tasks remains relatively stable over much of the individual's life span, with certain physical or motor abilities perhaps being exceptions.

The literature documents literally hundreds, if not thousands, of well-researched standardized tests of various human abilities (e.g., Geisinger et al., 2007), and investigations of the empirically estimated covariances among sets of such tests have produced considerable evidence for hierarchical taxonomic structures of human abilities (Carroll, 1993). In light of O*NET's objective of producing the most comprehensive occupationally relevant taxonomy, the development team incorporated the Fleishman and Reilly (1992) taxonomy of abilities to create the O*NET Abilities domain. There are 52 Abilities at the most specific level, 15 more general Abilities at the next level, and 4 Abilities at the most general level (Fleishman, Costanza, and Marshall-Mies, 1999). The abilities at one level are fully nested in the next higher level (see Appendix B).

The process of developing and administering surveys to gather information related to these abilities as occupational requirements has proven complex (see Chapter 4). The 52 Ability descriptors were used to describe occupations by asking raters (job incumbents or occupational analysts) to rate both the required level of the ability and the importance of the ability for being able "to perform the job." Neither the metrics for the scales nor the frame of reference is without criticism and could benefit from additional research and development. The same issues exist for the other descriptor domains as well. An additional difficulty is that the descriptors themselves

are defined only very briefly, and considerable expertise in the psychology of individual differences is required to understand some of them.

Work Styles

The current O*NET content model incorporates the taxonomy of Work Styles developed by the prototype team (see Appendix B). Work Styles refer to the personality or dispositional requirements of occupations. Similar to Abilities, Work Styles are seen as relatively stable attributes of individuals that affect their ability to perform different types of occupations. Work Styles are included in both the prototype and current O*NET content models because decades of previous research have shown them to be important determinants of individual differences in occupational performance, particularly components of performance having to do with teamwork, peer leadership, supervision, and management (Borman, Kubisiak, and Schneider, 1999). The term "work styles" was used, rather than "personality," because of the intent to emphasize personal characteristics that are occupationally related.

The Work Styles taxonomy was developed by a careful review of two different literatures. The first consists of research focused on developing taxonomies of personality dimensions and facets, such as the Big Five (Costa and McCrae, 1992). The second literature examined research that reflects the validity of personality characteristics for predicting different aspects of job performance (e.g., Barrick and Mount, 1991; Hough, 1992). The research team focusing on Work Styles (Borman, Kubisiak, and Schneider, 1999) synthesized the results of these two bodies of research and suggested a taxonomy of Work Styles incorporating 17 factors fully nested in 7 higher order factors. The taxonomy is shown in Appendix B. The Work Styles domain in O*NET is analogous to the Personal Qualities domain in the APDOT content model, which was to include information on an individual's characteristic, habitual, or typical manner of thinking, feeling, behaving, or responding as it relates to work (e.g., sociability, integrity).

The Work Styles taxonomy seems well grounded in previous research. However, identifying the most appropriate raters for what are essentially the personality requirements of occupations is perhaps more difficult to accomplish (see Chapter 4). In addition, the question remains about whether the judgments about the level of each work style that is required for an occupation should be with reference to minimal, average, or high performance. There is also recent evidence that for some occupations the relationships of certain personality factors to performance may be curvilinear (e.g., Benson and Campbell, 2007). The O*NET prototype specifications seem to imply only linear relationships, or at least monotonically increasing

predicted performance as a function of increasing scores on the personality factor.

Occupational Interests

The current O*NET content model uses the taxonomy of Occupational Interests adopted in the prototype content model (Sager, 1997; Sager et al., 1999). The prototype development team adopted Holland's typology of six types of occupational interests: realistic, investigative, artistic, social, enterprising, and conventional (Holland and Gottfredson, 1976), or RIASEC. The typology is based on a long record of vocational interest research going back over three decades, and its construct validity is really not in doubt. However, unlike the other taxonomies included in the prototype model, the descriptors are not hierarchical.

Work Values

The taxonomy of descriptors of Work Values in the current O*NET content model is nearly identical to that of the prototype content model. While interests are defined as the pattern of individual likes and dislikes for a large set of different activities, school subjects, and occupations, Work Values refer to an individual's evaluation of the importance of certain characteristics of the work environment for determining their job satisfaction (Sager, 1999). After a consideration of the research literature on the assessment of work values, the prototype team adopted a taxonomy developed by the Minnesota Studies in Work Adjustment (Dawis and Lofquist, 1984). In that model, the individual's self-rated importance for each value is assessed with the Minnesota Importance Questionnaire and the degree to which the job or occupation provides the opportunity to satisfy such values is rated by supervisors/managers using the Minnesota Job Description Questionnaire.

The prototype Work Values taxonomy incorporated two levels, with 21 descriptors of Work Values grouped into 6 higher order factors. The current O*NET content model changes the names of a few of the higher order factors, but the 21 Work Values are unchanged (see Appendix B).

Job-Relevant Knowledge

The taxonomy of Knowledge descriptors in the current O*NET content model is unchanged from the prototype content model. The prototype development team defined occupation-relevant Knowledge as a collection of discrete but interrelated facts and information about a particular domain having to do with performance in an occupation. The team adhered to the findings from cognitive psychology (e.g., Chi, Glaser, and Rees, 1983;

Lesgold, 1984) that knowledge is not very useful as a determinant of performance until it is embedded in an organized and meaningful cognitive structure.

The project team focusing on knowledge had to confront the difficult questions of how general or specific the Knowledge descriptors should be and how the Knowledge domains most critical for employment could be identified (Costanza, Fleishman, and Marshall-Mies, 1999). The team adopted the initial taxonomy of Knowledge descriptor from the Fleishman Job Analysis Survey (F-JAS), including 49 job-relevant Knowledge descriptors intended to cover (at a very general level) the knowledge requirements for all occupations in the labor force (Fleishman, 1992). The prototype development team compared the 49 F-JAS descriptors with the results of recent job analysis work at the Office of Personnel Management (Corts and Gowing, 1992). They also compared the descriptors to the Classification of Instructional Programs (Morgan, Hunt, and Carpenter, 1990) and to the preliminary findings of the National Occupational Information Coordinating Committee, which was attempting to develop a hierarchical taxonomy of educational preparation content. After many rounds of expert panel judgments concerning the comprehensiveness and suitability of alternative taxonomies, the prototype development team settled on a 2-level taxonomy consisting of 33 basic descriptors grouped into 10 more general categories. Each of the 33 descriptors was given a short (one or two sentence) specification.

The Knowledge descriptors are at a very high level of generality, which may suffice for some purposes, but not for others. For example, the subdisciplines in psychology are very different, and a knowledge requirement labeled "psychology" may not be informative. Also, the knowledge requirements for many technical services (e.g., plumber) and equipment operators (e.g., geothermal installation equipment operators, airplane pilots) do not appear to be included.

Occupational Preparation

The prototype content model included a taxonomy of the education, training, and other preparation required for occupations (Anderson, 1999). At the most general level, the descriptors were grouped into 7 categories: general education level, instructional program required (42 descriptors), subject-area education level (15 descriptors), licenses required (2 descriptors), requirement to obtain a license (6 descriptors), who requires the license (3 descriptors), and related work experience (4 descriptors). In the field test of the prototype content model (described in Chapter 4), job incumbents answered seven factual questions related to each category of information. Although these descriptors were relatively occupation specific,

multiple surveys of users of DOT had shown that they valued information on the amount and type of education needed to enter an occupation (Anderson, 1997). The Occupational Preparation taxonomy of the prototype content model was analogous to Specific Vocational Preparation in DOT, but it provided much more information. The current O*NET content model incorporates a less extensive taxonomy of occupational preparation, with five broad categories of information: general education level, related work experience required for hiring, onsite training required to perform the job, on-the-job training required, and number of years of apprenticeship required.

Skills

The current O*NET content model includes a taxonomy of Skills that is nearly identical to the Skills taxonomy in the prototype content model. This was the most difficult domain of occupational performance requirements to conceptualize, in terms of a taxonomy of descriptors. At the same time, both the advisory panel and many users of O*NET view information on skills as crucial. For example, presenters at our panel workshops described using O*NET to identify transferable skills to assist in matching individuals with jobs (see Chapters 6 and 7). However, simply defining the term "skill" is difficult, and the O*NET prototype development reports (Peterson et al., 1997, 1999) did not do so with any degree of concreteness or clarity. The lack of clarity is shown in the following statements, which reflect varying definitions of skill (Peterson et al., 1999, pp. 50-57):

- "In the past, skills have been defined in terms of specific task performance, educational requirements (e.g., the 3 Rs), or as a set of new capacities such as critical and creative thinking."
- "Skilled performance is a function of knowledge expertise as well as acquisition of a set of strategies, procedures, and processes for acquiring and working with information."
- "The procedures for acquiring and working with knowledge appear to represent the key components of skills."
- "Consequently, skills are not necessarily enduring characteristics of individuals. They depend on experience and practice. Second, they can be defined at different levels of generality; and thirdly, skills cannot be defined apart from some performance domains involving the acquisition of certain types of knowledge."

Given these attempts to define skill, the prototype development team then made the unsubstantiated statement that "sociotechnical systems theory" is the most widely accepted model for workplace behavior (Peterson

et al., 1999). Although we know of no evidence to support this statement, the project team used the sociotechnical systems framework to suggest that there are five categories of cross-functional skills (problem-solving skills, technical skills, social skills, systems skills, and resource management skills). The project team went on to identify more specific skills in each of the five categories, but it did not always provide a clear rationale for what was included or excluded. For example, there is a long-standing model of the problem-solving process that suggests there are several stages in the process, such as problem identification, information gathering, idea generation, etc. The prototype development team turned each of these stages into a separate cross-functional skill in the category of complex problem-solving skills. The team identified these stages as separate skills despite considerable evidence that suggests experts do not go through such stages when solving ill-structured problems. The current O*NET content model does not include these separate skills.

For the technical skills category, the team developed the taxonomy of descriptors by examining a sample of 48 job analyses (not identified) and inferring the existence of 12 distinct technical skills that enabled technical performance in them. Again, several of these technical skills had not been named in previous research. To develop the taxonomy in the social skills category, the team primarily drew on the social psychology literature (e.g., Cantor and Kihlstrom, 1987). However, the substantial—and occupationally relevant—literature on the training of interpersonal skills (e.g., Decker and Nathan, 1985; Goldstein and Sorcher, 1974; Latham and Saari, 1979) was not mentioned. Consideration of this literature would most likely have produced a somewhat different social skills taxonomy. The current social skills taxonomy in the O*NET content model is identical to the prototype.

The systems skills category included six individual descriptors of cross-functional skills, but they were given very little concrete specification (see Chapter 9 for a critique of one such descriptor, systems evaluation). The O*NET prototype development project final report (Peterson et al., 1997) appears to be the first place these six skills have been named. One possible exception is "visioning skill," which is at least semantically related in the management literature to the notion of leaders as visionaries. However, visioning does not have a research base and the current O*NET content model does not include it.

At the highest level of the prototype and current Skills taxonomies are the two broad categories, cross-functional and basic skills. Basic skills are further separated into content and process skills. Content skills include reading, writing, and arithmetic as well as listening skill and skill at using the scientific method. Process skills are "cognitive information processing skills that facilitate learning." However, Lohman (1994a, 1994b) has

warned against trying to convert hypothesized general cognitive processes into measures of individual differences.

The O*NET prototype development team did not define or specify the skills domain very clearly, admittedly a difficult task. As a consequence, there is considerable potential for confusing descriptors from the Skills taxonomy with descriptors with similar names from other domains (e.g., Abilities or GWAs). In addition, many of the specific skill descriptors were first named and defined as part of the O*NET prototype development project. The rationale for creating them is not always clear. The Skills taxonomy would have benefitted from considerable additional development and review.

Generalized Work Activities

The taxonomy of GWAs in the current O*NET content model is nearly identical to the taxonomy in the prototype content model. The prototype development team carefully defined these descriptors of the basic characteristics of the work itself. According to Jeanneret et al. (1999), GWAs are not tasks, they are not responsibilities, and they are not dimensions of performance. They are the underlying behavioral components of tasks, such that performance on a specific task, no matter how broad or narrow, could be a function of more than one GWA, and a particular GWA could be a component of performance on more than one job task or responsibility.

For example, in the world of sports, "throwing a ball" might be a GWA. It underlies any number of sports tasks, and any sports task that involves throwing a ball also is a function of additional GWAs (e.g., processing information about the batter, if the task is for a baseball pitcher to throw strikes). Describing work in terms of GWAs is seen as more general (nomothetic), rather than idiosyncratic, and as better than describing work in terms of tasks for the purposes of making comparisons between occupations and building useful data archives relating many different personal attributes to performance capabilities. These are difficult distinctions to make, and the GWAs are characterized somewhat differently in the O*NET book (Peterson et al., 1999) and the O*NET monograph published in *Personnel Psychology* (Peterson et al., 2001). They are referred to as worker oriented in the former and more work oriented in the latter.

The taxonomy of GWAs was based on an exhaustive review of the job analysis research literature that used general activity requirement assessment rather than specific task requirement assessment, such as the Position Analysis Questionnaire (McCormick, Jeanneret, and Meecham, 1969, 1972) or the Occupational Analysis Inventory (Cunningham, 1988). The developers of the GWA taxonomy reviewed job analytic data obtained

from all corners of the labor force. Their scholarship was detailed and comprehensive.

The resulting taxonomy adopted an information-processing model of work behavior incorporating at the most general level four categories of descriptors involving (1) information input, (2) mental processes using that input, (3) work output, and (4) interactions with others. The GWA taxonomy had 42 descriptors at the most specific level, 9 more general categories at the next level into which the more specific 42 descriptors were grouped, and finally the 4 general categories listed above. An outline of the full prototype taxonomy is shown in Appendix B. The current content model uses the same terms and incorporates all but 1 of these 42 descriptors.

Some of the ambiguities in the prototype and current GWA descriptors now become more readily apparent. For example, why is the current and prototype GWA "Repairing and maintaining mechanical equipment" not a task? Why is it not a skill? What makes it an underlying Generalized Work Activity? Many of the GWAs are very abstract and perhaps difficult for incumbents to relate to their own work. The information-processing model may exacerbate this problem by suggesting inclusion of such GWAs as "processing information" and "making decisions and solving problems," which are very difficult to specify in any concrete way (see Lohman, 1994a, 1994b).

Work Context

The prototype Work Context taxonomy was revised more extensively than the other taxonomies before its inclusion in the current O*NET content model. The prototype development team viewed information on the Work Context as critical for the O*NET system because it is important to identify health and safety hazards; investigate contextual effects on performance, satisfaction, group cohesion, and organizational effectiveness; help design selection systems; provide more realistic job previews; and improve compensation systems (Peterson et al., 1999). However, the team did not confront the question of what was and was not "context" or the question of the extent to which a particular context descriptor was specific to settings (e.g., a particular establishment) rather than occupations, which is the unit of analysis for O*NET. The unanswered question: Is the variability in contexts greater across settings for a particular occupation than the variability across occupations? In general, context variables were not defined except to say that they are "moderator" variables, without saying what relationships were being moderated (Strong et al., 1999).

The Work Context taxonomy was developed via an extensive search of the literature on context effects in many different disciplines, including a review of instruments used to measure these effects, as well as searches

of the literatures on environmental health and occupational health (Strong et al., 1999). After considerable review by subject-matter experts, the team created a three-level taxonomy of Work Context. In the field test of the prototype content model, over 50 questionnaire items were used to assess the first two levels of the taxonomy, with additional items to assess the most detailed level. Following the field test, the first two levels of the taxonomy were retained (see Appendix B), but the number of specific descriptors of Work Context was reduced from 97 to 57.

Organizational Context

The Organizational Context taxonomy is based on the assumption that the nature of an occupation will vary as a function of the nature of the organization in which it is embedded. This assumption raises questions. For example, is the occupation of economics professor described differently at a large public research university and a small liberal arts college? If so, should the differences be regarded as sampling error or as substantive occupational differences, and is the design of the O*NET database equipped to handle the latter?

The Organizational Context taxonomy was generated by examining the literatures on organization theory, organizational development, organizational design, organizational performance assessment, organizational sociology, and organizational psychology (Arad, Hanson, and Schneider, 1999). The resulting large number of organizational context variables that had shown important effects in previous research was organized into a four-level hierarchical taxonomic structure that seemed to best reflect the research results. At the top of the hierarchy, the context variables were designated as either structural characteristics or social processes. There are 6 second-order factors (type of industry, organizational structure, human resource systems and practices, culture, goals, and roles), 16 third-order factors, and 35 specific descriptors. The descriptors include such things as leadership characteristics, organization size, skill variety, autonomy, recruitment planning, and operations. In the field test of the prototype content model, information related to many descriptors was obtained from a single manager representing the organization, and information related to other descriptors (e.g., autonomy, skill variety, leader behavior) was obtained by aggregating the perceptions of individual job incumbents.

In general, the Organizational Context descriptors cover a wealth of information, but it is not clear how such data should be incorporated in the O*NET database, since they are not tied to occupations. Although this taxonomy of descriptors is included in the current O*NET content model (see Figure 1-1), the O*NET Center does not collect data on Organizational

Context and does not include information on Organizational Context in the current O*NET database.

Occupation-Specific Descriptors

As discussed above, the Advisory Panel for the Dictionary of Occupational Titles (1993) proposed a content model including occupation-specific data in the Knowledge and Skills domains. However, what the O*NET prototype project team began developing were occupation-specific Tasks and Work Activities. At the time the O*NET prototype development project was concluded in 1996, the team had completed only one pilot study of occupation-specific descriptors. This pilot was the precursor to the development of the DWAs descriptor taxonomy in subsequent years.

DEVELOPMENT OF THE CURRENT O*NET CONTENT MODEL

Once the prototype content model was fully developed, the project team conducted a field test of the prototype questionnaires. The team anticipated that the prototype content model would be revised as more research data became available and as user needs and the characteristics of the labor force itself changed (Peterson et al., 1999). Such changes could take the form of additions, deletions, or revisions of the descriptors in a domain; changing item formats and response scales; or even deleting or adding entire domains. However, despite the expectation that the prototype content model was not set in concrete, few changes were made as a result of the field test data and subsequent questionnaire evaluations.

Field Tests of the Prototype

The first step in testing the prototype content model was to define the unit of analysis by creating a new occupational classification system to replace the system of over 12,000 titles included in DOT.

The process used to create a new occupational classification system was summarized in O*NET Data Dictionary-Release 1.0, Appendix D (National Center for O*NET Development, 1998). That report indicates that the process entailed use of the occupational classification system adopted by the Bureau of Labor Statistics to administer the Occupational Employment Survey, the development of crosswalks to DOT title codes, cluster analyses of DOT data, analysis and aggregation of DOT task statements, and multiple reviews by subject-matter experts. The process resulted in identification of 1,122 occupations, referred to as "occupational units." As described in the 1998 report, even though DOT titles and task data contributed to the original formation of the occupational units, these were not the outcome of

a simple clustering of DOT titles, nor were they meant to represent simple aggregations of DOT titles. Thus, it is not unreasonable to conclude that, at the end of this development process, each occupational unit had its own identity—consisting of a title, definition, and task description—independent of, though partially informed by, DOT titles and task content.

The next step was to collect two sets of data related to these occupational units. The first data set contained ratings made by occupational analysts using the written descriptions of occupational units. It became the first O*NET database that could be analyzed to establish proof of concept. The second data set contained ratings by job incumbents, obtained through a survey of incumbents in a targeted set of 80 occupational units; the response rate to the survey was low, however.

Despite the limited response to the job incumbent survey, the two data sets were adequate to support a preliminary evaluation of the prototype content model. At least 5 analyst ratings were available for all 1,122 occupational units, and 30-35 of the 80 occupational units targeted in the survey were rated by at least 4 (mean = 10) incumbents (Peterson et al., 1997). The psychometric properties of both the analyst and incumbent ratings were generally encouraging. There were analyst versus incumbent differences in the expected direction (e.g., incumbents rated their jobs as more complex and demanding than did the analysts), but the differences were not startling. The various descriptor domains could discriminate among occupations, and there was reasonable variation across the domain descriptors for a specific occupation. However, exploratory principal components analyses tended to yield a smaller number of factors within domains than the investigators had hoped. For example the GWA descriptor covariances yielded only three factors corresponding roughly to data, people, and things—the same factors that had been used to rate the complexity of occupational titles in DOT. The researchers identified a similar three-factor structure for the Skills taxonomy, although they were labeled cognitive skills, organizational skills, and technical skills (Mumford, Peterson, and Childs, 1999).

The limitations of these data sets were thoroughly discussed by Peterson et al. (1999). However, despite these limitations, the results pertaining to the reliability and discriminant validity of the domain descriptors were encouraging and positive enough in the investigators' judgment to establish proof of concept for the prototype content model.

To address the low response to the job incumbent surveys, DOL commissioned a working group to test and revise the questionnaires. The revisions made on the basis of this review led to the questionnaires currently used to collect O*NET data (see Chapter 4).

Subsequent Changes

Subsequent to the field test and prototype revisions, the O*NET Center made several other changes to the content model and to the occupational classification system. These changes are discussed below, and changes to the occupational classification system are discussed in Chapter 3.

Organizational Context, Work Values, and Occupational Interests

Although the Organizational Context domain is a part of the current content model (see Figure 1-1), the O*NET Center collects no data related to this domain. It does not routinely collect data related to the Work Values and Occupational Interests domains as part of its primary data collection program, but it has used other methods to gather data related to these two domains. To generate updated information on Work Values, the O*NET Center engaged experts in vocational psychology to rate occupations (Rounds et al., 2008a). The raters were provided with information on the occupation, including the O*NET written description, Skills, GWAs, Work Context, Work Styles, Education, and wages. They applied a method developed earlier (McCloy et al., 1999) to assign an occupational values profile to each occupation. To develop updated information on Occupational Interests, the O*NET Center uses a similar approach, engaging trained occupational analysts. The analysts are provided with updated information on the occupation, including O*NET information, and apply a specified method to create an occupational interest profile for each occupation in the database (Rounds et al., 2008b).

Development of Detailed Work Activities

Consistent with the recommendations of the Advisory Panel for the Dictionary of Occupational Titles (1993), the O*NET Center facilitated the development of a taxonomy of more occupationally specific descriptors that came to be called DWAs. This taxonomy is included in the current O*NET content model and information on DWAs for each occupation is available as part of the work activities information in the database viewed through the website O*NET OnLine. However, the O*NET Center does not include DWAs in the core content model data files it makes available for downloading, providing these descriptors along with other information as supplemental data (http://www.onetcenter.org/supplemental.html).

In developing this new taxonomy, the O*NET Center specified a DWA as a descriptor of work activities that was intermediate in generality between specific occupational tasks and the GWAs described above. The goal was to create descriptors general enough to permit cross-occupational

matching, but specific enough to permit specific occupational differentiation (National Center for O*NET Development, 2003). To achieve this goal, the O*NET Center indicated that the DWAs should not overlap, or be redundant with, other content model descriptors, such as Abilities, Skills, and Knowledge, and should be found in more than one occupation. At the same time, the O*NET Center viewed any DWA found in more than 100 occupations as too broad to be useful and suggested it should be eliminated (p. 7). The O*NET Center sought to develop approximately 15-20 DWAs for each occupation.

The O*NET Center's development of DWAs built on the results of an earlier effort by the state of Oregon to develop a set of similar descriptors. That study reviewed the descriptors used in the Bureau of Labor Statistics' Occupational Employment Statistics survey, the Classification of Instructional Programs, and the task information from the DOT to develop "skill statements." The O*NET Center created additional statements and the resulting pool was edited for redundancy, clarity, cross-occupational relevance, and comprehensiveness of coverage to create an initial pool of 2,345 DWAs. In several rounds of review, subject-matter experts eliminated some DWAs from the pool and added others in order to meet the specifications listed above. In addition, the developers edited the DWAs for clarity, understandability, and appropriateness. Through this process, the O*NET Center created 2,165 DWAs and assigned them to occupations. Some examples are as follows: (1) adhere to government aviation regulations, (2) analyze dental data, (3) use airbrush techniques, and (4) apply appropriate physical restraints.

In keeping with this design, each DWA was assigned to a single GWA, and the best fitting assignment of DWAs to GWAs has significant convergent and divergent validity. Consequently, DWAs are fully nested within GWAs, and users of O*NET OnLine who access either the details report or the custom report for an occupation see a list of "work activities" which displays DWAs nested within GWAs.

Development of Tools and Technology

Consistent with another advisory panel recommendation, the O*NET Center began in 2006 to develop another domain of more occupationally specific descriptors, known as Tools and Technologies or T2. This domain is included in the current O*NET content model (see Figure 1-1).

The purpose of this effort is to incorporate additional contextual detail and occupation-specific descriptors into O*NET. The O*NET Center does not routinely collect data related to this domain through its main data collection program. Instead, the principal sources of T2 information are Internet-based searches and information gathered from various O*NET

customers, supplemented by review of printed publications and review by subject-matter experts (Dierdorff, Drewes, and Norton, 2006). To date, the O*NET Center has gathered this type of information for 427 occupations, approximately half of those in the current database. Like the DWA data, the T2 data can be viewed through the O*NET OnLine website, but they are not included in the core O*NET database made available for download. T2 data are available for download as supplemental information.

Lay Job Titles and Code Connector

The O*NET Center collects a "lay titles file," which is made available to users through a web-based application, the O*NET Code Connector. This application allows the user to match a particular job title to O*NET occupations. The Code Connector is designed especially to help workforce professionals determine the correct O*NET occupational codes for a specific job that the professional is helping an individual with. Although designed for the workforce development community, many human resource management professionals using O*NET find this feature valuable.

O*NET's Evolutionary History Recapitulated

There is a direct evolutionary progression from DOT through APDOT to the O*NET prototype to the current database, O*NET 14.0, and there are many similarities between the DOT and O*NET content models. The DOT content model was built in stages from the basic task descriptions, to aptitude requirements, to education requirements, to physical requirements, to vocational interest requirements, to work complexity (in terms of data, people, and things), and to temperament requirements. Virtually every taxonomy of descriptors in the current O*NET content model has an analog in the DOT, and most of these taxonomies (in both the DOT and O*NET) are cross-functional in nature. Although most elements of the O*NET content model provide cross-functional information, the model also includes occupation-specific tasks, as well as two elements that are to a certain degree occupation specific—DWA and T2 descriptors. The major difference between DOT and O*NET is the specification for the unit of analysis. The 1991 DOT provided information on over 12,000 occupational titles, whereas O*NET provides information on 1,102 occupations.

Another difference is that, by the 1980s, the cross-functional domains of occupational descriptors included in DOT had become rather dated. Research on the characteristics of jobs had progressed considerably beyond the DOT's aptitude, interests, temperament, and education requirements and work activity taxonomies. As a consequence, the advisory panel proposed very comprehensive recommendations for what the "new DOT,"

which became O*NET, should look like (Advisory Panel for the Dictionary of Occupational Titles, 1993). These recommendations do not appear to be based on a detailed analysis of specific user needs for occupational data. Instead, the APDOT content model may have represented an attempt to anticipate an unspecified user's future needs, whatever they might be, by incorporating everything about jobs that had been studied, in the name of explaining occupational choices, occupational performance, and work/occupational satisfaction. This included findings from the research literature in job analysis, performance measurement, cognitive psychology, and other fields.

Despite the breadth of the APDOT content model, the O*NET prototype development project came very close to total success in making it operational. The postprototype development of the DWAs and T2 information was in direct response to the proposed APDOT content model. One advisory panel recommendation that has not been implemented is the development of performance standards and critical performance outcomes for each occupation.

CONCLUSIONS AND RECOMMENDATIONS

The construct validity of the taxonomies of descriptors is very uneven across the different domains included in the content model. For example, in the Abilities domain, the descriptors reflect a long history of psychological research on the nature and measurement of human abilities, but many of the descriptors in the Skills domain lack such an extensive research base. In addition, the different domains lack detailed and concrete specifications and often include descriptors with the same name, making it difficult to distinguish among them. "Problem solving" appears in the Abilities, Skills, Work Styles, and GWA domains. Although there may legitimately be both a problem-solving Ability and a problem-solving Skill, the content model does not clearly distinguish the different meanings of problem solving in these two different domains.

This history of the research and development of the content model, as well as user experiences discussed in this report, raise serious questions about the completeness of some of the individual domains and the extent to which each uses the most appropriate level of generality or specificity for its descriptors. For example, in the Knowledge domain, the taxonomy includes a general descriptor for building and construction, but no more specialized Knowledge descriptors, such as plumbing or carpentry. In addition, by design, the GWAs have a very high level of generality. The lack of more specific descriptors in the Knowledge, Skills, and Abilities domains (specifically, physical abilities) limits the usefulness of O*NET data for human resource management and the determination of disabilities, and the

incomplete development of the DWAs domain limits its potential use in retraining displaced workers. These limitations, and the recommendations to address them, appear in Part II.

Research leading to revisions of elements of the content model, designed to address these weaknesses, could prove disruptive to current users of O*NET data. By maintaining the continuity of the core elements of the content model over the past decade, the O*NET Center has encouraged developers to incorporate O*NET data in a variety of useful tools and applications (see Chapter 6) and supported longitudinal research on changes in the labor market. Nevertheless, the panel members agreed that research to revise the content model could ultimately lead to long-term benefits to O*NET users that would outweigh short-term disruptions. Both the Advisory Panel for the Dictionary of Occupational Titles (1993) and the O*NET prototype investigators (Peterson et al., 1999) viewed the O*NET content model as needing continuous improvement, yet there have been few changes since the mid-1990s.

Recommendation: The Department of Labor should commission research to improve the content model, beginning with the skills and knowledge taxonomies. The goals of the research should be to reduce the redundancy of descriptors within and across taxonomies, distinguish more clearly among the taxonomies, enhance completeness, and specify descriptor variables in concrete and meaningful terms.

This research to refine the taxonomies would be aided by an analysis to identify which descriptors in each domain yield high standard errors across raters. Patterns of descriptors with high standard errors in a particular domain could provide insight into rater understanding of the rating scales and inform research and revisions of that domain.

Collecting data aligned with a simpler, more rational content model would require shorter surveys, freeing resources to improve data collection along other dimensions, such as increasing the number of detailed occupations in the classification system or reducing the time interval between successive waves of data collection.

To date, there has been little effort to use the hierarchical structure of the various domain taxonomies in the content model. Occupations are not "profiled" on the higher level variables represented by grouping descriptors into meaningful higher level categories. In addition, there has been little recent empirical research on the factor structure of the domains. Research is needed to determine whether improvements in the descriptor taxonomies and in the measurement scales would yield clearer and better differentiated factor structures. However, if the descriptors in a domain lack clear, dis-

tinct, and meaningful specifications, raters will have trouble distinguishing among them, and fewer distinguishable factors would result.

Recommendation: The Department of Labor should commission a series of studies to develop occupational profiles at each hierarchical level of each taxonomy of descriptors. For example, in addition to profiling an occupation on all 52 Ability requirements, each occupation could be profiled on the smaller number of higher level Abilities formed by grouping specific abilities into higher order factors. Developing these higher level profiles would not involve collecting new data. It would involve considerable analysis of the existing O*NET database and much effort devoted to writing the specifications for each of the higher order factors.

The panel thinks that if significant and steady progress were made on these recommendations, the usability and construct validity of the O*NET content model information would be significantly enhanced. The O*NET database would also gain in flexibility for meeting a greater number of user needs.

Technical expertise is needed to assist DOL in carrying out these two research recommendations and the larger research agenda outlined in Chapter 10, as well as to determine what other research will strengthen the quality of O*NET and enhance its use. Although the research agenda represents the panel's best judgment about important research needs at this time, important new questions about O*NET will emerge in the coming years. There is a pressing need for a sustained program of research and evaluation of O*NET to guide ongoing improvements in the content model, occupational classification system, data collection methods, and the usability of the database.

Recommendation: The Department of Labor should establish and support an external technical advisory board, comprised of senior scientists, to develop a research agenda for O*NET that will prioritize research suggestions from its members, the department, the O*NET Center, the user advisory board recommended below, and other sources. At a minimum, it should meet twice yearly, once to establish research priorities for the coming year and develop requests for proposals reflecting these priorities and once to review and rank proposals submitted by academic researchers or contractors.

The panel anticipates that the technical advisory board will prioritize research suggestions according to criteria that include the extent to which the research suggestion complies with the corpus of scientific literature and

current best practices, its cost, and the feasibility of implementation. The board will also weigh the research suggestion's potential to improve the reliability and validity of the data in the content model, to reduce or extend the length of the questionnaires, to enhance collection of complete, accurate data, or to negatively affect longitudinal research based on O*NET or user-designed platforms.

In Chapter 6, the committee proposes a user advisory board to communicate users' needs. DOL should not wait to initiate the research recommended in this report until the technical and user advisory boards have been constituted and are fully functioning, but should proceed with continuous improvement initiatives using its traditional advisers until these boards can be established. In addition, DOL should establish mechanisms for ongoing communication between the user advisory board and the technical advisory board.

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3

Evolution of the Occupational Classification System

The 1991 *Dictionary of Occupational Titles* (DOT) classified and described over 12,000 occupational titles, each representing a larger group of more specific jobs. Viewing data collection for this many occupational titles as expensive and time-consuming, both the National Research Council (1980) and the Advisory Panel for the Dictionary of Occupational Titles (1993) recommended that the "new DOT," which became O*NET, should cluster larger numbers of specific jobs into a smaller number of occupational categories. The current O*NET classification system defines and describes 1,102 occupations and is aligned with the system used by all federal agencies that gather occupational information, the Standard Occupational Classification (SOC) system.

The close correspondence between O*NET and SOC allows users of O*NET to access all of the six "windows" in the O*NET content model, including "workforce characteristics" (Figure 1-1). Information on workforce characteristics is provided to O*NET users through links to Bureau of Labor Statistics (BLS) data and other state and local data that are gathered using the SOC classification system.

Since the inception of the O*NET system in 1998, both users and non-users of the data have often expressed a need for information about more narrowly defined occupations. Requests to include more specific occupations continue today. For example, when the Office of Management and Budget requested public comments on the U.S. Department of Labor's (2008) request for approval to continue collecting data for three years, a group of economists and workforce development specialists requested that the O*NET occupational classification system break out Information

Technology occupations and "green" occupations—that is, those associated with conservation of energy and environment, the production of energy from nontraditional sources, and creation of products that are ecologically friendly—in greater detail (Reamer et al., 2009). A representative of the Social Security Administration told the committee that O*NET is not useful for this agency's process of disability determination because it does not break out occupations in enough detail and also because it does not include detailed information on physical abilities (Karman, 2009). Human resource management professionals surveyed by the committee expressed a need for more narrowly defined occupations; the lack of greater detail discourages this community from using O*NET (see Chapter 7).

This chapter describes the evolution of both the O*NET and the SOC systems. It then discusses how users view and use the occupational titles in the current O*NET classification system that do not completely correspond to those in the SOC.

THE O*NET OCCUPATIONAL CLASSIFICATION SYSTEM

O*NET-SOC 2000

The first O*NET database, published in 1998, included 1,122 "occupational units." The following year, the Office of Management and Budget (OMB) (1999) mandated that all federal agencies collecting occupational data use the SOC system (see Box 3-1). In response to the OMB mandate, the O*NET classification system was revised, becoming O*NET-SOC 2000 (Levine et al., 2001).

O*NET-SOC 2006

Between 2000 and 2006, further development resulted in O*NET-SOC 2006, to advance two stated goals. The first goal was to increase correspondence between O*NET and the SOC, in order to (a) improve the efficiency and accuracy of data collection (by allowing improved targeting of job incumbents for sampling) and (b) assist users in linking O*NET data to other SOC-based data sources. The second goal was to identify new and emerging occupations in order to (a) reflect changes in technology and society, (b) serve workforce investment in high-growth industry sectors, and (c) meet user needs (National Center for O*NET Development, 2006a).

Advancing the first goal, O*NET-SOC 2006 reduced the total number of occupations from 1,165 to 949 and the number of occupations not corresponding to the SOC to 128. To achieve the second goal, the National

Center for O*NET Development announced that research to identify new and emerging occupations was ongoing and would be incorporated in future revisions of the classification system.

To identify new and emerging occupations, the O*NET Center developed a methodology that includes soliciting information from O*NET users about occupations, gathering and analyzing data on proposed new occupations from a variety of sources, and requesting final approval from the Employment and Training Administration to begin gathering data related to these occupations (National Center for O*NET Development, 2006a).

O*NET-SOC 2009

The current O*NET database (14.0) incorporates a new classification system, O*NET-SOC 2009, which incorporates more new and emerging occupations. This revision was developed to advance the following goals (National Center for O*NET Development, 2009, p. 13):

- Meet the demand for more extensive information for workforce investment activities within rapidly changing in-demand industry clusters;
- More accurately reflect the many occupations found in today's world of work through the inclusion of new and emerging occupations;
- Maintain efficient and precise sampling of occupations for data collection through the use of SOC-based occupational employment statistics produced by BLS and the states; and
- Maintain correspondence of O*NET data with employment projections and other labor market information.

O*NET-SOC 2009 includes 1,102 occupations, of which data are collected on 965. Based on research begun in 2006, the system includes 153 new and emerging occupations identified in 17 "in-demand industry clusters" (as defined by the Department of Labor). Although a few of these additional occupations are identical to new occupations included in SOC 2010 (see Box 3-1), most are "breakouts" of existing SOC occupations or of SOC residual categories (e.g., "managers, all other"). These new occupations are created by splitting an SOC occupation and adding additional digits, beyond the six digits at the most detailed level of the SOC system. For example, in the field of health care, O*NET-SOC 2009 includes 37 occupations that are breakouts of SOC occupations (Lewis and Rivkin, 2009).

BOX 3-1
The Standard Occupational Classification System

Currently, federal statistical agencies collecting occupational data are required to use occupational classification systems that are aligned with the 1999 SOC (Office of Management and Budget, 1999). The 1999 SOC includes 4 levels, with 23 major groups at the highest level and 821 specific occupations at the lowest level. Each specific occupation is designated by a six-digit code. In addition to directing all federal statistical agencies to align with the SOC, the Office of Management and Budget (1999) stated that agencies may create more specific occupational categories, if desired:

> In addition, data collection agencies wanting more detail to measure additional worker characteristics can split a defined occupation into more detailed occupations by adding a decimal point and more digits to the SOC code. For example, Secondary School Teachers, Except Special and Vocational Education (25-2031) is a detailed occupation. Agencies wishing to collect more particular information on teachers by subject matter might use 25-2031.1 for secondary school science teachers or 25-2031.12 for secondary school biology teachers.

Beginning in fiscal year 2010, all federal agencies collecting occupational data will be required to align their occupational classification systems with the revised and updated SOC, known as SOC 2010 (Office of Management and Budget, 2009). It continues the 23 major groups from SOC 1999 and adds new occupations, for a total of 840 detailed occupations. Occupational areas with significant revisions and additions include information technology, health care, printing, and human resources. Agencies will continue to be permitted to split a defined occupation by adding a decimal point and more digits to the SOC code.

Dixie Sommers, a member of the interagency SOC policy commit-

Inclusion of Occupations for Which Data Are Not Collected

The current O*NET database maintains and displays for users the names and codes of 137 SOC occupations for which O*NET data are not collected (see Figure 3-1). Most of these occupations are included to maintain alignment with the SOC and ensure that O*NET users can readily access data on workforce characteristics—one of the six major windows in the O*NET content map (see Figure 1-1). For example, the inclusion of the SOC occupation "nuclear technicians" (19-4051) allows users to find information on education levels, wages, and projected employment

tee that oversaw the development of SOC 2010, provided information about the process to the panel (Sommers, 2009). In revising and updating the SOC, the policy committee used a list of detailed criteria, including the following criterion related to collectability of data:

> The U.S. Bureau of Labor Statistics and the U.S. Census Bureau are charged with collecting and reporting data on total U.S. employment across the full spectrum of SOC major groups. Thus, for a detailed occupation to be included in the SOC, either the Bureau of Labor Statistics or the Census Bureau must be able to collect and report data on that occupation.

Sommers (2009) reported that DOL and the National Center for O*NET Development contributed to the revision of the SOC in several ways. First, the Employment and Training Administration (ETA) is represented on the policy committee by the O*NET team leader, who shared knowledge the O*NET Center staff has gained through collection of data on knowledge, skills, tasks, and other detailed characteristics of jobs. Second, ETA and the O*NET Center contributed specific suggestions for additional detailed occupations to include in SOC, based on their experience in collecting occupational data and on their research into new and emerging occupations. The SOC policy committee reviewed the suggested additional occupations in light of both its criteria and public comments in response to the *Federal Register* notices.

The end result is that the 2010 SOC will include 10 new occupations that are currently in O*NET-SOC 2009 at a level of detail below the 2000 SOC, or are similar to O*NET-SOC 2006 occupations that are disaggregated from SOC occupations. However, the SOC policy committee determined that many more of the new occupations proposed by DOL and the O*NET Center did not meet the collectability principle noted above.

for this occupation. This information is obtained from federal and state agencies that collect wage and employment data using the SOC. However, because the O*NET Center does not collect O*NET information for the "nuclear technicians" occupation, the database does not provide more detailed information on this occupation's Skills, Abilities, Generalized Work Activities, and other characteristics of this occupation. The database does provide information collected by the O*NET Center on the Skills, Abilities, and other characteristics of two breakouts of the "nuclear technicians" occupation—"nuclear equipment operation technicians" (19-4051.01) and "nuclear monitoring technicians" (19-4051.02).

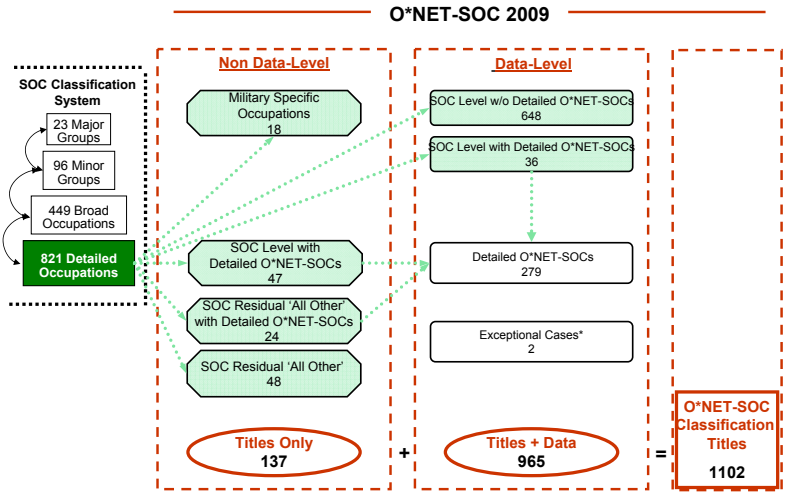

FIGURE 3-1 The O*NET-SOC 2009 occupational classification system.
SOURCE: National Center for O*NET Development (2009). Reprinted with permission.

In addition to maintaining SOC occupations and SOC residual occupations (e.g., "agricultural workers, all others") in the classification system, O*NET-SOC 2009 maintains military occupations. No data are collected on these occupations, however, because the O*NET Center and DOL determined that the military services would be the best source of this information (Lewis, Russos, and Frugoli, 2001).

USER VIEWS OF MORE DETAILED OCCUPATIONAL INFORMATION

O*NET-SOC 2009 includes 279 detailed breakouts of SOC occupations, or about 25 percent of 1,102 occupations in the system. In comparison, O*NET-SOC 2006 included 126 breakouts of SOC occupations, or about 13 percent of 949 occupations in the system (National Center for O*NET Development, 2006a). Given this large increase in the proportion of breakouts, it is important to consider how O*NET users currently view and use these more disaggregated occupational data.

For example, O*NET-SOC 2006 breaks the SOC occupation "accountants and auditors" (13-2011) into "accountants" (13-2011.01) and "auditors" (13.2011.02). These more detailed occupations can be linked to the SOC through the extended digits they are assigned. BLS gathers data on

current average wage level and current employment levels and prepares projections of future employment using the SOC system. It is therefore possible to obtain all of these types of data for the combined SOC, "accountants and auditors," but none of these labor market data are available for the separate O*NET occupations of "accountant" and "auditor."

The views of different O*NET users about the value of breakouts vary with the purposes for which they are using the system. For example, job analysts consulting with businesses and government agencies often use O*NET data as a starting point for defining tasks, knowledge, skill, ability, and other attributes required by the job and supplement this with additional information on the particular job context or job. For these users, information at the SOC level often provides an adequate starting point, but they would probably welcome the more detailed information from a breakout (e.g., information about an auditor, rather than about accountants and auditors). Because job analysts typically focus on defining the knowledge, skills, abilities, and other attributes of the job, they may have no need for information on wages, employment levels, or other information gathered at the SOC level. If job analysts do need these types of data, they may obtain it from private industry surveys, web-based job posting systems, or other sources.

The career development community welcomes the O*NET Center's research on new and emerging occupations and values the more detailed information provided by breakouts (see Chapter 6). For example, a guidance counselor would prefer to provide a young person with information about the educational, experience, and other requirements to become an auditor than about the broader group of auditors and accountants (Janis, 2009). A few respondents to the committee's informal survey of the career development community requested that O*NET include information on more and newer occupations (Janis, 2009).

At the same time, however, the inclusion of breakouts in O*NET poses some challenges to career information delivery systems. Developers of these systems use O*NET extensively, downloading the entire database, revising the information to make it more user-friendly, and linking it to other data sets, including BLS data on wages and employment levels in occupations. Because these system developers highly value wage and employment information collected by the states and BLS, some of them currently work around the breakouts in O*NET. For example, the Georgia Career Information System creates a combined occupational description using information from the separate O*NET-SOC 2006 occupations "accountants" and "auditors" to essentially recreate the SOC occupation "accountants and auditors." The combined information is then linked to federal and state information on wages, current employment levels, and projected future employment in the "accountants and auditors" occupation.

In general, in the field of career development, the importance of linking O*NET occupational information (such as the level of Knowledge, Skills, and Abilities required for an occupation) with wage data depends on the age of the user. Guidance counselors working with younger people have less need of detailed wage data than guidance or job placement counselors working with adult workers. For example, a middle school guidance counselor could meet students' needs with information from O*NET about the requirements of the "accountant" and of the "auditor," along with information from the BLS about wages and projected demand for the broader SOC occupation "accountants and auditors." However, adult workers with greater financial responsibilities have greater need for specific wage data. A career counselor or job placement specialist assisting an unemployed adult worker and working with O*NET information about the requirements of the "accountant" or the "auditor" would not be able to provide information about wage levels in the two breakout occupations. Of course, the counselor or the workers might be able to obtain more localized information about the wages in these two occupations from other sources, such as online job postings.

State and local labor market information specialists in public workforce development offices very frequently link O*NET data to SOC data. They do so both to assist individual job seekers and also to analyze and understand broader workforce trends. For example, some analysts have linked the two types of data to project future skill demands in their states or metropolitan regions; such projections help education and training providers align curriculum with skills in demand. Because they view the value of O*NET data primarily in terms of their ability to be linked to wage, employment, and other data collected at the SOC level, state labor market information specialists suggest that the occupational definitions in the two systems be coordinated (Ewald, 2009). Some state labor market information specialists have requested that, in the future, the O*NET Center continue its current policy of categorizing all new occupations as breakouts of SOC occupations and including additional digits beyond the six digits of the related SOC occupation (Calig and Ewald, 2009).

Nevertheless, some state and local workforce development officials value the greater detail provided by breakouts of SOC occupations in the O*NET classification system. For example, one survey respondent indicated that developers of a statewide job information system would like O*NET to include more information on newer occupations, including "green" occupations—and occupations in health care, construction, and energy (Janis, 2009). In addition, state labor market information specialists, in a letter to the Office of Management and Budget, requested that O*NET provide more detailed occupational titles in the fields of information technology and green jobs (Reamer et al., 2009).

CONCLUSIONS AND RECOMMENDATIONS

The question of the level at which occupations should be defined and described is not new. The National Research Council study of the *Dictionary of Occupational Titles* stated, "Research priority should be given to developing criteria for defining occupations—the aggregation problem" (National Research Council, 1980, p. 15).

There is a tension between the need of some O*NET users for more aggregated occupational categories and the need of other users for more disaggregated occupational categories. For the workforce development and career development communities, much of the power of O*NET derives from the alignment of its occupational classification system with the occupations included in the SOC system. For the human resource management community, the occupations in O*NET often lack the specificity needed for its purposes. To the degree that an O*NET occupation represents an aggregation of very different individual jobs or job titles, it will lack precision and usefulness to human resource managers as a unit of analysis and description. Moreover, from a statistical standpoint, data that are collected from a diverse set of component jobs and then combined or averaged when creating the occupation-level data reported in O*NET may be misleading or cannot be interpreted. These problems cause significant dissatisfaction with O*NET data among human resource managers, and, in many cases, discourage their use.

Reflecting this tension between the needs of different O*NET users, the panel did not agree about the appropriate level of aggregation of the occupational categories used in O*NET. Some supported the 2009 addition of new and emerging occupations and favored continuing expansion of the number of occupations, while others thought that a smaller number of more highly aggregated occupations, as defined by the SOC, should be included in O*NET.

> **Recommendation: The Department of Labor, with guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, should conduct an assessment of the potential benefits of continuing to expand the O*NET occupational classification system to include occupational titles more specific than those in the SOC. It should also consider all potential costs of continued expansion, including but not limited to the costs of collecting data on a larger number of occupations and of collecting data on occupations that may not easily be linked to labor market information collected at the SOC level.**

If this assessment determines that the classification system should continue to expand, the research organization should

- Conduct research to develop a systematic procedure and set of decision rules suitable for guiding ongoing disaggregation efforts and defining new occupations. This should include analysis of alternative methods for defining new occupations, such as the current methods used by the National Center for O*NET Development and methods used in the Current Population Survey and the SOC system. It should also include development of methods to determine when within-occupation aggregation obscures significant variability in physical and other requirements.
- Develop methods to maintain, and regularly update crosswalks and linkages between the new occupations and SOC occupations.

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4

The Data Collection Program

This chapter focuses on the methods used in collecting information to populate the O*NET database. Because the current survey design and data collection methods are based heavily on earlier experience with the O*NET prototype development project, the chapter begins by describing that experience. After briefly summarizing best practices for survey pretesting, it describes the pretesting conducted in the early stages of O*NET development. The chapter then reviews the O*NET study design, including the establishment and occupation methods of collecting data, the data collection procedures, response rates, and data editing and cleaning. A section on data currency follows. The chapter ends by focusing on the cost-effectiveness and efficiency of data collection and maintaining high levels of data quality.

THE O*NET PROTOTYPE DEVELOPMENT PROJECT

The prototype O*NET content model was complex, including many hundreds of descriptors organized into 10 domains, also referred to as taxonomies. The final stage in the prototype development project was a field test of the content model using real-world occupational data. The first step in the field test was to define the unit of analysis: the research team wrote descriptions for 1,122 occupational units.

Development of the Rating Scales

The next step in the field test of the content model was to develop rating scales that individuals could use to assess the extent to which each descriptor was required for each occupational unit.

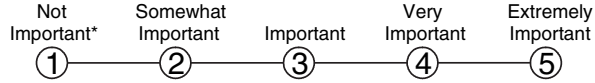
Abilities

For each of the 52 Abilities descriptors included in the taxonomy, the scale used to rate the importance for a given occupation ranged from (1) not important to (5) extremely important. The scale used to rate the level of each Ability is defined by "behavioral anchors"—brief descriptions of specific work behaviors—provided to assist individuals in making ratings. To generate the anchors, the development team asked panels of subject-matter experts to suggest multiple examples to illustrate different levels of each Ability. Another, independent set of panels of subject-matter experts was asked, for each Ability descriptor, to place the level represented by each anchor on a quantitative scale. For each Ability descriptor, the development team chose behavioral anchors that covered selected points on the scale, were scaled with high agreement by the subject-matter experts, and were also judged to be relevant for rating occupational (e.g., not educational) requirements. The selected anchors were then included in the final prototype rating scale. Although behavioral anchors for many Abilities descriptors had previously been developed over the course of the Fleishman job analysis research program (Fleishman, 1992), the anchors were apparently rescaled for the O*NET application (Peterson et al., 1999, p. 185).

The current rating scales used by trained occupational analysts to assess the importance and level of Abilities descriptors are largely unchanged from those developed in the prototype development project. These scales present problems for users of the resulting data. For example, Figure 4-1 depicts the current scale used to rate the level and importance of the descriptor Ability "static strength." One issue that becomes apparent in this example emerges from the question posed to the raters. The question, "What level of static strength is needed to perform *your current job*?" implies a dichotomy of the form "can perform the job" versus "cannot perform the job." The meaning of perform is unclear. All research on job performance assessment yields a continuous distribution of performance differences across job holders. Does perform mean perform at a minimally acceptable level, an average level, or a very high level? The ability requirements may be different for performing at the minimum level versus performing at a high level, and the performance referent should be made clear to raters.

32. Static Strength — **The ability to exert maximum muscle force to lift, push, pull, or carry objects.**

A. How important is STATIC STRENGTH to the performance of *your current job?*



* If you marked Not Important, skip LEVEL below and go on to the next activity.

B. What level of STATIC STRENGTH is needed to perform *your current job?*

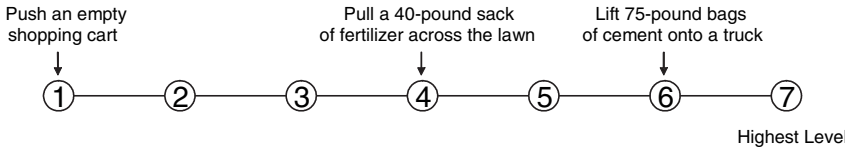


FIGURE 4-1 Current static strength rating scales.
SOURCE: National Center for O*NET Development (no date). Reprinted with permission.

Work Styles

For the Work Styles domain, the O*NET prototype development team developed rating scales that were similar to those for the Abilities taxonomy, including a 5-point scale for importance and a 7-point rating scale for the level of the Work Style believed to be required for a particular occupation. The current questionnaire includes the 5-point scale for rating importance but does not include a level scale with behavioral anchors.

Occupational Interests

Because the prototype O*NET content model used (as does the current O*NET content model) the model of interests developed in Gottfredson and Holland (1989), and extensive research applying this model to code occupations had already been conducted, the field test did not require additional ratings of the interest requirements of occupations.

Work Values

The prototype development team drew on a taxonomy incorporated in the Minnesota Job Description Questionnaire (Dawis and Lofquist, 1984)

to develop rating scales for the Work Values descriptors. The Minnesota Job Description Questionnaire describes occupations according to 21 "need-reinforcers," or values. In the pilot test of the prototype content model, job incumbents were asked, for each of these 21 values, to use a 5-point scale to rate the degree to which it described their occupation. Each question began with, "Workers on this job. . . ." For example, to rate the level of the value, "Ability Utilization," the job incumbent was presented with the statement, "Workers on this job make use of their individual abilities" (Sager, 1997, Figure 10-3). According to the prototype developers, the reasons for including individual interests and values as domains was not to offer interests and values as important determinants of individual performance. Instead, it was to facilitate the person-job match for purposes of enhancing job satisfaction and retention. The National Center for O*NET Development does not routinely collect data on Work Values as part of its main data collection program but does periodically develop data for this domain.

Knowledge

As was the case for Abilities and Work Styles, the prototype rating scales were designed to help individuals rate each Knowledge descriptor in terms of its importance for performance in a particular job and the level of the descriptor needed "to perform the job." Again, the prototype development team calibrated the level scale with behavioral anchors. Table 4-1 presents an example of a definition and behavioral anchors for rating the level of the psychology knowledge required to perform the job. The current rating scale for this descriptor incorporates the same behavioral anchors and a very similar definition of psychology (see Figure 4-2).

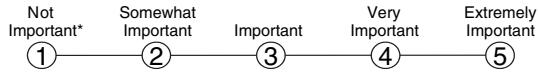
TABLE 4-1 Psychology Definition and Behavioral Anchors

Psychology:	Knowledge of human behavior and performance, mental processes, psychological research methods, and the assessment and treatment of behavioral and affective disorders.	High –	Treating a person with a severe mental illness.
		Low –	Monitoring several children on a playground.

SOURCE: Peterson et al. (1997, p. 243, Figure 4-1). Reprinted with permission.

18. Psychology — **Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.**

A. How important is knowledge of PSYCHOLOGY to the performance of *your current job*?



* If you marked Not Important, skip LEVEL below and go on to the next knowledge area.

B. What level of PSYCHOLOGY knowledge is needed to perform your current job?

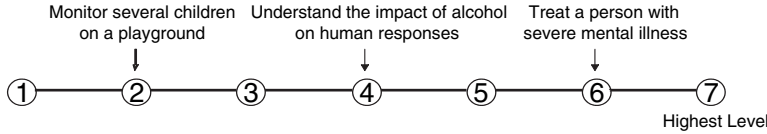


FIGURE 4-2 Current psychology rating scales.
SOURCE: National Center for O*NET Development (no date). Reprinted with permission.

Occupational Preparation

The prototype development team did not develop rating scales to gather information on the level or importance of occupational preparation. Instead, the prototype questionnaire included seven questions related to education, training, licensure/certification, and experience requirements. Each question asked the respondent to select one alternative from among a set of alternatives. The current questionnaire used by the National Center for O*NET Development is similar, presenting five factual questions.

Skills

As discussed in Chapter 2, the O*NET prototype development team struggled to define the Skills taxonomy of descriptors clearly. As a consequence, respondents to the questionnaires may confuse descriptors from this taxonomy with descriptors with similar names found in other taxono-

mies, including Abilities and Generalized Work Activities. Nevertheless, the research team developed a 7-point rating scale incorporating behavioral anchors to assess the level of each Skills descriptor, along with a 5-point rating scale to assess the importance of each to perform the occupation. An example for the Skill, "Reading Comprehension" is discussed later in this chapter.

Generalized Work Activities

The field test of the prototype included three rating scales to be used to describe the generalized work activities of an occupation: (1) a level scale with behavioral anchors that asked, "What level of this activity is needed to perform this job?" (2) an importance scale that asked, "How important is this activity to this job?" and (3) a frequency scale that asked, "How often is this activity performed on this job?" The current questionnaire includes importance scales and level scales with behavioral anchors but does not include the frequency scales. For example, one item asks the respondent, "What level of identifying objects, actions, and events is needed to perform *your current job?*" followed by a scale. Level 2 of the scale is anchored with "test an automobile transmission," level 4 with "judge the acceptability of food products," and level 6 with "determine the reaction of a virus to a new drug" (National Center for O*NET Development, no date).

Work Context

The prototype Work Context taxonomy included three levels, with 39 descriptors at the most detailed level (see Appendix A). In the field test of the prototype content model, the development team created over 50 questions with multiple responses for each of these 39 descriptors, resulting in a very long questionnaire. The current questionnaire includes a series of 5-point rating scales inviting respondents to assess the frequency of some aspects of Work Context (e.g., public speaking, exposure to contaminants) and the level of other aspects (e.g., freedom to determine tasks, priorities, or goals). The rating scales do not include behavioral anchors.

Organizational Context

The prototype development team created a complex taxonomy of Organizational Context descriptors along with rating scales to assess levels of these descriptors required to perform various occupations. Currently, the O*NET Center does not collect data on organizational context.

Occupation-Specific Descriptors: Tasks

The field test targeted 80 occupational units for study. For each unit, the development team reviewed DOT codes within the unit and extracted 7 to 30 critical tasks. The team surveyed job incumbents employed in each occupational unit, asking them to rate the importance and frequency of occurrence of each task listed for their occupation and also to write in additional tasks they thought should be included. The psychometric characteristics of these task ratings appeared promising, but the effort to develop this taxonomy of descriptors stopped there.

Later, the O*NET Center commissioned a study in which researchers reviewed existing task statements from a sample of occupations, analyzed write-in statements provided by job incumbents, and also developed methods for identifying which task statements are critical to the occupation and for analyzing write-in tasks (Van Iddekinge, Tsacoumis, and Donsbach, 2003). The current questionnaires are occupation-specific. They present a list of task statements and ask the respondent to indicate whether the task is relevant and, if relevant, to rate its frequency using a 7-point scale and its importance using a 5-point scale (Research Triangle Institute, 2008). The scales do not include behavioral anchors.

Prototype Data Collection: Applying the Rating Scales

In the field test, the prototype development team used the rating scales to obtain information about the level and importance of each descriptor for each of the 1,122 occupational units from two groups of individuals—trained occupational analysts and job incumbents. Before these field tests began, the project team believed that job incumbents, employed in the occupational unit, would be best positioned to rate the level and importance of each descriptor, based on their familiarity with the occupation (Peterson et al., 1999).

The occupational analyst sample consisted of trained occupational analysts who were graduate students in human resource related disciplines. They used the rating scales described above to rate the level and importance of each O*NET descriptor for performance in each occupational unit. For the job incumbent sample, prescribed sampling techniques (see Peterson et al., 1999) were used to identify a representative field test sample of 80 occupational units, a sample of establishments in which the 80 occupations could be found, and at least 100 incumbents in each occupation who could be surveyed. Not every incumbent completed every questionnaire; a rotation design was used with the expectation that every domain questionnaire would be completed by 33 incumbents and every possible pair of questionnaires would be completed by at least 6 incumbents. The survey package for each incumbent was expected to take 60-90 minutes to complete.

Response Rate in the Prototype Field Test

The response rate for the incumbent surveys proved disappointing. Of the 1,240 establishments selected for the study which had identified a point of contact, 15 percent proved ineligible because they were too small or out of business. Of the 1,054 remaining, 393 dropped out during the planning of the incumbent surveys. At this stage, the field test team sent a total of 15,529 incumbent questionnaires to the points of contact in the remaining 661 establishments, asking them to distribute the questionnaires to the job incumbents within their establishments. However, only 181 of those identified as a point of contact carried out this request, distributing 4,125 questionnaires to job incumbents in these 181 establishments. These points of contact returned 2,489 questionnaires, for a response rate at the incumbent level of approximately 60 percent.

BEST PRACTICES IN QUESTIONNAIRE PRETESTING

Before discussing the pretesting of the pilot O*NET questionnaires, this section briefly describes best practices in survey pretesting. Increasingly, federal agencies and private-sector organizations are applying questionnaire pretesting and evaluation methods as an important step in developing surveys. Methods include expert review (e.g., Forsyth and Lessler, 1991), cognitive testing (e.g., Conrad, 2009; Willis, 2005), and focus group testing (e.g., Krueger, 1988). These methods, grounded in cognitive psychology, help to assess how representatives of a target survey population perform cognitive tasks, including interpreting and following instructions, comprehending question content, and navigating through a survey instrument. More recently, many survey design and pretesting principles have been applied in evaluations of the usability of web-based instruments (e.g., Couper, 2008). Some of these methods were used in the O*NET prototype field test.

Expert Review

Expert review is a quick and efficient appraisal process conducted by survey methodologists. Based on accepted design principles and their prior research experiences, the experts identify possible issues and suggest revisions. In some cases, they use a cognitive appraisal form that identifies specific areas (e.g., conflicting instructions, complex item syntax, overlapping response categories) to review each item on the instrument. A typical outcome of an expert review is improved question wording, response formats, and questionnaire flow to maximize the question clarity and to facilitate response. When usability methodologists conduct an expert review,

the focus not only includes the content, but also extends to the application of additional principles to judge ease and efficiency of completion, avoidance of errors, ability to correct mistakes, and how the content is presented (overall appearance and layout of the instrument).

Cognitive Interviewing

Cognitive interviewing is designed to test questionnaire wording, flow, and timing with respondents similar in demographics to those being surveyed. This technique is particularly helpful when survey items are newly developed and items can be tested with a population similar to the one to be surveyed. Information about a respondent's thought processes is useful because it can be used to identify and refine instructions that are insufficient, overlooked, misinterpreted, or difficult to understand; wordings that are misunderstood or understood differently by different respondents; vague definitions or ambiguous instructions that may be interpreted differently; items that ask for information to which the respondent does not have access; and confusing response options or response formats.

Focus Group Testing

Focus groups are an excellent technique to capture users' perceptions, feelings, and suggestions. In the context of a redesign effort, questions may be based on the results of an expert review and thus can focus on areas that have been determined to be potentially problematic. In cases in which an existing form or publication is being evaluated, an expert reviewer will identify key areas or features of the document that should be addressed in questioning participants. In the context of designing a larger population-based survey, focus groups are used to elicit important areas that should be addressed by the survey. Comparative information may also be gathered from different segments of the target population.

A focus group is typically a discussion among approximately 10 people who share some common interest, trait, or circumstance. Sessions are ideally 1 to 1½ hours long and are led by a trained moderator. The moderator follows a prepared script that lists questions and issues that are relevant to the focus group topic and are important to the client.

Usability Testing

The primary goal of usability testing with a survey instrument is to uncover problems that respondents may encounter so they can be fixed before it is fielded. Issues that may lead to reporting errors, failure to complete the survey, and break-offs (breaking off before completing and submitting

a survey) are of utmost importance. Testing is typically conducted with one individual at a time, while a moderator observes general strategies respondents use to complete the instrument; the path(s) they take (when a linear path is not required); the points at which they become confused and/or frustrated (which can indicate potential for break-off); the errors they make, how they try to correct them, and the success of their attempts; and whether the respondent is able to complete the instrument.

PRETESTING OF THE O*NET PROTOTYPE SURVEYS

Following the disappointing response rates to the surveys of job incumbents used in the field test of the prototype content model, in 1998 the U.S. Department of Labor (DOL) charged a working group with reviewing the questionnaires and making changes that would reduce the respondent burden while keeping the content model intact.

Findings from the Prototype Review

The working group assigned to evaluate and revise the questionnaires used several of the methods described above, including expert review, focus groups, and interviews with respondents.[1] Based on findings from these methods, the group created revised questionnaires, which they then pilot tested with a small group of RTI employees in various occupations for the purpose of obtaining time to completion estimates. Hubbard et al. (2000) summarize the types of problems identified in their evaluation and pretesting of the pilot questionnaires:

- Respondents reported difficulty understanding the questions and associated instructions as presented in a box format.
- The rating task itself was very complex, and respondents had difficulty making some of the judgments required.
- The rating scales (e.g., level, importance) and technical terminology were insufficiently defined.
- Anchors used on the behavioral rating scales, although intended to provide examples of levels of performance, were unfamiliar to some respondents and potentially confusing or distracting.
- No explicit referent period was provided, so it was unclear how respondents were interpreting the questions—the job as it is now, in the past, or in the future.

[1]Respondent demographics are not available by method used.

- Some respondents recommended using either a 5-point or a 7-point Likert scale for all the items rather than presenting different response categories for different sets of items.
- Respondents pointed out the redundancy across the various survey questionnaires.
- The directions for each questionnaire were unnecessarily long, and the reading levels were too high for both the directions and many of the items.

Survey Revisions

The pretesting results provided the working group with extremely useful feedback, and revisions were made to many of the questionnaires. A few of the revisions based on respondent feedback are highlighted below (Hubbard et al., 2000):

- Formatting changes, including a modification of the box-format presentation of instructions;
- Reducing the length and detail of the instructions and lowering the reading level to some degree;
- Providing an example at the beginning of each new section;
- Asking importance first, adding a "not relevant" option, followed by the level scale (in the Abilities, Generalized Work Activities [GWAs], Skills, and Knowledge questionnaires);
- Reducing the number of anchors that provided examples of job-related activities and presenting them at specific numbers on the scale (in the GWAs questionnaire);
- The level scale was removed from the Work Styles questionnaire;
- Some rating scales were eliminated on the basis of previous data (Peterson et al., 1999) showing them to be highly intercorrelated;
- A small number of redundant descriptors were combined or aggregated into a single descriptor; and
- A very small number of descriptors was eliminated because no respondents could understand their meaning.

A summary of the changes, comparing the current, revised questionnaires with those used in the field test is shown in Table 4-2.

With regard to the results of the pilot test regarding the estimated time to completion for the revised questionnaires, the times are considerably reduced, and most of the estimated savings, except for the Work Context questionnaire, are due to changes in formats and reading difficulty. The item-by-item changes for all the descriptors for all the domains can be found in Hubbard et al. (2000).

TABLE 4-2 Revisions to O*NET Questionnaires

Domain	Number of Items		Response Scale Changes
	Revised	Original	
Abilities	52	52	No changes
Work Styles	16	17	Keep importance scale, drop level scale
Work Values	0	21	Dropped from current O*NET
Knowledge	33	33	Keep level and importance
Skills	35	46	Keep level and importance, drop job entry requirements
Education and Training	5	15	Drop: (a) instructional program required; (b) level of education required in specific subject areas; and (c) licensure, certification, and registration
Generalized Work Activities	41	42	Keep level and importance, drop frequency
Work Context	57	97	Adopt consistent use of 5-point scales (not currently administered)
Total Items	239	323	

SOURCE: Hubbard et al. (2000, Table 2, p. 25). Reprinted with permission.

In keeping with its charge to reduce the time burden and increase clarity and ease of use without changing the form or substance of the content model, the working group made no real substantive changes to the taxonomies of descriptors that made up the prototype content model.

Despite the findings about respondents' difficulty with the behavioral anchor format of the level scales, this format was retained, although the number of anchors for a scale was sometimes reduced to achieve greater clarity and ease of use. In addition, the anchors were moved to the closest integer scale point (e.g., 3.0 or 4.0) rather than the actual mean judgment obtained from the previous scaling studies (e.g., 3.13 or 3.81). The working group believed that the loss of precision was more than compensated for by the gain in clarity, as documented by the interview and focus groups.

Finally, the working group decided to retain two different rating scales for four of the seven taxonomies of descriptors, one to measure the importance of the descriptor and another to measure the level required to perform the occupation.

In the panel's view, the revisions made in response to the pilot test

results, the pretest of the O*NET data collection methodologies and instruments, and the Hubbard et al. (2000) review were inadequate to ensure that the surveys are understandable and usable.

DESIGN OF THE O*NET DATA COLLECTION PROGRAM

Like any survey of occupational information, the O*NET Data Collection Program faces trade-offs along three dimensions that affect data quality: the size of the sample collected for each occupation, the number of detailed occupations individually surveyed (rather than subsumed within broader occupation categories), and the time interval between successive waves (or "refreshes") of the data. Improving the O*NET Data Collection Program along any one of these dimensions increases the total cost of data collection; holding constant data collection costs, improvements on one dimension necessitate cutbacks along either or both of the remaining dimensions.

As a result of the DOL decision to make few revisions to the content model following the field test, the O*NET Center today collects data related to 239 descriptors, using multiple rating scales for many of them, for a total of 400 rating scales[2] (see Table 4-3). This amounts to a burdensome data collection effort, for both the O*NET Center and the survey respondents themselves.

To reduce respondent burden, the O*NET Center has developed three separate questionnaires that are administered to job incumbents—one focusing on Knowledge (this questionnaire also includes the short lists of questions related to Education and Training and Work Styles), another for GWAs, and a third for Work Context. The requirement to survey three different sets of job incumbents to obtain data for these five domains elevates the cost of administering the Data Collection Program. The O*NET Center also obtains data for these five domains from occupational experts, who are asked to complete all three questionnaires, and it has developed separate questionnaires for Skills and Abilities, which are completed by occupational analysts.

Rating Scales

One result of DOL's limited response to the review and pretesting is that the questionnaires currently used to gather data for four domains (Skills, Knowledge, GWAs, and Abilities) include scales for both level and importance that have been subject to criticism.

[2]This total excludes task descriptors, because the number of these descriptors varies by occupation.

TABLE 4-3 Current O*NET Questionnaires

Exhibit 2. O*NET Data Collection Program Questionnaires

O*NET Data Collection Program Questionnaire	Number of Descriptors	Number of Scales per Descriptor	Total Number of Scales	Data Source
Skills	35	2	70	Analysts
Knowledge	33	2	66	Job incumbents
Work Styles[a]	16	1	16	Job incumbents
Education and Training[a]	5	1	5	Job incumbents
Generalized Work Activities	41	2	82	Job incumbents
Work Context	57	1	57	Job incumbents
Abilities	52	2	104	Analysts
Tasks[b]	Varies	2	Varies	Job incumbents
Total (not including Tasks)	239	NA	400	NA

NOTES: Occupation experts use the same questionnaires as job incumbents for those occupations whose data collection is by the Occupation Expert Method. NA = not applicable.

[a] The Knowledge Questionnaire packet also contains the Work Styles Questionnaire and the Education and Training Questionnaire.

[b] All job incumbents are asked to complete a Task Questionnaire in addition to the domain questionnaire.

SOURCE: U.S. Department of Labor (2008). Reprinted with permission.

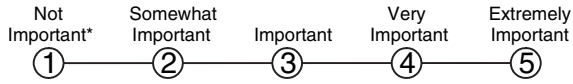
Level Scales

The level scales retain behavioral anchors with complex terminology and technical terms that were unfamiliar to some respondents in the pretesting. As determined by Hubbard et al. (2000), many of the behavioral anchors were examples from occupations unfamiliar to most job incumbents, and the level of difficulty or complexity of the requirements was confounded with the specific performance requirements of a particular occupation. For example, Figure 4-3 shows the current rating scales used for the "Reading Comprehension" skill.

In general, the anchors for the high end of the level scale are embedded in high-level occupations. However, relative to this particular descriptor, anyone with some knowledge of surgery might find comprehending such a journal article quite easy. After all, scientific writing is intended to be clear, direct, and simple. In contrast, an article on surgery might be incomprehensible to a Nobel laureate in literature with a very high level of general reading comprehension but little knowledge of surgery. At the other end of the scale, the level of reading comprehension required to read step-by-step instructions for completing a form may vary, depending on the content of the instructions and the complexity of the form. For example, many people find the step-by-step instructions for completing the Internal Revenue Service's tax forms for computing the alternate minimum tax virtu-

1. Reading Comprehension — **Understanding written sentences and paragraphs in work-related documents.**

A. How important is READING COMPREHENSION to the performance of *your current job*?



* If you marked Not Important, skip LEVEL below and go on to the next skill.

B. What level of READING COMPREHENSION is needed to perform *your current job*?

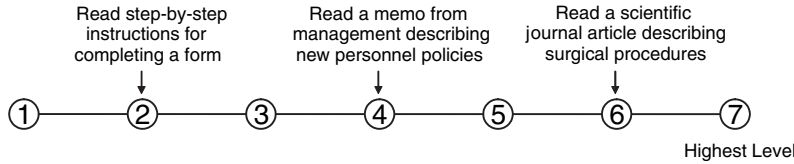


FIGURE 4-3 Reading comprehension rating scales.
SOURCE: National Center for O*NET Development (no date). Reprinted with permission.

ally incomprehensible. In short, this example illustrates the larger problem identified by Hubbard et al. (2000)—the behavioral anchors included in the level scales confound difficulty level with domain specificity.

In a study of O*NET commissioned by the Social Security Administration, Gustafson and Rose (2003) found that some of the behavioral anchors do not represent a clear continuum of levels of difficulty of a descriptor. As in the example of reading comprehension above, Gustafson and Rose found that some rating scales are consistently biased, placing behaviors in professional domains viewed as high level (including medicine, law, science, and "corporate") near the top of the scale, regardless of the actual difficulty of the descriptor being measured. Another example is the anchor at level 6 of the 7-point "oral comprehension" scale, "understanding a lecture on advanced physics."

Handel (2009) also argues that the anchors for some scales do not reflect equal intervals along a continuum of levels of difficulty. Based on an analysis of ratings of 809 occupations, he identifies a pattern of placing extremely complex behaviors at level 6 in the 7-point rating scales, which discourages respondents from using the upper end of the scale. Anchors placed at level 6 include arguing a case before the Supreme Court, nego-

tiating a treaty as an ambassador, and designing a new personnel system for the Army.

Gustafson and Rose (2003) found that some scale anchors include extraneous life-threatening or urgent situations that are not relevant to difficulty level. For example, the Ability "written comprehension" is defined as "the ability to read and understand ideas presented in writing." The level 6 anchor, "understand an instruction book on repairing missile guidance systems," confuses the difficulty of reading the material with the serious implications of a missile system in need of repair. In addition, they found that some behavioral anchors are inconsistent with—or only vaguely related to—the definition of the descriptor being measured, and others conflate learned techniques or skills with high levels of physical abilities.

Importance Scales

It is clear that some of the behaviorally anchored rating scales used to measure the level of descriptors are problematic, and the rating scales for importance have also been subject to some criticism. For example, experts have noted that the meanings of the scale points (e.g., "somewhat important," "very important") are not specified. Raters must impose their own internal metric, which they apparently can do with some degree of consistency (Tsacoumis and Van Iddekinge, 2006). However, the rater's metrics may not correspond to the metrics employed by specific users. In addition, the importance scales cannot be used to reflect substantive occupational requirements. They can be used only for relative comparisons between occupations. Handel (2009, p. 15) notes that "in principle, the concept of level of complexity is more meaningful than importance." A thorough discussion of this issue can be found in Handel (2009), along with proposals for more concrete metrics.

Correlation Between Level and Importance Scales

As noted above, the questionnaires related to Skills, Knowledge, GWAs, and Abilities include scales for both level and importance. These questionnaires contain 161 two-part items that ask respondents about the importance of the descriptor and, if at least somewhat important, the level of the descriptor needed to perform the job (see Figures 4-1 through 4-3). Analyses of the pretest data indicated that the responses to importance and level items were so highly correlated ($r = .95$) as to suggest that the two scales were largely redundant (Peterson et al., 1999). Handel's (2009) analysis of current O*NET data indicates that the two scales remain largely redundant, with a mean correlation between importance and level responses of .92. Re-

spondent burden could be reduced and resources conserved if only a single scale were used to gather data in each of these four domains.

Ratings Provided by Occupational Analysts

The prototype development team believed that job incumbents would be best positioned to rate the level and importance of each descriptor (Peterson et al., 1999). Currently, however, occupational analysts rate the importance and level of the Abilities and Skills descriptors, which comprise 87 of the 239 item descriptors (approximately 37 percent) included in the standardized O*NET questionnaires; items for other domains (Knowledge, GWAs, Work Context, Work Styles) are rated by job incumbents (see Table 4-3). In the first years of data collection, analysts rated only Abilities, but since 2006, they have also rated Skills.

The choice of raters is controversial. In a presentation to the panel, Handel (2009) argued that job incumbents are the most knowledgeable source of information about their own jobs and suggested that the O*NET Center replace the current behaviorally anchored rating scales with different types of questionnaires, including specific questions that he viewed as more understandable to incumbents. In another presentation, Harvey questioned the credibility of ratings provided by analysts, based on his view that they lack extensive firsthand experience with the occupation and also questioned the use of job incumbents, saying they "arguably represent among the least-credible sources of job analysis ratings" (Harvey, 2009a).

Research on Raters as Sources of Occupational Information

The U.S. Department of Labor (2008, p. 6) notes that the O*NET prototype team expected to rely on job incumbents as the primary data source, based on earlier studies indicating that incumbents were capable of accurately rating occupational characteristics (Fleishman and Mumford, 1988; Peterson et al., 1990, 1999). More recent research indicates that job incumbents can provide psychometrically sound ratings of more concrete characteristics of occupations, such as tasks, but that their ratings of more abstract occupational characteristics, such as those relating to abilities or job-related personality traits, are less reliable (Dierdorff and Morgeson, in press; Dierdorff and Wilson, 2003). These recent findings, however, are clouded by unresolved research issues regarding the interpretation of interrater agreement and reliability in job analysis (Harvey and Wilson, 2000; Sanchez and Levine, 2000; Sanchez et al., 1998). In addition, a variety of factors are believed to influence the degree to which ratings by job incumbents and occupational analysts are interchangeable, including job complexity, rater training, written materials, and the information on which

analyst ratings are based (Butler and Harvey, 1988; Cornelius and Lyness, 1980; Lievens and Sanchez, 2007; Lievens, Sanchez, and Da Corte, 2004; Sanchez, Zamora, and Viswesvaran, 1997).

Documentation of the Decision to Use Analysts

According to the U.S. Department of Labor (2008, p. 6), the decision to use analysts to rate Abilities was based on research leading to the O*NET Data Collection Program, which examined various sources and methods for collecting occupational data. The later decision to use analysts to rate Skills was based in part on a study by Tsacoumis and Van Iddekinge (2006), which compared incumbent and analyst ratings of Skill descriptors across a large sample of O*NET occupations. Although the researchers found statistically significant differences between incumbent and analyst ratings—incumbents provided higher mean ratings but demonstrated lower levels of interrater agreement than analysts—these differences were regarded as having minimal practical significance, and they recommended basing the choice of rating source on other factors.

The O*NET Center therefore decided to use analysts to make the Skills ratings based on "considerations of relative practicality, such as cost" (U.S. Department of Labor 2008, p. 6), although it did not provide comparative data on the costs associated with either rating source. Tsacoumis (2009b, p. 1) also alluded to "theoretical and philosophical reasons for preferring one rater group to the other for collecting different types of data." Tsacoumis further asserted that incumbents are generally more familiar with the day-to-day duties of their job and therefore are the best source of information regarding tasks, GWAs, and work context, whereas trained analysts "understand the ability and skill constructs better than incumbents and therefore should provide the ability and skills data" (p. 1).

Methods Used in Analyst Ratings

Analysts are provided written materials about occupations, referred to as "stimulus" materials because they are designed to stimulate a response in the form of a rating. Analysts do not directly observe or interview incumbents employed in the occupations they provide ratings for. Donsbach and colleagues (2003) describe a process of streamlining the stimulus materials used in rating Abilities. First, the researchers removed O*NET data on the Knowledge, Skills, Education and Training, and Work Styles for the occupation being rated, because these materials were judged to be irrelevant to Ability ratings. Next, GWA and Work Context items that were judged to be relevant to a specific Ability by a panel of eight industrial/organizational psychologists were retained. From this pool of items, those that did

not reach a certain cutoff of importance, according to incumbent ratings, were eliminated. This process greatly reduced the amount of stimulus materials provided to analysts to rate Abilities (see Donsbach et al., 2003, Appendix E). Tsacoumis (2009a) indicated that analysts are currently provided with a similar set of rating materials for use in rating Skills. As noted above, research suggests that the type of stimulus materials provided can affect the quality of the ratings.

Tsacoumis and Van Iddekinge (2006) reported that 31 unique analysts had participated in the various cycles of data collection. Eight analysts provided the Skills ratings for the ninth cycle of 106 occupations (Willison and Tsacoumis, 2009). The choice of this specific number of raters used is supported by a series of studies of the psychometric properties of their Skills ratings (Tsacoumis, 2009a), even though the manner in which these psychometric properties were computed is not free of criticism (Harvey, 2009b). Tsacoumis (2009a) also clarified that all analysts received rater training and met certain minimum requirements regarding training and experience.

Unanswered Questions About Analyst Ratings

On the basis of this brief review of the literature and published information from the O*NET Center, the panel identified several questions regarding the use of analysts or incumbents to rate occupational characteristics. Why are analysts used to collect data for the Abilities and Skills domains but not for other domains? If the decision to use analysts for these two domains is based on the argument that analysts are better raters than incumbents of trait-like, abstract aspects of the job, then it is unclear why ratings of Work Styles are still made by incumbents. As noted in Chapter 2, the Work Styles descriptors, such as dependability, stress, tolerance, and integrity, resemble abstract personality traits. Similarly, if analysts are preferred on the basis of research indicating that incumbents are likely to inflate their ratings (Dierdorff and Wilson, 2003), it is unclear why they are not used to rate Work Context descriptors, such as the seriousness of a mistake and the results of decisions on other people, which appear equally vulnerable to inflation bias.

Other questions concern how analysts acquire occupational information. For example, how may the streamlining of rating stimulus materials affect the quality of analyst ratings? Would opportunities to directly observe or interview incumbents influence the quality or usefulness of analyst ratings? Might these or other methods used to provide occupational information to analysts influence the degree of convergence or divergence between analyst and incumbent ratings?

Another question concerns what criteria should be used to evaluate the quality of ratings. Researchers have often focused on interrater agreement,

and interrater reliability (both across and within constructs and occupations), but these have drawbacks as quality metrics. Low levels of interrater agreement among job incumbents may reflect legitimate differences in how different incumbents view their job (Tsacoumis and Van Iddekinge, 2006). Conversely, the relatively high interrater agreement among analysts does not necessarily reflect high validity, because it could result in part from excessive simplification of stimulus materials so that relevant information on Abilities and Skills is lost.

Finally, might it be possible to reduce costs by avoiding the use of analysts? Hybrid approaches capitalize on archival data documenting the empirical relationships among various sets of ratings. For example, known empirical associations between GWA and Ability ratings gathered in the past could be used to mechanically derive Ability ratings using newly collected incumbent-based GWA ratings, thereby eliminating the need to collect analyst ratings with every new wave of incumbent ratings.

Data Collection from Job Incumbents

Job incumbents are the source for most O*NET data (U.S. Department of Labor, 2008). Although they do not rate the importance and level of the Skills and Abilities descriptors, job incumbents do provide data for 6 other domains (Knowledge, GWAs, Work Context, Education and Training, Work Styles, Tasks). The O*NET Center uses two methods to collect information from job incumbents. One method is a carefully designed probability sample of establishments and employees in those establishments, referred to as the "establishment method." The other method, used for occupations that are more difficult to locate in establishments, is referred to as the "occupational expert method" (U.S. Department of Labor, 2008). O*NET Center staff determine which method is most appropriate for each occupation, using information on the predicted establishment eligibility rate and the predicted establishment response and employee response to quantify the efficiency of the two approaches.

For most domains (except Skills and Abilities), the O*NET Center uses the establishment method to collect data for approximately 75 percent of the occupations and the occupational expert method to collect data for approximately 25 percent of the occupations (U.S. Department of Labor, 2008). The occupational expert method is used for occupations that are more difficult to locate in establishments, when employment data for the occupation are not available, or the numbers of incumbents are very low, and one or more professional organizations are available to indentify occupational experts. The updated occupational data collected using these two approaches are not combined and thus estimates are presented separately.

Establishment Method

Frame, sample design, and sample waves. According to the U.S. Department of Labor (2008), a stratified two-stage design is used to select a sample of workers. The first stage is a sample of businesses (the primary stage) that were selected with probability proportional to the expected number of employed workers in the specific occupations being surveyed. From these first-stage sampling units (the businesses), a sample of employees is selected.

The frame for the primary stage contains approximately 15 million establishments, including the self-employed. Employment statistics published by the U.S. Bureau of Labor Statistics (BLS) are merged with the industry information from Dun and Bradstreet to help identify industries in which particular occupations are employed.

For occupations that are difficult to locate, another frame is used to either supplement or replace the Dun and Bradstreet frame. The National Center for O*NET Development and RTI (2009a) identified three scenarios in which another frame was used: (1) a supplemental frame of job incumbents obtained from the membership list of a professional association; (2) a supplemental frame of employers selected from a targeted listing of establishments that employ workers in the occupation; and (3) a special frame of establishments that provides better coverage of the occupation of interest than the Dunn and Bradstreet frame. Dual frame estimation techniques were used for occupations requiring two frames.

Stratification is used to obtain adequate representation for establishments with varying numbers of employees. This is done by undersampling smaller establishments (fewer than 50 employees) and oversampling large establishments (250 or more employees).

The sample design incorporates a wave design to control sample overproduction. Groups of occupations that are expected to occur in a similar set of industries are formed. This approach minimizes the number of establishments to contact. Model-aided sampling is employed, which controls employee sample selection. This approach is beneficial in reducing data collection costs, with minimal effects on the accuracy of the estimators (Berzofsky et al., 2008).

Sample size and selection. For a given occupation, a minimum of 15 valid, completed questionnaires for each of the 3 domain questionnaires is required to meet precision targets, while task and background information is collected via a minimum of 45 respondents. The current precision targets for O*NET are that virtually all 5-point scale ratings have a 95 percent confidence interval no wider than +/–1 and that virtually all 7-point scale ratings have confidence intervals no wider than +/–1.5. In O*NET data collection to date, the average number of respondents per domain question-

naire is approximately 33 and for task and background information 100. And 90 percent of the 5-point and 7-point scale ratings are within the precision targets (National Center for O*NET Development and RTI, 2009a).

The establishment method involves multiple sample selection steps (see Data Collection Procedures, below), including sampling establishments at the first stage and employees at the second stage. Probability proportional to size selection is used to select a subsample of establishments from the simple random sample of establishments that were initially selected.

Weighting and estimation. Because the sample selection process for the establishment method is a complicated design, complex procedures are required in the analysis of these data. The weight development and estimation have been carefully outlined (U.S. Department of Labor, 2008, pp. 65-86). The final weights account for the sampling of establishments, occupations, and employee selection; adjustments for early termination of employee sampling activities due to higher-than-expected yields and multiple sample adjustments; adjustments for nonresponses at both the establishment and the employee levels; and adjustments for under- and overcoverage of the population. Weight trimming is used to adjust for extremely large weights.

Final estimates are produced for each occupation, but no subgroups or domain estimates are produced or released. Standard deviations are available for each item. No item imputation is conducted because of the low item nonresponse (U.S. Department of Labor, 2008, Appendix H). Design-based variances are produced using a widely used survey design software package called SUDAAN, which was developed at RTI. This software accounts for the complex survey structure used in the establishment method. Variances are estimated using the first-order Taylor series approximation of deviations of estimates from their expected values. Standard error estimates and 95 percent confidence intervals are included with all estimates of means and proportions.

Occupational Expert Method

According to the National Center for O*NET Development and RTI (2009a), the occupational expert method is used when the establishment method would be problematic due to low rates of employment in some occupations, such as new and emerging occupations. This method is used when the occupation is well represented by one or more profession or trade associations that are willing and able to identify experts in the target population. An occupational expert is knowledgeable about the occupation, has worked in the occupation for at least 1 year, and has 5 years of experience as an incumbent, trainer, or supervisor. The occupational expert must have had experience with the occupation in the past 6 months.

For this method, samples of experts are selected from lists of potential respondents. A stratified random sample of occupational experts is selected from the provided lists to prevent investigator bias in the final selection. Sample sizes are designed to ensure that a minimum of 20 completed questionnaires are available for analysis after data cleaning. According to the U.S. Department of Labor (2008), the goal of 20 questionnaires was set as a reasonable number to enable adequate coverage of experts, occupation subspecialties, and regional distribution. Although the DOL provides estimated standard deviations for the mean estimates based on the occupational expert method, it does not indicate that 20 was selected based on sample size calculations to meet any current measure of variability. Because data collected from using this method are not based on a probability sampling design, unweighted estimates of means and percentages are reported.

Both the establishment and occupational expert approaches are carefully documented (U.S. Department of Labor, 2008). Details of the probability sampling design, stratification, sample sizes, weighting, and estimation for the establishment method are well defined. Steps in the development and analysis seem appropriate. The nonprobability approach for the occupational expert method is distinguished from the probability approach of the establishment method, and it is noted that these estimates should be viewed separately from the establishment method. However, the Data Collection Program relies on model-aided sampling. Although the model-aided sampling approach is discussed in an article published by RTI Press (Berzofsky et al., 2008), this approach would be viewed by a larger audience and gain more exposure if published in a more widely circulated professional journal in the field of survey methodology.

Data Collection Procedures

The O*NET data collection process employs a complex design that first identifies business establishments and then surveys employees in those establishments. The U.S. Department of Labor (2008) describes the 13-step process for both the establishment and the occupational expert methods. RTI International designs, implements, and supervises the survey data collection.

Selection of an employee for the establishment method is a multistep process. Establishments are first selected, and occupations are then assigned in selected establishments. Employees are selected through a point of contact in the establishment who is responsible for coordinating data collection within the establishment and for following up with nonresponding employees. Once the contact agrees to participate, informational materials and questionnaires are mailed to both him or her and the job incumbents.

The O*NET Center and RTI (2009b) report that, based on their experience almost all establishments prefer to coordinate data collection themselves and their sense is that many establishments would refuse to participate if they were required to provide the name of their employees. The Center and RTI determined that it was not feasible to contact the employee directly for nonresponse follow-up purposes, because most employers will not divulge confidential employee contact information.

A number of tools commonly used to improve and monitor response rates are implemented throughout the data collection process. First, the data collection team employs a complex web-based case management system that enables up-to-date tracking of all activities while the survey is being fielded. Incentives are offered to the point of contact, establishments, and employees to encourage participation and improve response rates. Multiple modes of data collection are offered to the employee, including web and mail versions of the surveys. In addition, multiple contacts, another well-known survey procedure to improve response rates, are also in place. Spanish versions of the questionnaires are available (and can be requested by calling a toll-free number) for occupations with a high percentage of Hispanic workers, although these are not distributed in high numbers. The O*NET Center outlines further enhancements that are implemented to maximize response rates (U.S. Department of Labor, 2008, Section B.3).

The steps in the data collection protocol for the occupational expert method are similar to the process followed in the establishment method. However, since occupational experts are enlisted for this approach, there are no verification or sampling calls.

Response Rates

Calculating response rates—the number of eligible sample units that cooperate in a survey—is central to survey research. It is valuable to standardize definitions of response rates in order to allow comparisons of response and nonresponse rates across surveys of different topics and organizations. The American Association for Public Opinion Research (AAPOR) has developed standard definitions that clearly distinguish between the response rate and the cooperation rate, cover different modes of survey administration, discuss the criteria for ineligibility, and specify methods for calculating refusal and contact rates (American Association for Public Opinion Research, 2008).

The U.S. Department of Labor (2008) reports relatively high response rates for both the employees and the establishments contacted using the establishment method. However, it is unclear whether the rates reported are response rates or cooperation rates, as defined by the AAPOR. In response

to our questions, the O*NET Center provided more information about response disposition categories but did not provide detailed disposition rates as defined by AAPOR.

Data Editing and Cleaning

This stage of data processing can be another source of nonsampling error. Responses from the mail questionnaires are keyed using double entry and 100 percent key verified, which reduces the potential for data entry error. A final stage of data cleaning for the O*NET data is defined as the "deviance analysis" for task questionnaire data. Deviance analysis identifies cases with response profiles differing from the response profiles of the rest of the cases in the occupation. For this analysis, cases with response profiles that differ from the response profiles are considered "deviant" and referred to as "outliers."

Although the O*NET Center provided a written description of this analysis in a response to a question from the panel (National Center for O*NET Development and RTI, 2009c), there does not appear to be any public documentation of this process. It appears that outliers that have lower task endorsement in this analysis are identified. For example, cases that do not have more than 33 percent or more of tasks rated as "3 or higher" and have less than 50 percent or more of the tasks rated as "relevant" would be identified as potentially deviant.

DATA CURRENCY

From 2001 to 2006, the O*NET Center collected and published updated information on approximately 100 occupations twice yearly. Over the past 3 years, with a lower budget, it has collected and published updated information on approximately 100 occupations once each year (Rivkin and Lewis, 2009a). The current O*NET database includes comprehensively updated information for 833 of the 965 occupations for which data are gathered. The 132 occupations that have not yet been updated are among the new and emerging occupations added to the O*NET-SOC taxonomy in 2009. Overall, across all occupations, the average currency of data is 2.59 years.

The O*NET Center prioritizes occupations for waves of data collection and updating on the basis of an extensive list of criteria, including not only when the occupation was last updated, but also whether the occupation is considered a "demand-phase occupation" by DOL. According to the O*NET Center, "demand-phase occupations" are those that (Lewis and Rivkin, 2009a, 2009b):

- Are identified as in demand by DOL;
- Are identified by DOL as a "top 50" occupation on the basis of job openings and median income;
- Are identified with high growth rates and/or large employment numbers;
- Are linked to technology, math, science, computers, engineering, or innovation;
- Are identified in a high "job zone" (i.e., require considerable or extensive preparation); and
- Are identified as a green occupation.

The O*NET Center's stated goal is to update all demand-phase occupations at least once every 5 years. There is no stated goal for regularly updating other occupations (Lewis and Rivkin, 2009a).

This priority-based sampling approach results in a database with uneven currency across occupations. Although data for most occupations in the current O*NET database is relatively fresh, data for just over 5 percent of occupations have not been updated in 5 years or more (Lewis and Rivkin, 2009a, 2009b).

CONCLUSIONS AND RECOMMENDATIONS

To gather information for most content model domains, the National Center for O*NET Development employs a multimethod sampling approach, whereby respondents for approximately 75 percent of the occupations are identified through probability-based sampling, and respondents for 25 percent of the occupations are identified by other less scientifically rigorous methodologies. To gather information for the Skills and Abilities domains, respondents for all occupations are identified by methodologies other than probability-based sampling. This mixed-method approach results in the collection of occupational data from different types of respondents (occupational analysts, job incumbents, occupational experts) who may or may not represent the work performed in that occupation. It is unclear what impact this has on measurement error, since each type of respondent introduces a different source of error.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2, commission a review of the sampling design to ascertain whether the current methodology represents the optimal strategy for consistently identifying the most knowledgeable respondents in each of the occupations studied and whether the results obtained are generalizable geographically, ethnically, and in other ways. The review should include

investigation of the reliability, quality, and usefulness of data collected from different types of respondents and the cost-effectiveness of collecting data from these different groups.

The researchers commissioned by DOL should examine the errors involved in the current combination of probability-based sampling and other sampling approaches and distinguish the inferences made from these two approaches. If they determine that the current mix of methods does not represent the optimal strategy, DOL should commission research to explore other approaches to gather information on rare occupations, such as adaptive sampling designs.

This review should consider other surveys with which O*NET could piggyback, such as the Current Population Survey or other national household surveys.

Surveys administered by the O*NET Center include rating scales with behavioral anchors that define points on the scales. The surveys ask respondents to assess the level and importance of various descriptors required to perform the occupation. Some characteristics of these scales make them difficult to use or result in an inconsistent frame of reference across raters. For example, some scales lack interval properties, and the instructions provided to focus the rater's task are unclear. In addition, in the scales used to assess the required level of a descriptor, many of the behavioral anchors are taken from occupations that are not familiar to many job incumbent raters.

Recommendation: The Department of Labor should, in coordination with research on the content model discussed in Chapter 2,[3] and with advice and guidance from the technical advisory board recommended in Chapter 2, conduct a study of the behaviorally anchored rating scales and alternative rating scales. This research should examine the rater's understanding of the rating scales and frame of reference for the rating task and should include verbal protocol analysis as well as pretesting and feedback from respondents of different demographic backgrounds, sampled from a variety of occupations. So that researchers can fully evaluate the strengths and weaknesses of the pretest results, the demographic profile of the pretest respondents should be included as part of the study documentation, using appropriate techniques to protect individual privacy.

[3]Because the research recommended in Chapter 2 may result in the elimination of some descriptors, there would be no need to study the behaviorally anchored rating scales associated with those descriptors.

If the pretest results indicate problems with comprehension of the survey items, DOL should consider implementing changes that will facilitate a better understanding of the rating task, including revision of instructions, adjustment of the overall reading level, and revision of the rating scales so that the questions are not double barreled (combining two or more issues into a single question).

Most O*NET data are collected through surveys of employees (job incumbents) of a sample of establishments, an approach referred to as the establishment method. The O*NET Center reports relatively high response rates for both the employees and the establishments contacted using this method. However, it is unclear whether these reported rates are response rates or cooperation rates, as defined by AAPOR.

Recommendation: To improve the cost-effectiveness of data collection, conform to best practices for survey design, and comply with current federal requirements for survey samples, the Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2, explore ways of increasing response rates. This research should consider the costs and benefits of pilot-testing all questionnaires on real job incumbents, directly contacting job incumbents rather than relying entirely on the establishment point of contact for access to job incumbents, and using incentives to encourage participation.

As part of this exploration, DOL should consider cost-effective ways to identify nonresponders and encourage their participation. The results of these studies should be released for public use. Because the representativeness of the establishment method sample depends partly on the response rates, the O*NET Center should publish a detailed breakdown of the response disposition using the definitions of AAPOR. Such a detailed breakdown of the response rates would facilitate evaluation of the sample and help the O*NET Center and DOL to target nonresponse research efforts.

Through data collection over the past 10 years, DOL has achieved its initial goal of populating O*NET with up-to-date information from job incumbents and job analysts, replacing earlier data based on the *Dictionary of Occupational Titles*. However, short-term policy agendas related to workforce development have at times reduced focus on the core activities of developing, maintaining, and updating a high-quality database. For example, the O*NET Center prioritizes occupations for waves of data collection and updating based on an extensive list of criteria, including not only when the occupation was previously sampled but also whether it has been identified as "in-demand" by DOL, whether it has been identified as a new and emerging occupation, and whether it is one of the "top 50" oc-

cupations identified by DOL (based on the numbers of job openings and median income). This priority-based sampling approach results in a database with uneven currency across all occupations. The average currency of data, across all O*NET occupations, is 2.59 years, but over 5 percent of occupations have not been updated for 5 or more years.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, develop a clear and closely followed policy and set of procedures for refreshing survey data in all O*NET occupations. The policy and procedures should take into account the length of time that occupational data remain viable as well as the need of various O*NET user communities for the most up-to-date information. As part of this effort, the Department of Labor should explore the potential benefits and practical feasibility of adding an O*NET supplement to the ongoing Current Population Survey, in order to provide a sample of fresh data to assess the currency and representativeness of the data in O*NET.

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5

The Role of Technology

This chapter focuses on the presentation of the O*NET database on the web for use by individuals and organizations. It begins by describing and reviewing the O*NET user interface and then describes the use of the O*NET database by outside developers. Next the chapter discusses the structure of the database and its current presentation on the web. It then discusses the development of the "semantic web" and the possibilities for development of a semantic web structure for O*NET. The next section presents possible approaches to encourage outside development of tools and applications incorporating O*NET, and the chapter ends with conclusions and recommendations.

THE O*NET USER INTERFACE

The field of website usability is developing rapidly and now includes sophisticated methods to gather feedback from users about their interactions with websites (Butler, 2009). Although the panel lacked the expertise and time to apply such methods to a complete review of the O*NET user interface, our brief review suggests that a more in-depth study by qualified professionals in the field of usability is needed.

The O*NET web presence includes six different web domains in a variety of styles. These web domains are only loosely connected through hyperlinks, without any navigation tools that span them. They include

- O*NET OnLine (http://online.onetcenter.org/)
- O*NET Resource Center (http://www.onetcenter.org/)

- O*NET Code Connector (http://www.onetcodeconnector.org/, also at http://www.onetcenter.org/codeconnector.html)
- O*NET Academy (http://www.onetacademy.com/)
- O*NET OnLine Knowledge Site (http://www.onetknowledgesite.com/)
- O*NET Data Collection Program (https://onet.rti.org/)

In addition, the Employment and Training Administration of the U.S. Department of Labor (DOL) maintains another website, including the following pages:

- O*NET Beyond Information-Intelligence (http://www.doleta.gov/programs/onet/)
- O*NET in Action (http://www.doleta.gov/programs/onet/oina.cfm)
- O*NET FAQs (http://www.doleta.gov/programs/onet/faqs.cfm)
- O*NET Contacts (http://www.doleta.gov/programs/onet/contact.cfm)

It appears that these sites were created by separate contractors at different stages of O*NET web development without considering how each website would fit into the larger O*NET web presence. The appearance changes from site to site, with wide variations in font sizes and column layouts. Some sites provide the viewer with little guidance about how they should be used. For example, the O*NET Academy offers a series of podcasts, recorded webinars, and online training courses about O*NET. Some of these materials appear to be aimed at job seekers, and others are targeted to employers and to government and education professionals. However, the materials are all presented together, with no sorting by the role or interest of the user.

Some of the information contained in these websites is presented on static web pages, and other information is available in the form of documents and data files that can be opened and viewed or downloaded. For example, many research and technical reports are available for viewing and downloading from the O*NET Resource Center website. Similarly, although the O*NET self-assessment tools are not available for use through an interactive website, they are available for downloading from the O*NET Resource Center website. Some of these tools are available for use in print form, and others are available in electronic form for downloading and use on local computers.

The review of the O*NET web presence that follows suggests that the multiple websites do not conform to three key principles of effective web design: (1) navigation across websites, (2) user-centered design, and (3) interactivity (Hunt, 2008a; Ta'eed, 2009). The discussion below supports

our recommendation that DOL undertake a comprehensive evaluation of all elements of the websites by usability professionals.

Navigation Across Websites

According to Hunt (2008a) and Ta'eed (2009), providing users with a consistent set of navigation aids is one of the most important principles of website design. According to Hunt (2008a), providing navigation aids helps people know "where they are, where they can go, and gives them the means to get there easily."

Navigating through the various O*NET websites can be time-consuming and difficult. Navigation links change dramatically from one web page to another, and the user may not be sure where on the multiple sites the current page resides. For example, no links or navigation aids are provided to allow a user to easily move between the O*NET data collection page of the O*NET Resource Center website (http://www.onetcenter.org/dataCollection.html) and the O*NET data collection page maintained by RTI (https://onet.rti.org/). There is no single O*NET home page; instead, each of the O*NET web domains has its own home page.

Navigation throughout the entire O*NET web presence is also made difficult by the lack of a single search tool. To search across all the websites, the user must leave the site and go to an outside search engine, such as Google. As noted above, a great deal of information, including the O*NET database itself, is made available free for downloading by users. However, in an effort to track usage, the O*NET Academy requires users to register before gaining access to online training materials, which may discourage some users.

Some of the O*NET websites include an area labeled "O*NET Sites" displayed on the upper right and lower right of each web page, with a drop-down menu providing direct links to other websites. In general, however, our review indicates that the O*NET websites provide few aides to facilitate navigation by users. This aspect of the design of the websites stands in contrast to the research on web design reviewed by the panel, which emphasizes that ease of navigation strongly influences both the extent of use by an individual visitor to the site and the number of repeat visits.

User-Centered Design

A second key principle of effective website design entails identifying the likely audience for the site, designing for that audience, and testing its effectiveness with that audience (Butler, 2009). Experts in website usability agree that it is essential to understand who the user is and target the site content to the user (Butler, 2009; Hunt, 2008a, 2008b; Ta'eed, 2009). If

there are different groups of users, then the web designer should design the site to meet the needs of each user group when possible, arranging the site so that users can find the information they need in a form that is relevant to them. The following sections describe O*NET OnLine and review the website in light of this principle.

Description of O*NET OnLine

The O*NET Center makes the database directly available to the public through its website, O*NET OnLine. The website is divided into four primary categories: Find Occupations, Advanced Search, Crosswalks, and Occupation Search (see Figure 5-1). The Find Occupations area offers drop-down menus for searching the database using different criteria, such as by "in-demand industry cluster," by O*NET descriptor, or by science, technology, engineering, and mathematics (STEM) education required. The Advanced Search area has a drop-down menu linking to a Skills Search page and a Tools and Technology Search page. The Crosswalks Search area has a drop-down menu allowing the user to choose among pages for different occupational classification. These pages allow the user to enter either the specialized code from a different classification system, such as the SOC,

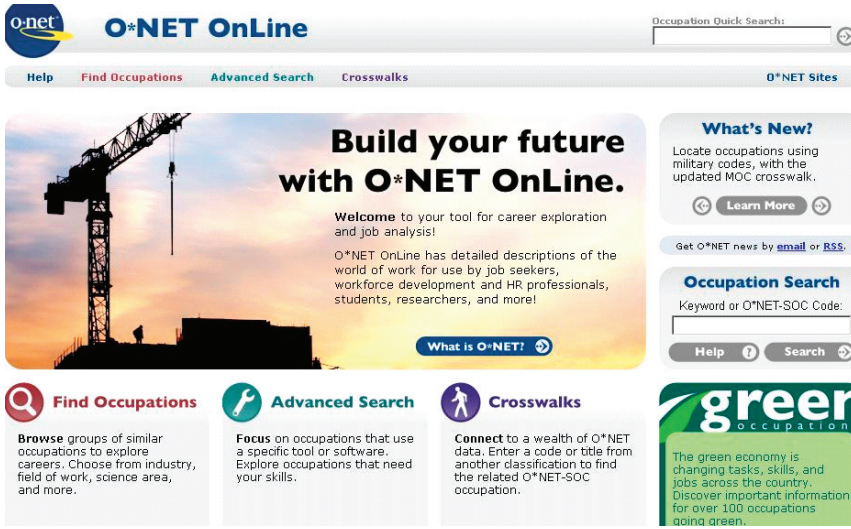

FIGURE 5-1 O*NET OnLine.
SOURCE: National Center for O*NET Development. Reprinted with permission.

or keywords to search for an occupation. The Occupation Search Area includes a single text box for searching by keyword or O*NET-SOC code.

From the Advanced Search drop-down menu, the user may select the Skills Search page. This page allows the user to select any number of Basic Skills, Complex Problem-Solving Skills, Resource Management Skills, and other skill descriptors and search for occupations that most closely match that combination of skills in the O*NET data. Alternatively, the user may select Tools and Technology. This page contains a text box for entering specific tools or technologies in order to search for occupations using these tools.

Usability of O*NET OnLine

The O*NET OnLine home page states that it offers "detailed descriptions of the world of work for use by job seekers, workforce development and HR professionals, students, researchers, and more!" (see Figure 5-1). However, the home page contains drop-down menus with many undefined acronyms and terms with meanings that cannot be obvious to any but very experienced users.

One example of the difficulty users may encounter is in the Find Occupations section of the home page, which invites the visitor to "Browse groups of similar occupations to explore careers." The user is offered a drop-down menu to search by Career Cluster, Green Economy Sector, In-demand Industry Cluster, Job Family, Job Zone, O*NET Descriptor, or STEM discipline. To respond to this menu, a novice user would first be required to look up the meanings of these terms. Similarly, the Crosswalks Search area offers a drop-down menu of the following options: CIP, DOT, MOC, OOH, RAPIDS, and SOC. Nowhere on the home page is there any indication of the meaning of these acronyms. The lack of clarity in these two areas of the home page, which provide key entry points to the database, may reduce interest in and use of the website (Hunt, 2008b; Tufte, 1990).

If the user persists and opens one of the drop-down choices in the Crosswalks Search area, he or she will find the definition of the particular acronym chosen. These definitions, such as Classification of Instructional Programs for CIP and Military Occupational Classification for MOC, are unlikely to be meaningful to the average lay person (although they may hold meaning for specialists in occupational and educational classification systems).

Continuing in the Crosswalks Search area, the user finds a page for each occupational classification system with a text box for searching either by occupational title or by using that classification system's code. If the user enters a title in one of these search boxes, the website returns a page with a long list of links to occupations. The page does not provide definitions of

the occupations. Selecting an occupation from this list leads to the summary report—one web page containing approximately four printed pages of text in a small font. Research evidence in the field of usability suggests that users often do not read web pages presented in this way (Hunt, 2008a, 2008b; Ta'eed, 2009). A workforce development specialist who spoke to the panel described the level of detail in the summary report as "overwhelming for the lay person" (Graybill, 2009).

A user who chooses the detailed view for an occupation receives approximately 10 pages of text listing all of the 200-plus descriptors in the content model, with bar graphs showing the importance of each descriptor (Skills, Abilities, etc.). Comparing these characteristics of the occupation with those of another occupation requires the user to first print the pages associated with one occupation, then back out and select the other occupation and print out those pages. As an alternative, the user could save each subsection of each page to a separate worksheet program (such as Microsoft Excel) or to a generic comma-separated-values file. The website's lack of support for side-by-side comparisons of occupations hinders workforce development specialists from analyzing skill gaps of displaced workers or designing customized retraining programs to fill those gaps (Graybill, 2009).

The panel's brief review, together with the lack of any data based on user testing or tracking user interactions with the website suggests that development of O*NET was not based on the principle of user-centered design. The design does not reflect a process of identifying the likely audience for the site, designing for that audience, and testing the effectiveness with that audience.

Interactivity

The third principle of modern web design is to make information service interactive and responsive to user input (Hunt, 2008a, 2008b; Ta'eed, 2009). O*NET OnLine limits the user's ability to assemble and compare similar data across multiple occupations. For example, a user viewing the detailed information about an occupation, including the importance levels for various descriptors of Skills and Abilities, cannot easily view other occupations for which these descriptors are equally important. Although it is possible to select some occupational characteristics (Skills, Abilities, Work Values, and others) and to search for occupations requiring these characteristics, it is not possible to search on the basis of other criteria, including required level of education and median wages. Nor can a user select classes of occupational characteristics and then narrow selection according to different characteristics. For example, the user cannot identify the set of oc-

cupations for which knowledge of psychology is important and then select the subset that requires a master's degree.

The next generation of Internet tools, often referred to as Web 2.0, allows website users to do more than simply retrieve information. These tools divide data storage from its presentation and provide users with great flexibility in how they use data (Schroeder et al., 2009). Similarly, the use of scripting languages, backend data storage, and flexible display design can make the user's interaction with a website more productive. Application of these tools could encourage use of O*NET OnLine.

USES OF THE O*NET DATABASE

In addition to making the database available to the public through O*NET OnLine, the O*NET Center makes it available for download and use by outside organizations and developers. Many individuals and organizations download the database and incorporate it into tools and applications that are used in career development, workforce development, human resource management, and research (National Center for O*NET Development, 2009). From January 2002 to December 2008, the database was downloaded over 70,000 times (Lewis and Rivkin, 2009a). Although the database is free and no license is required, the O*NET Center requests developers to comply with a formal user agreement (see Box 5-1).

To cite just one of many examples, the University of Oregon downloads the O*NET database to create occupational profiles that are linked to other data on education and training programs and financial aid in a comprehensive career information system (CIS). This system is used in more than 7,000 schools and state agencies, and it serves as the basis for state-based career information delivery systems in 15 states (see Chapter 6). The University of Oregon CIS is one of 14 large online career guidance systems that incorporate the O*NET database; these systems provided O*NET data to approximately 37 million individuals in February 2009, with the typical user accessing the database throughout academic year 2008-2009 (Janis, 2009).

By comparison, O*NET OnLine received 766,000 visitors per month in 2008, or approximately 9.2 million visitors over the course of 2008 (Lewis and Rivkin, 2009a). These 9 million visitors carried out 10.5 million searches and viewed more than 13 million occupational reports, translating to just over one search per visitor and one report per visitor (Lewis and Rivkin, 2009b). Most activity at the O*NET OnLine website was concentrated in the keyword search area.

On the basis of the limited evidence available, it appears that the use of O*NET OnLine is much smaller than the use of O*NET by visitors to external websites incorporating O*NET data. While it is important to

BOX 5-1
User Agreement and Certification

Developers of products, software, or system applications using O*NET are subject to the terms of a formal O*NET Database Products User Agreement (http://www.onetcenter.org/agree/database). The agreement requests the individual to complete a registration form with contact information that is sent to the O*NET Center. The registration form asks the individual about his or her willingness to share information about their use of O*NET products; those who agree to this condition provide valuable information on usage to the O*NET Center and to DOL. However, some of those who download the database elect not to complete the voluntary registration form, and some of those who complete it elect not to be contacted to share information on their use of O*NET.

The terms of the user agreement include acknowledging that O*NET® is a trademark of the U.S. Department of Labor, Employment and Training Administration, and displaying the trademark symbol. The user must also display the version number of O*NET included in the product, such as O*NET 14.0, and must display the "O*NET In It" mark in and on the product. To support this element of the user agreement, the O*NET Center makes the "O*NET In It" graphic available for download and reproduction (http://www.onetcenter.org/graphics.html). In addition, the O*NET Center provides O*NET OnLine graphics for use by website developers that link to O*NET OnLine from within their own websites and graphics.

maintain a user interface providing direct access to the database, this function should be seen as clearly secondary to the task of maintaining the core O*NET data. Any web development efforts should focus on the provision of services that are not effectively offered elsewhere. The finding that the database is used most widely in applications created by outside developers leads to our discussion in the following sections of the role of technology both to increase availability and use of O*NET and to assist in gathering background occupational data.

STRUCTURE AND AVAILABILITY OF THE DATABASE

To encourage outside developers to make use of the most current O*NET database, referred to as the development database, the O*NET Center makes it available for download approximately 3 months before it is incorporated into O*NET OnLine. For example, the O*NET Center made O*NET 14.0, the current development database, available for download

in June 2009.[1] At that time, O*NET OnLine continued to incorporate the older version of the database, O*NET 13.0, which the O*NET Center refers to as the production database. The most current database, O*NET 14.0, was incorporated into O*NET OnLine in fall 2009.

Database Content

The database includes, for each occupation, survey information related to most domains in the content model, such as descriptors of Abilities, Skills, and Work Values.[2] Although information on workforce characteristics, one of the six major categories of information in the content model (see Figure 1-1) is included in O*NET OnLine, it is not included in the database made available for download. In addition to the database comprised of core files related to the content model, the O*NET Center makes other information, including Emerging Tasks, Detailed Work Activities, Tools and Technology, and crosswalk files available separately for download. The O*NET Center refers to these other data sets as "supplemental files." It maintains archives of all survey data collected and earlier published versions of the database and the supplemental files.

Availability of the Database

Users can directly download the core O*NET data from the O*NET Resource Center website in the format of a compressed file containing 22 separate files stored as text. The supplemental files, such as the Detailed Work Activities, are also made available as separate, compressed text files. Each data table is contained in one of the 22 separate files, and assembling the full database is cumbersome. The user must download each file separately, uncompress it, and read it into the user's application. The user must specify the fields in a table to be used to uniquely identify each observation and must also specify the relationships between rows in different tables. Users may not be aware that an "O*NET Data Dictionary" is made available along with the database, or that this dictionary includes a section describing the relationships between the tables and the elements of the tables that operate as identifiers. The complex and time-consuming process for downloading the database and the supplemental files could easily result in errors.

[1]While making the most current database available for downloading, the O*NET Center also continues to make the previous database available for those who prefer that version.

[2]In addition to the mean value of survey responses, the O*NET tables include a few additional items of summary statistical information about the data collected to populate the content model. Some additional detail on the survey instrument responses is provided in a table called Occupation Level Metadata.

Downloading the database and supplemental files is easier for users whose computers employ the Windows operating system. The National Crosswalk Service Center supported by the Department of Labor provides the O*NET data preloaded for three proprietary database programs: Microsoft Access, Visual Fox Pro, and SAS, all Windows applications with proprietary data formats.

Downloading the database would be easier for all users if it were made available in structured query language (SQL) format. SQL is a nonproprietary computer language that can be used to query and modify data and manage databases. It is designed specifically to facilitate the retrieval, insertion, updating, and deletion of data in relational databases, such as O*NET. It is widely used and has been standardized by the American National Standards Institute (ANSI).

Making O*NET available in ANSI SQL format would facilitate downloading by developers who use the three currently supported database programs. It would also facilitate the downloading and use of O*NET by developers using other proprietary and nonproprietary database programs. Making the database available in ANSI SQL, in addition to the currently available versions, would lower developers' costs of creating local copies and reduce the probability of error for developers who do not use the three currently supported database programs.

THE SEMANTIC WEB

Much of the usefulness of O*NET is derived from linking it to other data sets, including data on wages and employment levels, to create new applications and tools (see Chapter 6). New technological tools could facilitate links between O*NET and other data sets on the Internet, expanding the potential for developers to create useful applications. This section introduces an emerging technology for linking data sets across the Internet: the semantic web.

The early development of the Internet was motivated by the need to efficiently transmit large quantities of data between locations (Berners-Lee, Hendler, and Lassila, 2001). The early World Wide Web incorporated a presentation protocol that allowed transmission of human-readable information between computers. Over time, the increasing use of data in web applications led to the development of tools, most notably XML, for transmitting data in a way that preserved its structure and allowed greater ease in communicating it between computers as long as the sender and recipient agreed on the meaning of the content of the data. These tools are now being used to exchange occupational information.

The HR-XML Consortium

Technical experts in the human resources field have created standards for communicating data between computers. The HR-XML Consortium (http://www.hr-xml.org) is made up of over 70 members, including Monster, SAP, Microsoft, Oracle, Kelly Services, ADP, EDS, and the Society for Human Resource Management. The consortium publishes and develops XML schemas for transaction processing in human resource departments and firms. It has used O*NET data to identify common elements of human resource management systems and develop specifications that allow organizations to capture and use occupational information for human resource functions, such as building competency models, conducting job analyses, and developing performance appraisal systems (U.S. Department of Labor, 2008).

Standards developed by the HR-XML Consortium enable automation of human resource–related data exchanges. For example, through HR-XML, a standardized set of information can be exchanged between a staffing supplier (such as a staffing agency) and its customer (such as a manufacturing firm). This information might include order processing, key competencies of employees, employee assignments and hourly rates, hours worked, and payroll expenses. The HR-XML communication protocol may be seen as a step in the direction of an ontology for the field of human resources (Bizer et al., 2005), and an ontology for HR-XML may not be that far off (Bohring and Auer, 2005).

Although XML provides a reliable way to transmit data, it does not provide significant "semantic content," or a definition of the data independent of the processes being used to transmit them that would allow computers to read and interpret the data. A database such as O*NET can be given meaning by defining an *ontology* for it. An ontology is a formal representation of meanings and relationships in a given context, in this case, data stored on the web. The main standard-setting body for protocols used on the World Wide Web has created a system of semantic web standards (World Wide Web Consortium, 2009), designed to provide information about the meaning of a data element in a way that can be interpreted unambiguously by a computer program. This system, the Resource Description Framework (RDF), assigns a specific context to web objects (Powers, 2003). The key standards for expressing ontological information are the RDF Schema (RDFS) standard and the Web Ontology Language (OWL) (Allemang and Hendler, 2008). It is important to note that, although the use of these current standards is growing, new semantic web tools may emerge in the future.

Standards for the Semantic Web

In the RDF system, the label used to assign an unambiguous context to an object or data set on the web is referred to as a Uniform Resource Identifier (URI). A URI is simply a web address that is a global identifier for the ontology of the data that are being made available on the web. The ontology allows a computer program to draw inferences about meanings and relationships of objects in the data set.

Data that can be retrieved through a URI are often referred to as an RDF store. As the owners of various data sets establish RDF stores, it becomes possible for data users, including researchers and applications developers, to write a data query that draws data from distinct, but semantically linked, data sets (Sadler, 2009). Such a query can select, filter, and merge data from the various data sets. Semantically linking data sets offers several benefits to the owners of these data sets and to data users generally. It allows Internet-wide data mining and analysis, provides the opportunity for interoperability between widely dispersed data sources, and increases the likelihood that unexpected innovations using linked data can develop (Sadler, 2009). Recognizing these benefits, the owners of many large public data sets on the web have assigned ontologies to their data sets, and these data sets are now semantically linked (see Figure 5-2).

Semantic Web Tools in Federal Agencies

The federal government has recently begun to deploy semantic web techniques. For example, Jet Propulsion Laboratories, under contract with the National Aeronautics and Space Administration (NASA), has developed and is continuing to expand ontological schema for all data derived from NASA planetary exploration programs. Jet Propulsion Laboratories is also building an ontology for environmental science information, designed to allow researchers to remotely query any of the numerous data stores distributed around the country, using different computer platforms and different storage technologies. The National Cancer Institute has released a public ontology that allows computers to more easily assist in exploring information on genetics, biology, and chemistry developed through institute-sponsored research and other research in order to advance the institute's mission.

The Office of Management Budget has developed an ontology for its Federal Enterprise Architecture initiative, a government-wide effort to maximize the contribution of information technology systems and resources in support of each agency's performance goals.

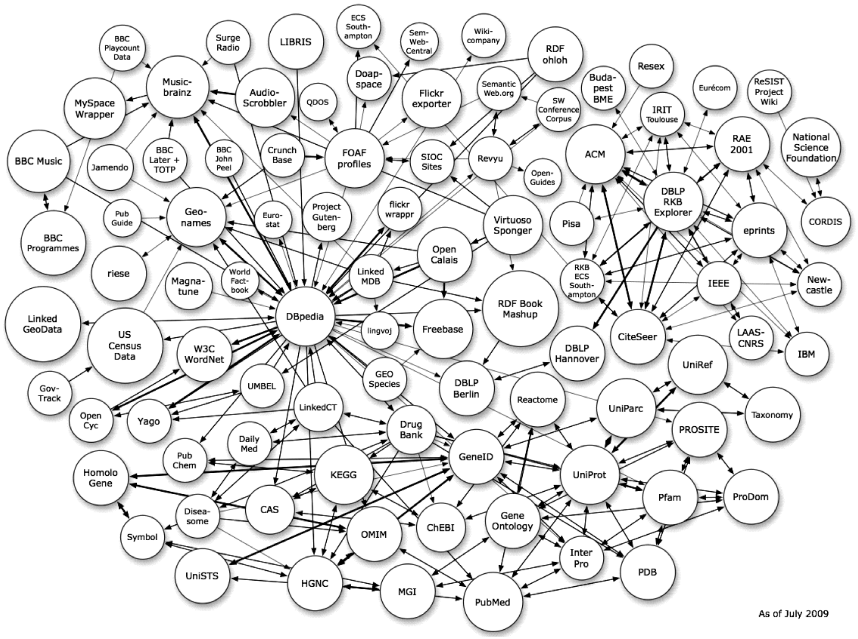

FIGURE 5-2 Large public data sets that are semantically linked on the web. SOURCE: Cyganiak and Jentzch (2009). Reprinted with permission.

SEMANTIC WEB POSSIBILITIES FOR O*NET

As the creators of the data, DOL and the O*NET Center are uniquely positioned to define authoritatively the ontology of O*NET data. If DOL created an ontology for O*NET and then placed the structured database on the web, web users could query the O*NET data, along with any other related, semantically enabled data, and use them for display, for research, or for local storage to serve as an input to a local application. In this scenario, any user with a web browser would be able to query the data, using SQL or another computer language or application.[3] For example, a job-seeker using her laptop at a coffee shop could use her own copy of Microsoft Excel, with its built-in database query tool, to query the O*NET data. A state employment office might develop a small application that would allow the laptop user at the coffee shop to run a program that queries O*NET

[3]As we discuss below, it is not necessary that the data image being queried is on a server operated by DOL or the O*NET Center. A public data image on a DOL or Center server may or may not be one of the data stores responding to semantic queries.

and combines the result with online information about local job openings and places markers with phone numbers on an online map, together with local bus routes and current bus locations. Such an application would draw on semantic data from at least four different sources, combining them to deliver a useful service.

In this scenario, the O*NET Center would continue its current practice of publishing database images for download by users who need to keep a local copy of the data. The key difference is that, with a clear public ontology, the O*NET database images would not only be used privately as an input to a local application, but would also be accessible from other public sites. This service redundancy for Internet data is often referred to as "mirroring."

The structure of semantic relationships in the O*NET database is relatively simple, because the data are already organized using a classification system based on the SOC and the content model. Creating an ontology to describe these existing relationships between data elements in O*NET would not require a large amount of time or money.

According to Bizer et al. (2005), semantic linkage between O*NET and other human resource data sets might result in a substantial expansion of the use of O*NET in human resource management information systems and in human resource management processes more generally. If the O*NET data and its ontology were published to the web, DOL might set up a process to encourage development of innovative applications of O*NET.

Possibilities for Semantic Web Linkages

If it developed an ontology for O*NET, DOL might want to extend it to include related data sets. As noted above, many third parties currently download the O*NET database, link it with other data, and then publish the result in a local application or service. These efforts might accelerate through semantic web linkages between O*NET and other occupational and education data sets.

The National Crosswalk Center has already developed crosswalks between O*NET and other occupational and education data sets, including the SOC and the Classification of Instructional Programs. Adding these crosswalks to a new O*NET ontology would allow computers to understand the relationships between O*NET and these crosswalks. Including the SOC in the ontology would facilitate automated discovery (data mining) and linking of O*NET and SOC data and allow further linkages to be made to any data with a computable relationship to SOC.

Wiki Technology

Later in this report, we identify weaknesses in communication between the O*NET Center and O*NET users (see Chapters 6 and 7). Deployment of online collaboration tools, or wikis, could help DOL and the O*NET Center enhance communication with users and with outside experts in occupational analysis, data collection, and information technology.

The most famous and widely used wiki tool is Wikipedia, the collaboratively created online encyclopedia. Wikipedia Foundation provides the computing infrastructure, the server, wiki software, general rules for entries, and style guidelines. Content is generated by anyone who has access to an Internet browser. Users can edit existing content pages or create new pages on topics not yet covered. The Wikipedia wiki software provides the online editing environment, tracks the changes made to pages, and allows contributors to engage in an online discussion about the content of pages. Page and text formatting is accomplished by simple specialized mark-up tags.

Wiki software tools have been adopted by corporations, universities, and other organizations to encourage sharing of best practices and exchange of knowledge. Federal agencies have also begun using these tools (Schroeder et al., 2009). For example, the U.S. General Services Administration (GSA) operates a wiki environment to encourage communication across governmental entities (see http://colab.cim3.net/cgi-bin/wiki.pl?WikiHomePage). The GSA site helps people across federal agencies who are engaged in a particular subject or project to share experiences and learn from each other through a central online point of contact, rather than attempting communication through a series of e-mail conversations.

DOL and the O*NET Center might use wikis and other online collaboration tools to establish an ongoing dialog with local workforce development agencies, career information delivery systems, human resource management associations, and other O*NET users. Such a dialog could potentially enhance service to users and quality of the database. DOL could also use wiki technology to generate a valuable two-way flow of information about technical issues between outside researchers and the O*NET Center that could inform improvements to the database and data collection methods.

Wiki technology might also be used to support the O*NET Center's collection of data related to newer domains of descriptors, such as Tools and Technology and Emerging Tasks as well as data related to new and emerging occupations. These data are not collected through national surveys of job incumbents, but are gathered primarily through Internet searches and consultations with professional associations and customer feedback, sometimes supplemented by expert review (e.g., Dierdorff, Drewes, and Norton, 2006).

Using wiki technology to establish open lines of communication with trade and professional associations and outside experts would allow the O*NET Center to obtain a broad range of information related to these domains and new occupations at low cost. However, it is important to note that wiki systems encourage all users to freely contribute information. Users, who are self-selected, may enter information and edit others' entries, making corrections or offering additional information. The resulting information would be of uneven quality and would not be nationally representative. The O*NET Center would need to conduct further review of the information and compare it with other data sources of known quality before deciding whether to include it in O*NET. The semantic web technologies described above could also assist in data collection, making it easier for professional associations and others with knowledge of occupations to provide information to the O*NET Center. However, this information, too, would be of mixed quality and would not be nationally representative.

LEVERAGING DEVELOPMENT EFFORTS

Because most use of O*NET data takes place through applications developed outside DOL and the O*NET Center, DOL may want to consider several possible approaches to encouraging and expanding development of these outside tools and applications. These approaches might be taken separately or in combination.

One possibility would be to support the creation of an open-source development community. Communities of developers using open-source code, which is freely available on the Internet, have created major software products including web servers (Apache) browsers (Firefox), word processors (Open Office), and the Linux operating system. Major private companies, including IBM, Hewlett-Packard, Apple, Sun Microsystems, and RedHat Software also participate to some extent in the open source model of software development. DOL might set up a process to encourage and possibly reward the development of innovative, nonproprietary applications of O*NET data that would be made available to all interested parties at no charge.

Another possibility would be to offer awards or prizes to the best new applications using O*NET. The technical advisory board recommended in this report might participate in selecting the best new O*NET applications, which might include standalone applications, new related semantic web objects, web applications, mashups with O*NET mixed in, and code samples that users could copy and drop into their own applications.

The Environmental Protection Agency proposed another possible approach to supporting outside developers in its roadmap for publishing environmental data. The roadmap envisions the creation of widgets—reusable web code—that could be used by service providers to build new web pages

incorporating environmental data (U.S. Environmental Protection Agency Web Workgroup, 2008). Such an approach would provide DOL with a mechanism for measuring O*NET use by these tools.

Another possibility would be to hold a periodic conference of O*NET developers, users, and researchers for sharing new studies, uses, and applications of O*NET. A conference setting would also provide an opportunity for user feedback to DOL on how O*NET could be enhanced.

CONCLUSIONS AND RECOMMENDATIONS

The O*NET database is incorporated into many web applications that are easy to search and are widely used. However, the formats in which the database is currently made available for download—either as a series of text files or in three proprietary programs used with the Windows operating system—limit even wider incorporation of O*NET data within these web applications.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, explore methods for distributing O*NET data in platform independent, nonproprietary formats that facilitate its acquisition and use in the widest variety of database applications. In particular, DOL should make the O*NET database available in the American National Standards Institute (ANSI) structured query language (SQL) in addition to the current formats. In addition, DOL should make efforts to encourage the development of O*NET applications by states, private firms, and educational institutions. The active development of O*NET applications by others would allow DOL to focus O*NET resources on the core functions of collecting, maintaining, and publishing high-quality data.

A review of web design literature and a preliminary evaluation of the O*NET websites suggests that the sites do not conform to three key principles of web design: ease of navigation, targeting of content to users, and interactive elements that can flexibly respond to user interests and styles of use.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, consider conducting a usability study to obtain user feedback on the ease of use of the O*NET websites. The study should emphasize the basic website functions of providing access to information in the O*NET database

and to information about O*NET. Toward this end, the study should identify likely users of the site and lead to improvements that will provide these users with easy ways of navigating to information that is relevant to their particular needs. The goal should be to present information on the websites in a way that is engaging and encourages exploration.

The use of Web 2.0 or wiki-type processes in which those who retrieve information from a website are also able to add to and update some items interactively online could potentially support wider dissemination of the O*NET database and enhance collection of information on occupations. However, these processes would not yield nationally representative data.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, commission research exploring the potential for using wiki processes to enhance communication with and among O*NET users and to obtain occupational information. However, data gathered using these processes should not be a replacement for data collected systematically from carefully specified samples.

Semantic web techniques have the potential to enhance uses of O*NET data and significantly expand the opportunities to link O*NET data to other data sets available on the web.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, explore semantic web techniques. Specifically, DOL should consider creating an occupational classification ontology that would encompass O*NET and the Standard Occupational Classification system. The usefulness of this new ontology would be enhanced by continuing efforts in the future to add semantic links to closely related data sets, such as data sets on education and training programs and workplace competencies.

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Part II

Major Current and Potential Uses of O*NET

6

Workforce Development and Career Development

This chapter focuses on uses of O*NET in workforce development and career development. It begins with a discussion of the role of O*NET in advancing workforce development goals. The next section focuses on the importance of linking O*NET to other data sets in order to support workforce development. Then, the following sections discuss the role of O*NET in advancing the workforce development goals of skills transferability, analyzing skill gaps, and supporting human resource management. The final section focuses on the role of O*NET in career development.

This chapter draws on information and presentations to the panel from O*NET users, technical experts, and scholars as well as analysis of O*NET documentation and studies. It is also based on responses to an e-mail request for input from the workforce development community, largely represented by state labor market information department directors (Calig and Ewald, 2009; Ewald, 2009; Froeschle, 2009). About 20 state directors responded with comments about the strengths and weaknesses of O*NET for workforce development purposes. The discussion of career development is based on presentations to the panel and e-mail and phone responses to a survey of this community (Janis, 2009a, 2009b).

WORKFORCE DEVELOPMENT GOALS

The mission of the U.S. Department of Labor's (DOL's) Employment and Training Administration (ETA) is to:

> . . . contribute to the more efficient functioning of the U.S. labor market by providing high quality job training, employment, labor market information, and income maintenance services primarily through state and local workforce development systems (U.S. Department of Labor, 2009).

As noted in Chapter 1, this mission and the flow of funding for O*NET clearly indicate that DOL views O*NET as a tool to support workforce development rather than a stand-alone statistical program.

Historically, workforce development programs have provided a safety net to workers negatively affected by economic change. The unemployment insurance program operated today by state and local workforce offices was created by the Wagner-Peyser Act of 1933. This and other programs administered by workforce development officials today continue to provide a safety net to help unemployed and underemployed individuals with job placement, career guidance, and, if needed, education and training.

The mission of workforce development has expanded. Under the Workforce Investment Act of 1998 (P.L. 105-277), the mission is to support the optimal transition and movement not only of individuals but also of the larger workforce in response to changing economic needs. Whether in a growth economy, when demand for skilled labor is outpacing supply, or in a depressed economy when workers are being displaced, the mission of workforce development is to support businesses and workers alike. Accomplishing this broad mission requires occupational information.

O*NET provides key components of the information needed to advance four workforce development goals identified by the panel:

1. Defining critical occupations for economic and workforce development for national, state, and regional areas. This includes defining clusters of occupations relevant to policy, program, or research initiatives, such as high-skill, high-demand occupations; science, technology, engineering, and mathematics occupations; career pathways; green jobs; etc.
2. Developing skill transferability and worker assessment tools for use in placing adults in jobs, rapid response to layoffs, and supporting economic development.
3. Identifying appropriate education and training options for displaced and transitioning workers.
4. Assisting employers in human resource management activities, including employee recruitment, retention, and development.

Following a discussion of the importance of linking O*NET data with other data sets, the remaining sections of this chapter will review and evaluate uses of O*NET in advancing these four goals.

THE IMPORTANCE OF DATA LINKAGE

Representatives of the workforce development told the committee that they use O*NET data not as self-contained solutions, but as building blocks which they link to other data sets in a multitude of applications. The ability of O*NET to contribute to these applications depends on the extent to which it can be linked with other taxonomies and data systems. The most important linkage is that between O*NET and the Standard Occupational Classification (SOC) coding system. The linkage of federal employment statistics collected using the SOC taxonomy with O*NET data allows users to expand the array of occupational information that is available and serve a much broader audience than if O*NET stood alone as an independent occupational classification system. Workforce development professionals who spoke to the panel expressed the view that any revisions of the occupations included in the O*NET occupational classification system should be aligned with revisions to occupations included in the SOC (Calig and Ewald, 2009). They suggested that efforts to identify new and emerging occupations and green occupations should not necessarily lead to the addition of new occupations to the classification system that would make it less aligned with the SOC.

An important feature of the connection between O*NET and SOC is the ability to link to other useful education and labor market data sets that can be associated with SOC. For example, the U.S. Army and Marines use a system of military occupational classification (MOC) codes to classify occupational data, and the military services organize information on training using the Military Occupational Training Data System (see Box 6-1). The alignment of these two classification systems with SOC facilitates the development of crosswalks that can be used to link O*NET data with data on military occupations and training. The National Center for O*NET Development provides crosswalks between O*NET and MOC codes, available through O*NET OnLine and for download from the O*NET Resource Center website. Similarly, data collected by the Census Bureau using the SOC system can also be easily linked to O*NET because of the alignment of O*NET with SOC. The connection of O*NET with the SOC also enables linkage of O*NET data with projections of future occupational demand.

The value of mechanically linking data to O*NET from multiple sources enabled by the alignment of O*NET with the SOC cannot be overstated. The connections facilitated by crosswalks enable development of career information delivery systems, occupational information systems, and other useful applications of O*NET data.

BOX 6-1
Military Occupations and O*NET

Although the O*NET occupational classification system includes 18 military occupations, the O*NET Center does not collect data related to these occupations. The military services currently use a variety of different occupational classification systems, and the Department of Defense recently commissioned a study to explore the feasibility of developing a common occupational framework as one element of a broader human capital strategy (Hanser et al., 2008). In addition, the department is researching methods to establish and maintain what it calls a human interoperability enterprise, which cuts across the branches of the service and homeland security. The O*NET content model could potentially play a role in these efforts to improve alignment of occupational information systems across the military services.

This research by the military is at an early stage, and state workforce development specialists regularly face the challenge of helping service members transition from active duty to civilian life. Matching the skill sets of active-duty personnel to job opportunities in the private sector can be especially difficult. To help workforce development officials meet this challenge, the O*NET Center, the Defense Manpower Data Center, and the National Crosswalk Center have collaborated to create a a crosswalk between the military occupational clasification codes and O*NET occupations and codes. In June 2009, the crosswalk was updated with information from the Department of Defense on over 8,700 military occupations as defined by the military occupational classification system (National Center for O*NET Development, no date, a). However, the military occupational classification system is not used by all branches of the military. In addition, the O*NET Center and collaborators do not provide a crosswalk between O*NET and the more detailed occupational data included in the Military Occupational Training Data system. Improved linkage between military occupational information and O*NET data would help workforce development officials to assist veterans in moving into civilian jobs and would help young people to explore military as well as civilian careers.

Linking to Education Data

Preparing the workforce of tomorrow requires some understanding of the occupational skills, knowledge, and abilities that will be required in the future. State workforce development officials sometimes link projections of

future employment in specific occupations with O*NET data on the skills and knowledge required by those occupations, in order to project future skill demands.

Taking the next step—identifying any existing education programs that could develop the skills and knowledge required or gaps in what is available, suggesting a need to develop new education programs—requires data on education programs. The National Center for Education Statistics (NCES) collects and publishes such data, using the Classification of Instructional Programs (CIP) system to report on completion of postsecondary degrees in various major fields of study (National Center for Education Statistics, no date). It has collaborated with DOL to create crosswalks between the CIP, the SOC, and O*NET, available both from the National Crosswalk Service Center supported by DOL and from NCES.

State workforce development agencies download these crosswalks and the O*NET database, using them to create a variety of tools that assist in planning for economic development and workforce development. For example, with funding from DOL, a consortium of state labor market information specialists created a web-based database called the Occupational Supply and Demand System (OSDS, see http://www.occsupplydemand.org). The OSDS combines national and state-level occupational characteristics, occupational projections, wage trends, licensing data, and industry employment with postsecondary graduation data (supply) for analysis of labor markets and training options. The OSDS can be used to relate structured education and training programs to the occupations filled by their graduates. The OSDS is designed to help business and industrial analysts, education program planners, workforce administrators, and others determine labor availability and training program offerings on the basis of the supply-demand mix. It assists states in economic development by providing companies moving into the state with a snapshot of qualified professional and nonprofessional workers.

The workforce development community views development of OSDS as a model of their ability, with federal support, to create very useful tools incorporating O*NET data. This community especially values the inclusion of data for all 50 states in OSDS. Although the states that have developed their own data systems incorporating similar linked data sets and more local data use OSDS less frequently than other states, it is widely valued and used. During June 2009, the OSDS website had 70,292 hits.

An example of a state-developed tool linking O*NET data with education data is the Ohio Skills Bank Data Tool (see http://ohiolmi.com/asp/SB/SkillsBank.htm). This website can be used to identify critical occupations in different economic development regions in the state and target education resources to meet those needs. It is tailored to meet the needs of a select audience of education workforce analysts located in each region of the state.

Both of these valuable tools link education data with data on projected employment levels in different occupations, a process that depends on the availability of crosswalks among CIP, O*NET, and SOC. All three of these data systems are in the process of being revised. In 2009, the National Center for Education Statistics (no date) released the updated CIP 2010, the National Center for O*NET Development released the updated O*NET-SOC 2009, and the Office of Management and Budget (2009) announced the updated SOC 2010. To facilitate development of useful workforce development tools, it is important to update these crosswalks. In particular, updating the crosswalks between the CIP and O*NET would assist the workforce development community to align education and training programs with evolving demands for workforce skills.

Linking to Industry Staffing Patterns

Because the demand for labor is a derived demand—that is, job creation is dependent on consumer demand—the best way to determine future occupational skill needs is to project industry demand. Data on current demand in various industry sectors, collected using the North American Industrial Classification System (NAICS), are used to project future industry demand. The Bureau of Labor Statistics (BLS) has established the relationships between industry and occupational data through its ongoing Occupational Employment Survey, which yields data on current occupational employment (defined by the SOC) in various industry sectors (defined by NAICS). BLS combines information on current industry staffing patterns with projections of future industry demand to create projections of future employment in different SOC occupations. Because O*NET is aligned with SOC, workforce development specialists are able to link these projections of future occupational employment with the Abilities, Knowledge, Skills, and other characteristics of these occupations, to guide workforce development and economic development activities. For example, analysts in Illinois linked O*NET data and BLS occupational employment projections to project potential shortages of 15 skills (as defined in O*NET) in the year 2012. The largest projected shortages were in the skills of reading comprehension, active listening, speaking, and writing (Ginsburg and Robinson, 2006).

Defining Critical Occupations

The first workforce development goal identified by the panel is to define critical occupations for use in planning economic, education, and workforce development initiatives. Workforce development specialists define critical occupations various ways. They often use such criteria as whether an occupation is large, its projected future growth rate, the median salary,

and whether it is needed in key industries that a city or state is trying to recruit or develop. Defining critical occupations requires information on occupational characteristics that can be supplied by O*NET, along with information on current and projected employment levels and wages and other data. The goal of these activities is to align workforce development policies with projected labor market demand and also to influence future labor market demand by supplying skilled workers to support the growth of targeted industries.

The process of defining critical occupations, like workforce planning more generally, is not unlike human resource management but on a larger scale, such as a regional, state, or national economy. O*NET provides a key component of the data needed in this process.

Because DOL views O*NET as a tool for workforce development, it is not surprising that the agency has tried to make this tool more effective by defining critical occupations and incorporating them into O*NET. For example, in 2006, DOL identified "high growth industry sectors" and directed the O*NET Center to search for new and emerging occupations in these sectors for possible inclusion in O*NET (National Center for O*NET Development, 2006). In a related activity, O*NET OnLine includes areas that target occupational searches toward 16 "in-demand" industry clusters that are defined as "economically important, projected to have long-term growth, or are being transformed by technology and innovation" (National Center for O*NET Development, no date, b). A user who clicks on an industry cluster will find a list of "in-demand" occupations highlighted with green flags. The occupational search area of O*NET OnLine also targets occupational searches towards "green" occupations and occupations that require knowledge of science, technology, engineering, and mathematics.

The workforce development community has mixed views about these efforts to define critical occupations nationally (Calig and Ewald, 2009). Some do not find the critical occupations defined by DOL important at the state or local level. For example, Bonnie Graybill (2009a) of the California Employment Development Department told the panel that the "in demand" flag is overused. She indicated that California workforce development officials do not believe these occupations are demand, given the current economic downturn, and recommended that the flags be eliminated from O*NET OnLine (Graybill, 2009b).

In another example, DOL has defined green occupations as critical, directing the O*NET Center to identify such occupations for inclusion in the O*NET classification system (Dierdorff et al., 2009). In Texas, however, workforce development and economic development officials consider only those green occupations associated with wind energy to be critical. At the regional level, wind energy occupations are critical in west Texas, but not in the eastern part of the state. At the most local level, the economy in

Bastrop, an Austin suburb, is dependent on tourism. Officials in Bastrop are not at all interested in occupations related to geospatial technology, although they are defined as "in demand" in O*NET OnLine.

Labor market information specialists who responded to the panel's call for feedback on O*NET also expressed concern about what they viewed as a lack of transparency in DOL's definitions of critical occupations. They said that information was lacking on the methods and criteria used to define the 16 in-demand industry clusters (Calig and Ewald, 2009).

Some workforce development specialists also question whether DOL and the O*NET Center should create tools incorporating O*NET. They prefer to download the O*NET database and incorporate it into their own tools, such as OSDS and the Ohio Skills Bank Data Tool, which can be tailored to meet the needs of specific local users while allowing flexibility in searching for information.

Skills Transferability

The second major goal of workforce development is skills transferability. This involves efforts to identify the broad, transferable skills an individual may possess in order to help him or her qualify for a new or different job. Skills transferability is very useful for workforce development specialists for two purposes: (1) to assist displaced or dislocated workers to find new employment opportunities and (2) to plan workforce development policies and programs, as described above. Although the first purpose of skills transferability appears to address the needs of the individual and the second to address the needs of business and the community, from a systems perspective, neither goal can be met without considering the needs of both. However, these two communities operate with their own unique concepts, jargon, objectives, and time frames. Although aligning them around a common language to communicate about occupations is a formidable challenge, the O*NET database provides such a common language.

Automated skills transferability systems use computer technology to sort and filter data on worker and labor market characteristics. The systems use O*NET data to identify transferable skills, knowledge, and other characteristics as well as gaps in which increased skills (and knowledge and other characteristics) are needed in order to gain employment. The information they provide can help workers become reeducated and reemployed, explore occupational possibilities, and smooth transitions between jobs. Providing information for use in person-job matching is a primary role of O*NET. The O*NET Center provides two automated tools for self-assessment and skills transferability—the Computerized Interest Profiler and the Work Importance Profiler. An individual can use the tools to

identify his or her personal characteristics and to identify the level and importance of various skills, knowledge, work values, and interests required by their current occupation. The individual can then compare the skills, knowledge, work values, etc., he or she possesses with the skills, knowledge, and other requirements of a different occupation. For example, the O*NET database provides information on such basic skills as reading comprehension, mathematics, writing, and speaking. The individual can identify the basic skill levels associated with his or her current or most recent occupation and the skill levels required by the occupation he or she may wish to enter. People who do not possess the basic skills required by the job they are interested in must either consider remedial basic education or decide to accept a job with basic skill levels that more closely match those they already possess.

Many states and private vendors have developed automated skills transferability tools incorporating O*NET data to assist in matching workers to jobs. For example, the California Employment Development Department has created an online tool, the California Occupational Guides (see http://www.labormarketinfo.edd.ca.gov/occguides/), which links wages, projected employment levels, and O*NET data on the tasks, skills, and other characteristics of occupations (Graybill, 2009b). The department used it to help loan officers laid off in the southern part of the state, by identifying these workers' transferable skills and a cluster of related occupations, including customer service, payroll, and tax preparation occupations. Department staff also used this tool to assist workers laid off in the aerospace industry, due to closures of military bases and manufacturing plants.

Some skills transferability tools include numerical indexes of individuals' skills. For example, the Indiana Department of Workforce Development used a tool with such numerical data to identify the skills of laid-off workers and match them with occupations requiring these skills (Clark, 2009). The Manpower Corporation has developed an automated skills transferability system incorporating a similar numerical index (Dorman, 2009). These systems rely on O*NET descriptors as the basis for the various sorting and filtering algorithms.

As these examples illustrate, states and private developers have created useful automated skills transferability systems, as well as other tools incorporating O*NET. Because they are in touch with the information needs of their constituencies, states and private developers can easily design the systems to meet these needs. This suggests that, rather than using limited funding to create tools and applications, DOL should focus its efforts primarily on maintaining the quality of the O*NET database and facilitating access to it.

Identifying Education and Training Options

Another way O*NET data are used in workforce development is to analyze skill gaps and identify education and training to fill those gaps. A consortium of state labor market information specialists, with funding from DOL, created the Skills Projections System software. This system integrated O*NET data with state-specific occupational projections in an effort to facilitate worker transferability (Tsacoumis, 2007). This and the other skills transferability tools described above allow an individual to identify the importance and level of skills, knowledge, and abilities they have developed in one occupation and identify other occupations requiring similar skills, knowledge, and abilities.

However, most such tools cannot be used to identify an appropriate training or development strategy for a displaced worker who needs to develop new types of skills (and/or knowledge, abilities, or other characteristics) to qualify for a closely related occupation.[1] Nor do they illuminate how a displaced worker could increase his or her skill levels to qualify for job openings in occupations requiring types of skills similar to those he or she already possesses, but at higher levels. For example, it is unclear what a displaced worker with an oral expression level of 2 in the skills domain should do to become qualified for a job requiring oral expression skills at level 4. Equally unclear is how a worker might prepare for job openings in occupations that require such skills as "active listening" or such abilities as "fluency of ideas" or "originality." The formal education and training system, including public higher education, does not classify courses or fields of study around the Skills, Knowledge, and Abilities descriptors included in the O*NET content model. The result is a gap between an individual's identified skill levels, the skills required by jobs the individual may be interested in, and the education needed to develop them.

A different set of O*NET descriptors could fill this information gap. Instead of relying only on the Skills, Knowledge, and Abilities descriptors, skills transferability systems could add (or substitute) descriptors from the Detailed Work Activity (DWA) domain. As noted in Chapter 2, the DWA library in O*NET offers some 2,200 standardized statements that are assigned across all O*NET occupations. These statements are designed to be somewhat occupationally specific as well as somewhat transferable, so that one statement can be found in several different occupations. For example, the DWA statement, "Analyze biological research, test or analysis data" is found in the occupations of animal scientists, forensic science technicians, biological technicians, foresters, medical and clinical lab technicians, and

[1]One exception is the automated skills transferability system used by Manpower, Inc. The company has collaborated with a training partner to provide a list of courses related to each skill and knowledge required for various occupations.

other occupations. Because this descriptor is standardized across occupations, it can readily be used for skills transferability purposes. Such use would be based on the assumption that the performance of the DWA connotes a certain level of skill and/or knowledge.[2]

The potential of DWAs for skills transferability is apparent in the history of their development. Workforce development specialists in Oregon developed the "skill statements" that were the precursors to DWAs for the specific purpose of helping individuals identify their skills and match them to occupations and to education and training programs aligned with the skills needed in those occupations. Current DWA statements, like the earlier skill statements, consist of short phrases, such as "adhere to government aviation regulations" or "use airbrush techniques," that are similar to those found in resumes and job advertisements. Because each DWA is defined in terms of doing something concrete, it is possible to compare the DWAs of large or growing occupations that could provide jobs for displaced workers with the curriculum of education and training courses and programs. Such a comparison could serve to identify existing courses and programs most likely to develop displaced workers' mastery of the DWAs in demand, or to focus the design of new courses or instructional programs to develop these DWAs (see Figure 6-1). Using DWAs as the common language connecting the worlds of work and education might increase the efficiency of individual job searches and worker retraining initiatives.

However, the current library of DWAs is inadequate for skills transferability applications (Froeschle, 2009). Although the O*NET Center commissioned a project to develop the DWAs in 2003 (National Center for O*NET Development, 2003), these efforts stopped when the project concluded. The project team's goal of assigning 15 to 20 DWA statements to each occupation has not been achieved. Currently, there are 26 occupations that have fewer than 10 DWAs. At the same time, one occupation (pile driver operator) has only one DWA, while the occupation of industrial/organizational psychologist has 114 DWAs. Another problem is that some DWAs incorporate vague descriptions of work that are more appropriate to the Generalized Work Activities domain—such as "writes reports," "makes decisions," and "uses government regulations"—rather than concrete descriptions of specific activities. In addition, 65 current DWAs are "double-barreled," describing more than one activity.

Recognizing this problem, the Texas Workforce Commission has launched an employer validation initiative to expand the breadth of applicable DWAs across all occupations and assess their relevance to the Texas

[2]As noted in Chapter 2, O*NET descriptors of abilities and skills required "to perform the job" do not reflect research showing a continuous distribution of performance differences across job holders.

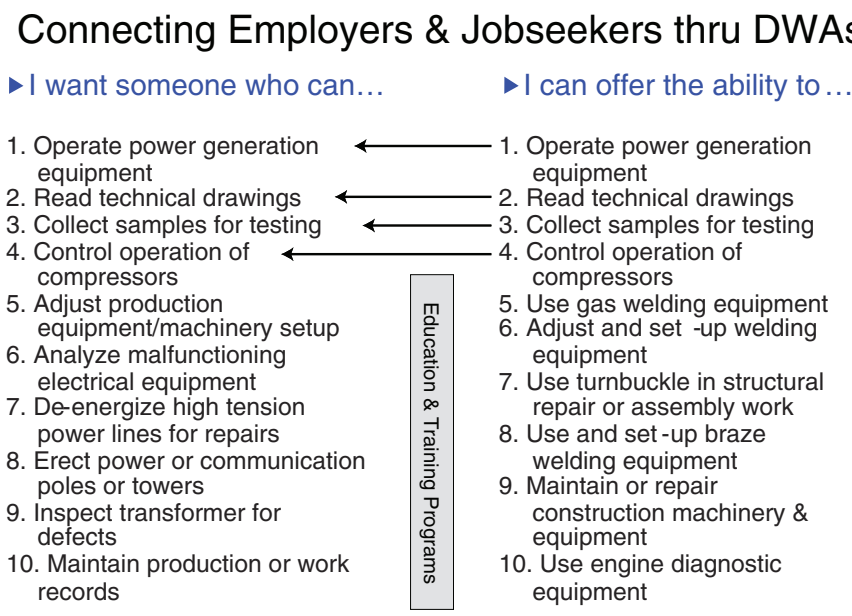

FIGURE 6-1 Example of identifying education and training needs with DWAs. SOURCE: Froeschle (2009).

employer community. Given the importance of workforce development to the O*NET mission, the panel thinks that DOL should review the DWA descriptors, assess their potential for use in skill transferability, and explore the potential for their further development.

Human Resource Management

In many cases, workforce development officials are requested to assist the business community in strategic human resource planning. O*NET data can help officials respond to such requests. This section focuses on the use of O*NET by workforce development officials to assist private organizations in human resource management. A more detailed discussion of the use of O*NET by private organizations is found in Chapter 7.

Businesses do not organize job information using federal occupational classification systems, such as O*NET or the SOC. They may apply any title they choose to occupations. When the Texas Workforce Commission asked employers to provide payroll job titles and other information as part of a survey conducted between 1993 and 1998, it received over 500,000 discrete titles, many of which had little or no meaning outside the individual firms in which they were used. Thus, the first step in engaging employers as

users of O*NET is to determine the correspondence between employer job titles (often referred to as "lay" job titles) and O*NET occupations.

The O*NET Center has taken this step, developing crosswalks between approximately 68,000 lay job titles and O*NET occupations. However, they have some weaknesses. For example, entering the term "bridge builder" in the quick search area of O*NET OnLine yields a list of occupations that range from construction laborers and bridge and lock tenders to dental laboratory technicians. Until the crosswalks are readily available, highly flexible, automated, and simple to use, employers are not likely to use them.

Assuming the crosswalk problem can be solved, workforce development specialists could assist business leaders in using a range of O*NET data to inform their human resource management decisions. A common use of O*NET in private organizations is to specify the skill, knowledge, and other requirements of a particular job. Workforce development specialists could help managers in this process and could also, by using some of the tools described above, link the resulting skill requirements with data on the current and projected future supply of individuals possessing these skills and education and training programs to develop the skills. Workforce development officials can also help managers draw on federal and state data to compare wages across occupations and regions.

O*NET data can help managers answer many business questions ranging from "Where do I place a new plant?" to "How much do I pay workers for this job in this community?" They can also help to answer managers' questions about employee development and training. For example, they can help managers identify education and training providers engaged in developing skills the business needs to compete. Using this information, managers can collaborate with education and training providers to develop customized training programs to supply the needed skills. Workforce development officials often assist in development of such customized training programs and also assist curriculum developers in creating new training programs aligned with business needs.

CAREER DEVELOPMENT

Career development professionals and their clients use O*NET OnLine and the associated Career Exploration Tools in a variety of ways. Some examples include looking up specific job titles and job families, finding transferable skills, researching possible career paths, helping shape career goal-setting, and starting conversations about careers. Career development professionals can also help clients use O*NET OnLine to prepare for job search interviews, explore careers, prepare resumes, generate position descriptions, and search for alternative job titles.

Federal Websites for Career Development

There are two federal government websites that make extensive use of O*NET data to foster career exploration and decision making: The U.S. Department of Labor's Career OneStop (see http://www.careeronestop.org) and a collaborative website between the U.S. Departments of Labor and Education, Career Voyages (see http://www.careervoyages.gov). Career OneStop's Occupation Profiles display the "most important" knowledge, skills, abilities, and generalized work activities, occupation specific tasks, and the tools and technology from the O*NET database. The Occupation Profile also includes state and national wages and employment trends. Additional links to financial aid, related occupations, education and training, and other web resources are provided. An Occupational Description in Career Voyages includes O*NET information on knowledge, skills, abilities, interests, work styles, and tools and technology. Both websites incorporate O*NET occupational descriptions and content model statements verbatim. Cross-references and linkages between both websites and O*NET are provided strategically and frequently.

According to the National Career Development Association (NCDA) website, the mission of NCDA is to "promote the career development of all people over the life span." Thus, career development is a dynamic process over most of one's lifetime that includes, for example, such end-users as middle school students, college students, and mid-life career changers. As the "nation's primary source of occupational information" the O*NET program does exceptionally well. However, to address the needs of diverse, end-user populations, career information delivery system developers, for many years now, have incorporated O*NET data (and previously DOT data) and additional career information into their products to provide the end-user with a comprehensive system that meets their needs.

Career Information Delivery Systems

Comprehensive online career information delivery systems (CIDS) are widely used and available throughout the country. There are just over a dozen major developers of CIDS, plus state systems that use and augment the developers' systems or develop their own (see Box 6-2). Some CIDS developers are not-for-profit state agencies and others are for-profit companies. All of the CIDS programs, whether they are for-profit or not, use O*NET data.

In February, 2009, the committee conducted a telephone poll of these system developers. Based on this poll, the committee estimates that nationally, CIDS programs were accessed at more than 86,000 sites by over 37 million users in February 2009, with the typical user accessing the site

BOX 6-2
Major Developers of Comprehensive Career Information Delivery Systems

1. ACT-Discover (https://actapps.act.org/eDISCOVER/)
2. Bridges/XAP (http://www.bridges.com/us/home.html)
3. Career Cruising (http://www.careercruising.com/)
4. California CareerZone (http://www.cacareerzone.org/flash/index.html)
5. CareerZone Pennsylvania (http://www.pacareerzone.org/home.jsf?conversationId=27335)
6. COIN Career Guidance System (http://www.coinedu.com/)
7. EBSCO/COIN Career Solutions (http://www.coin3.com/)
8. IntoCareers/Career Information System (CIS) (http://cis.uoregon.edu/)
9. iseek, Minnesota's Career, Education, and Job Resource (http://www.iseek.org/)
10. New York CareerZone (http://www.nycareerzone.org/)
11. Michigan Occupational Information System (http://www.mois.org/)
12. Eureka (http://www.eureka.org/)
13. Kuder (http://www.kuder.com/)
14. Texas Cares (http://www.texascaresonline.com/)

throughout the academic year 2008-2009. Thus, for career exploration and development purposes, CIDS programs are collectively the primary providers of O*NET information.

To meet standards established by the Association of Computer-based Systems for Career Information (ACSCI), CIDS must "provide integrated components that are consistent with career development theory in their design and facilitate career development in their application" (*ACSCI Standards Implementation Handbook*, 2009, see http://www.acsci.org).

Most of the CIDS programs are managed and delivered to end-users via user sites. Typically, students (end-users) at a high school (user site) get access to and help with the CIDS program from the school staff (e.g., counselors, teachers, advisors, graduation coaches, etc.), who are both end-users and career specialists. These web-based systems are delivered to a wide array of sites, including schools, colleges and universities, employment service offices, rehabilitation services offices, family and children services offices, juvenile justice centers, correctional facilities, counseling agencies, and public libraries.

CIDS developers use the O*NET database as their primary source for developing occupation descriptions for their systems. However, with system products targeting end-users whose ages range from elementary school students through adults, the O*NET data content is often rewritten in a more user-friendly, information style and format, and at a more appropriate reading level. For example, Georgia State University's Georgia Career Information System contains data from the O*NET on occupation dental hygienists. The task statement "Clean calcareous deposits, accretions, and stains from teeth and beneath margins of gums, using dental instruments" is rewritten to a ninth grade reading as "Clean patient's teeth using dental instruments" so it is more accessible to users. Furthermore, CIDS developers create occupation descriptions, using O*NET content from task statements, knowledge, skills, abilities, work activities, work context, interests, work styles, and work values. O*NET clearly is the foundation for the development of the occupational content in CIDS.

The occupational content in CIDS also includes state and national wage data and employment projections. These data imports are available because of the crosswalks between O*NET occupations and the BLS data, enabled by the alignment of O*NET with the SOC.

Most CIDS contain extensive information files about occupations, career pathways, programs of study and training, job searching, financial aid awards, job interviews, and military employment, along with a glossary of terms and occupational videos. Each of the 500+ occupational descriptions in a CIDS is internally linked to a group of related occupations. The occupational descriptions also are internally linked to one or more related program of study descriptions from the CIP, and the programs of study descriptions are internally linked to postsecondary institutions, financial aid sources, industry information, and other related data. The entire system is fully integrated, containing multiple links from one information file to another, to help guide the user through their career development process.

Tools for Self-Assessment and Career Exploration

An important aspect of career development is relating self-knowledge to the world of work. Two O*NET career exploration tools, the Interest Profiler and the Work Importance Locator, help individuals identify their work-related interests and what they consider important on the job (see http://www.onetcenter.org). CIDS developers have created online versions of these tools and integrated them into their systems. They also have used some O*NET descriptors (e.g., Skills, Knowledge, Abilities) to develop additional online self-assessment tools. The results of these self-assessment instruments, filtered lists of occupations based on user inputs, are linked to the O*NET-based occupational information. Two examples of these

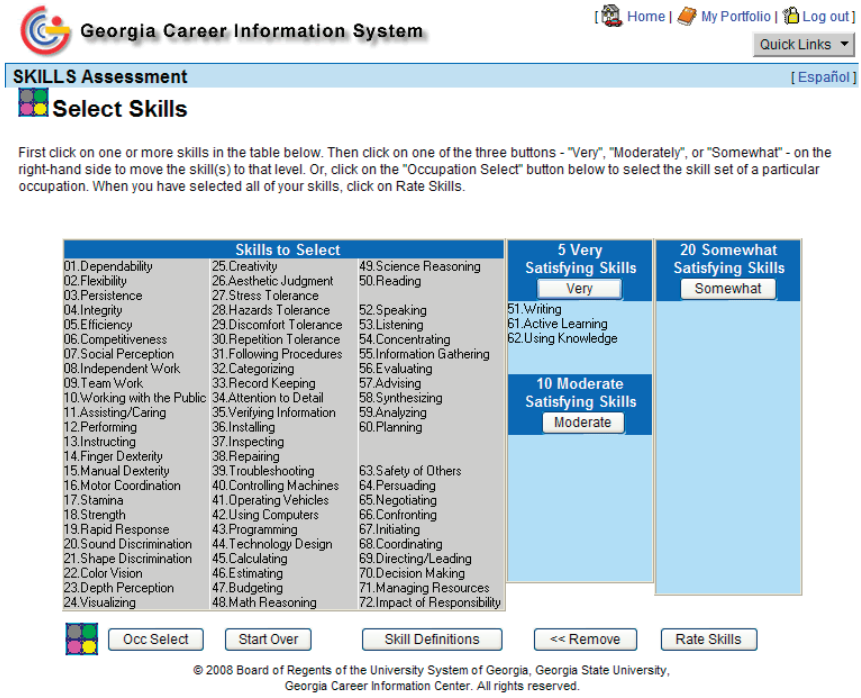

FIGURE 6-2 Skills assessment in the Georgia Career Information System. SOURCE: Georgia Career Information System. Reprinted with permission.

career tools are the Skills Assessment of the Georgia Career Information System (see Figure 6-2) and the Career Finder from the Choices Planner (see Figure 6-3).

The Career Portfolio

A fundamental component of CIDS systems is the portfolio. Fully integrated into the systems, portfolios assist users with their career exploration, management, and decision making. These personal career folders store users' occupational and educational preferences, career plans, assessment and interest inventories results, skills and abilities, accomplishment, resumes, and other pertinent career-related information. Many CIDS portfolios offer career plans of action, using assessment results along with career development activities and worksheets. For students, the portfolios provide a multiyear course planner to help them relate and store their educational options and endeavors toward the world of work.

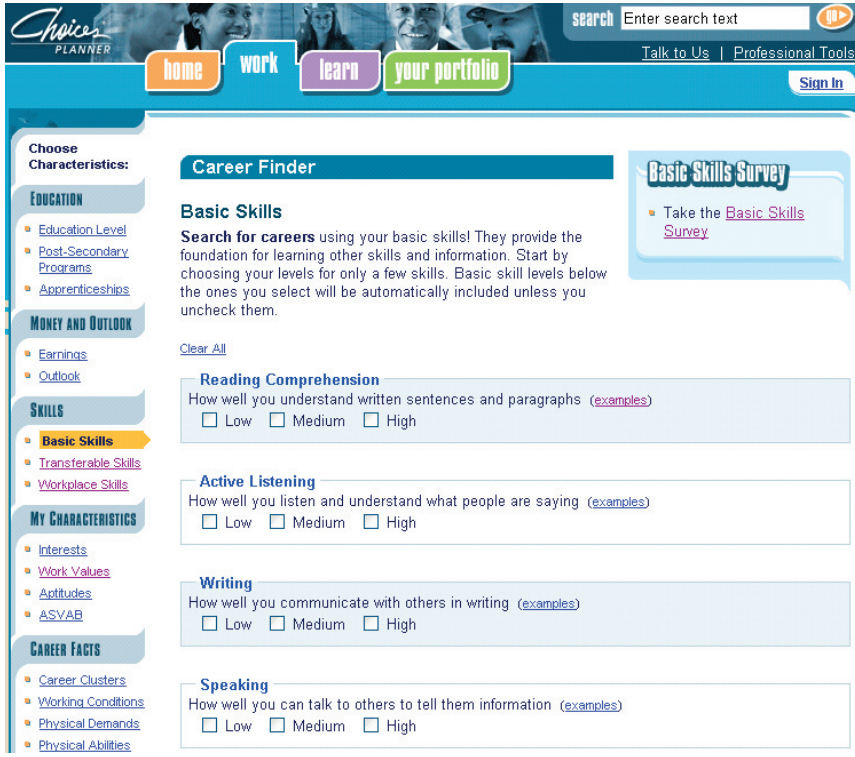

FIGURE 6-3 Skills assessment in the Choices Career Information Delivery System. SOURCE: Zap Corporation. Reprinted with permission.

Training and Support Services

CIDS developers provide training and support services for their systems to user site personnel (e.g., educators, counselors, agency staff). Typically, state CIDS offer staff development workshops at many locations throughout the state. State CIDS staffs also provide technical assistance, support the activities of their local counseling and career development associations, and present their systems at conferences.

Use of the O*NET Database in Career Information Delivery Systems

The continuous updating of the O*NET database provides CIDS and other content users with current occupational information, including lists of new and emerging occupations. CIDS also incorporate the lay titles file

and crosswalks described above. Generally, the CIDS community welcomes DOL efforts to define critical "in-demand" occupations, occupations requiring science, technology, engineering, and mathematics (STEM) and most recently "green occupations," because CIDS users value the currency of these data products. However, the inclusion of new and emerging occupations in the O*NET classification system also poses some challenges to CIDS developers (see Chapter 3).

Some CIDS developers have translated portions of their systems into Spanish. However, the Spanish translation of O*NET version 4.0 provides little value to CIDS. The translation would have to be kept current, and, as mentioned earlier, the O*NET occupational content is frequently revised, essentially negating the usefulness for CIDS of the O*NET center's efforts in the Spanish translation.

Another use of O*NET in career development relates to the Carl D. Perkins Career and Technical Education Improvement Act of 2006. This law requires states to define high-demand, high-wage, and high-skill (high-DWS) occupations. States are to use their definitions for high-DWS occupations to ensure that their career and technical education programs of study prepare students for high-DWS. Some states have used O*NET data to develop their definitions for high-DWS occupations (see http://www.occsupplydemand.org).

CONCLUSIONS AND RECOMMENDATIONS

An array of individuals and organizations rely on O*NET to inform important activities in workforce development, economic and career development, and analysis of workforce trends. O*NET's common language, coding structure, framework, and crosswalks are invaluable to the career development community. The impartiality and high quality of O*NET data are essential to assisting people who need to make informed choices about education, training, and careers.

Collecting, maintaining, and publishing high-quality occupational data are essential government functions that require the federal government's objective perspective and capacity for funding large projects. O*NET uses a common language to describe occupations across industries and states, facilitating communication and shared understanding of the education, skills, and other requirements of occupations among employers, researchers, education and training providers, students, and workers. Without public funding, a few large, well-funded firms, industry associations, states, or localities might be able to develop proprietary occupational information systems, but they would have little incentive to include information representative of the entire workforce, to share a common language, or to link with other proprietary occupational information systems.

O*NET, as a common, national database, provides the foundation for multiple private-sector and public-sector applications and tools. The federal investment in collecting and maintaining the data encourages further investment in supplementary tools that extend the value and benefit of the database.

However, short-term policy agendas related to workforce development have at times reduced focus on the core activities of developing, maintaining, and updating a high-quality database. DOL has created definitions of critical occupations and has incorporated these definitions in O*NET tools and applications, with little feedback from or communication, with the workforce and career development communities.

The states, the career development community, and private developers, who are closer to their end users than DOL, have developed useful applications incorporating O*NET and have developed their own definitions of critical occupations.

Recommendation: The Department of Labor should focus O*NET resources on the core functions of collecting, maintaining, and publishing high-quality data, leaving development of most new applications and tools to the private sector and to state and local governments.

The full potential of O*NET has not been realized, partly because of a lack of ongoing communication and feedback between the National Center for O*NET Development and current and potential users. As a result, the O*NET Center has an incomplete understanding of user needs, resulting in development of an O*NET that is not fully aligned with these needs and marketing activities that do not explain all its potential uses. In fact, users with different needs and goals draw on different O*NET data elements and apply them as building blocks toward more complete or customized solutions.

Recommendation: The Department of Labor should establish and staff an ongoing, external user advisory board, including at least one representative of each major user group, as well as representatives of potential users in the U.S. military and in K-12 and higher education. The board should meet regularly to provide advice and recommendations to DOL regarding processes for identifying users' evolving needs and communicating information about O*NET and its uses.

DOL should also establish mechanisms for ongoing communication between this user advisory board and the technical advisory board recommended in Chapter 2. This will ensure that O*NET users are aware of on-

going research and its implications for existing applications and will inform the technical advisory board of users' needs and concerns.

For the workforce development and career development communities, much of the power of O*NET derives from the alignment of its occupational classification system with the occupations included in the SOC system. The research recommended in Chapter 3 would provide guidance to DOL in balancing these needs with the needs of other O*NET users and potential users.

Labor market information specialists need to be able to link O*NET data on the skills, knowledge, and educational requirements of occupations with data on instructional programs of study. Without such links, the specialists find it very difficult to provide reasonable and informed advice about training options for the adult workforce or to propose rational training investment options to the workforce development community. DOL should provide, for each occupation in O*NET, a crosswalk to the Classification of Instructional Programs.

Recommendation: The Department of Labor should, with advice and guidance from the user advisory board, update the existing crosswalk between O*NET and CIP as soon as possible, to reflect the recently completed revisions of both the CIP and O*NET.

Developers have created promising applications to match individuals or groups with occupations, drawing on the Skills, Knowledge, and Abilities domains of O*NET. These applications are useful for workforce development. However, the Detailed Work Activities domain may offer the greatest potential as a common language or bridge among employer hiring needs, the capabilities of displaced workers or new labor force entrants, and the program and course offerings available through the public education system.

Recommendation: The Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board, review past efforts to develop the Detailed Work Activities and the current status and usefulness of these descriptors. Based on this review, the Department of Labor should explore the potential costs and benefits of further development of the domain.

Effective, usable crosswalks that link military job descriptions and characteristics and civilian information in O*NET would allow workforce development officials to improve matches between military occupations and their civilian occupation counterparts. Such matches would allow them to assist transitioning veterans to identify additional skills training they might

need in order to qualify for different occupations, thus increasing their chances for successful transition. Such crosswalks would also assist young people in considering all occupations (both civilian and military) in which their skills might be used and their interests met. Although the O*NET Center has collaborated with the Defense Manpower Data Center and the National Crosswalk Center to create crosswalks, there has been no systematic evaluation of their usefulness or investigation into how they might be improved for use by the military or civilian populations.

Recommendation: The Department of Labor should, with assistance from the military services representatives on the user advisory board, evaluate the existing crosswalks between O*NET occupations and military occupations as well as other tools that the military uses and ensure that the crosswalks are effective and usable for both civilian and military users. Enhanced crosswalks would better facilitate the transition of veterans and other military personnel into civilian life as well as inform the youth population about military careers.

The potential of O*NET to inform critical decisions and communications about workforce development, economic development, career development, and education at the state and local levels is not fully realized because of a lack of understanding of O*NET in these communities.

Recommendation: The recommended user advisory board should advise the Department of Labor on strategies to market, train, and promote the use of O*NET in local, state, and regional career and workforce development and education communities. These strategies should be developed in collaboration with, and marketed by, associations in these communities. In addition, the strategies should include a reinvigorated effort to promote the initial marketing concept of "O*NET in It" in order to clearly separate O*NET as a database from applications using O*NET. These strategies should be supported through use of technology to make the O*NET database more widely usable and accessible.

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7

Human Resource Management

O*NET was initially conceived of as a useful tool for a multitude of human resource management (HRM) applications (Peterson et al., 2001). Both descriptions of O*NET development and information on the O*NET websites—including the O*NET Academy and the O*NET Knowledge Site—note how O*NET might be used in designing systems to select, train, evaluate, and support workers, as well as to reconfigure jobs (Peterson et al., 1999). This chapter reviews the evidence regarding the extent of O*NET usage in HRM applications and evaluates its value for these purposes. The final section presents the panel's conclusions and recommendations.

The chapter has two major sections. The first describes the major categories of O*NET use: job analysis (which, as the most widespread use, is subdivided according to the specific aims of the effort), person-job matching systems in organizations, human resource strategic planning, and worker health and safety programs. We review both actual uses of O*NET as well as potential, undocumented uses. The second major section discusses user views of O*NET's strengths and limitations.

The evidence reviewed in this chapter was gathered from a number of sources. The panel reviewed information about O*NET in the scholarly HRM literature, searching for mention of O*NET not only in titles and abstracts but also in the body of papers. We also reviewed supporting materials provided by the National Center for O*NET Development (the O*NET Center) regarding uses in HRM. Second, experts invited to the panel's workshops provided examples of applications of O*NET in HRM.

Third, the panel conducted a short qualitative survey of HRM professionals, asking about possible users of O*NET (Ryan and Pearlman, 2009).

Although these information sources were valuable, they cannot be presumed to comprehensively represent the entire user community of O*NET for HRM. Time and resource constraints precluded us from conducting systematic, in-depth, or long-term fact-finding or data-gathering efforts. The panel faced the problem that "we did not know what we didn't know." It is not possible to determine how much additional information on uses of O*NET data for HRM purposes might have been uncovered had time permitted additional efforts. Because there is no single, readily available repository of O*NET user information and feedback to shed additional light on typical O*NET applications and data needs, the information that follows must be considered suggestive. Furthermore, because of these limits, it was not possible to evaluate the effectiveness or appropriateness of the specific applications of O*NET reported to us by human resource managers and consultants.

Despite these caveats, the panel judged the data gathered sufficient to reach conclusions and recommendations about the use of O*NET data for HRM purposes. This judgment is based on intensive and diligent efforts to solicit and receive input from a relatively wide range of O*NET users. It is also based on the observation that there is some degree of repetition or redundancy among the comments made and issues that surfaced across workshop presentations and papers and other user input. This can be considered a sign that most of the relevant issues or information has been captured.

USES OF O*NET IN HUMAN RESOURCE MANAGEMENT

Job Analysis

A major use of O*NET is for job analysis. Note that the terms "job analysis" and "occupational analysis" are not synonymous. An occupational analysis looks at all those holding jobs in a given occupational category (e.g., all firefighters), whereas a job analysis focuses specifically on those holding jobs in an organization (e.g., all firefighters in the city of Detroit). O*NET provides an occupational analysis, but job analysts are typically not interested in all jobs in an occupation, but only those job holders in their own organizations.

Organizations conduct job analyses to describe the nature of work to be performed and to identify worker requirements for accomplishing that work. O*NET provides four essential elements of a job analysis that can serve as input to various HRM applications: (1) O*NET can inform job descriptions for use in designing and implementing selection systems, train-

ing and development programs, and performance management systems; (2) O*NET descriptor information may be used in job redesign efforts; (3) O*NET information might play a role in job clustering for various HRM purposes; and (4) O*NET information might serve to supplement internal, multipurpose organizational job analysis efforts. Each of these uses is discussed below.

Job Description

Job descriptions are used in many ways in organizations. In this section, we discuss six applications of job description information for which there is some evidence that O*NET has been used.

Organizations use job descriptions generated from O*NET data for *designing selection systems*. O*NET's role in selection system design may take several forms. O*NET job descriptions are used to determine minimum and "preferred" qualifications for a position (e.g., a minimal level of knowledge required). For example, one survey respondent described mapping reading requirements for O*NET occupations onto the National Assessment of Adult Literacy reading scale using a Census Bureau crosswalk to derive literacy requirements for occupations synthetically. In a related effort, O*NET has been used in developing competency models that underlie organizational selection systems (e.g., Jeanneret, 2009, describes this use in the refining and insurance industries). O*NET also has been used for checking competency models already developed by an organization against O*NET descriptor profiles.

O*NET also has been used in evaluations of the job-relatedness of existing tools. For example, a test or interview process is examined to determine what knowledge, skills, and abilities are assessed relative to what O*NET descriptions suggest are the required characteristics (Human Resources Research Organization, 2009). O*NET job information also has served as an input to efforts to develop new instruments, such as designing experience inventories for job applicants (e.g., Anderson, 2009) and developing or documenting question content for structured interviews (Ryan and Pearlman, 2009). O*NET taxonomies have been used specifically in supporting content validation efforts. For example, Jeanneret (2009) describes linking interview questions to O*NET general work abilities to assist a client in the hospitality industry.

Numerous publications report the use of O*NET in job component validation (e.g., Coaster and Christiansen, 2009; D'Egidio, 2002; Jeanneret and Strong, 2003; Johnson et al., 2003; LaPolice, Carter, and Johnson, 2008). Job component validation is a methodology used by organizations for identifying selection tools that are appropriate for a specific job component that may be common to multiple jobs. This process is often used

for jobs with few incumbents when conducting criterion-related validation studies at the job level is infeasible. Organizations also use it as an efficient way to develop selection procedures for large numbers of jobs efficiently. For example, LaPolice, Carter, and Johnson (2008) successfully used O*NET knowledge, skills, ability, and generalized work activity data to predict literacy requirements for occupations and to thus support the use of assessments of literacy in selecting employees.

Most of these selection efforts describe using O*NET as a starting point, followed by collection of job analysis data for a specific organization and job, rather than using O*NET as the sole source of legally defensible job-analytic information. However, there are anecdotal examples from the panel's survey of HRM professionals in which O*NET data were used by themselves to support the legal defense of selection tools.

O*NET has also played a role in organizational *recruitment* efforts. Organizations have used O*NET descriptions in developing job information materials that are used to inform and attract job candidates. For example, the employment services company Manpower, Inc., uses O*NET job descriptions as a basis for developing its standard job descriptions, which are then used for recruiting and job advertisement (Dorman, 2009). DeLuca and Hirsh (2009) describe using O*NET data for identifying alternative sourcing opportunities when recruiting for occupations with a limited supply of workers.

Another possible use of job analysis information by human resource professionals is in *designing compensation systems*. O*NET information could be used to identify compensable factors (i.e., determinants of pay). O*NET might also provide input to comparisons of jobs in wage and salary system design. The National Center for O*NET Development (2009b) describes one compensation analyst from the banking firm Trustmark Corporation using O*NET data to help managers develop job descriptions that then served as input into determining salary ranges. DeLuca and Hirsh (2009) also note the use of O*NET in investigating whether organizations are retaining and rewarding the right skills and competencies through studies on turnover and raises. Overall, there was little documentation of using O*NET in any extensive way for compensation system design, although anecdotal evidence suggests that it can serve in such a capacity.

Another major category of job description usage is in *performance management system design*. That is, organizations create processes to evaluate job incumbents' performance, to provide developmental feedback, and to motivate future performance. O*NET can serve as input for such system design by providing information on competencies and tasks to be evaluated. The U.S. Department of Labor (2008) mentions this use and Jeanneret (2009) and Anderson (2009) both provided examples of using O*NET taxonomies as organizing frameworks in developing performance

evaluation systems. Overall, there was only a small amount of evidence of O*NET data being used for this purpose.

O*NET information has been used for *training and development system input*. Specifically, it might be used to design job-specific training programs. For example, O*NET was used by one organization to structure electronic technician training programs (National Center for O*NET Development, 2009a). It also has been used in identifying the training needs of an individual employee for a specific job (Ryan and Pearlman, 2009) or the relevance of existing training courses for workers in specific jobs. For example, Dorman (2009) describes how Manpower uses O*NET descriptors in matching individuals with specific courses in their training programs. O*NET information might indicate trends in worker requirements for future training program development. O*NET information might also be used to identify jobs in which cross-training is feasible (i.e., other jobs with similar competency requirements). Overall, the evidence suggests that O*NET data are used more frequently to inform state and local workforce development programs (see Chapter 6) than they are used to inform internal training and development programs created by private employers. Nevertheless, there is some documentation of employers using O*NET data to inform their training and development programs.

A final use of O*NET in a job analysis capacity is to define occupational training, education, and experience requirements of jobs in order to be in *compliance with government regulations or to determine eligibility for various government programs*. For example, the U.S. Department of Labor (DOL) might use O*NET data in its process of making determinations on permanent labor certification; such certification allows an employer to hire a foreign worker to work permanently in the United States. Similarly, decisions about the "essential job functions" that must be defined to comply with the Americans with Disabilities Act might be informed by O*NET information. The State Department's Diversity Visa Lottery program, which provides visas to randomly selected applicants who meet strict eligibility requirements from countries with low rates of immigration to the United States uses O*NET data on the education/training and experience requirements of occupations. As another example, organizations have used O*NET data to align job descriptions for employee visa sponsorships with the database used by the U.S. Customs and Immigration Service (Ryan and Pearlman, 2009). Although some survey respondents described these sorts of uses, there are also clear examples of O*NET's being considered not useful for eligibility determinations. For example, as Chapter 8 describes, the Social Security Administration has found that O*NET is not currently useful for the purpose of determining disability eligibility.

In sum, O*NET information has been used in developing job descriptions for a wide variety of HRM purposes. Indeed, as discussed in

Chapter 5, the HR-XML Consortium has used the O*NET database to identify common elements of human resource systems and develop standard definitions, suggesting that O*NET may play a larger role in these systems in the future.

Job Redesign

O*NET data could provide useful information for organizational job redesign efforts—specifically, in deciding whether jobs are similar enough to be treated the same for HRM purposes. Conversely, O*NET information might support the splitting of an internal organizational job category into two or more jobs with different worker requirements to better utilize worker skill sets or to make pay systems or training programs more efficient. O*NET data might be used to suggest how an organization could adjust specific job duties or requirements in response to substantive changes in operations, procedures, or equipment used. Although these uses are possible, little documentation was available documenting actual use of O*NET for these purposes.

O*NET information can be used when planning for downsizing or outsourcing of work. For example, the Boeing Corporation used O*NET data to evaluate the transferability of individual workers' skills when planning for an anticipated plant closing (National Center for O*NET Development, 2009b).

O*NET data can inform redesign efforts that change the way work is structured to improve productivity, worker well-being, and worker health. For example, O*NET might serve to identify jobs in an organization that are candidates for increased flexibility (in time or place of work), nonstandard work arrangements (e.g., job sharing), team-based structures, and greater self-management. Anderson (2009) provided an example of how O*NET taxonomies and rating tools might be used to identify which jobs are candidates for "greening," that is, redesign to reduce energy consumption and waste. Thus, there is potential for O*NET usage in assisting organizations in changing the nature of work to meet with environmental, social, and economic changes, although there is currently little documented use for this purpose.

Job Clustering

O*NET has been used to identify various types of similarities across jobs (such as in tasks or worker requirements). Such information can be used to cluster jobs for specific HRM purposes. For example, organizations use O*NET to cluster jobs according to various worker requirements (e.g., skills, abilities) when designing selection systems so as to make more

efficient use of selection tools that assess those requirements (Jeanneret, 2009; Ryan and Pearlman, 2009). In addition, when organizations wish to extend the use of a selection instrument across jobs (Jeanneret, 2009) or to determine if an instrument shown to be valid for a particular job category might demonstrate generalizability across organizations, units, or cultures, O*NET information has been useful. For example, Taylor et al. (2008) found that O*NET descriptors are meaningful in other countries as well as in the United States. Jeanneret (2009) provided the panel with multiple examples of the use of O*NET for job grouping, including a grouping of over 100 different titles for first-line supervisory jobs at a large telecommunications firm, a grouping of 63 jobs in the hospitality industry into 8 families, and a grouping of over 900 jobs in a municipal government into smaller job families. Thus, there is documentation of O*NET use in job clustering for selection-related purposes.

Jobs also are clustered for use in compensation programs, unified performance management systems, and common training programs, and O*NET descriptors can be used to determine appropriate grouping for these purposes. For example, DeLuca and Hirsh (2009) describe using O*NET to identify similarities in occupations for their compensation clients and to create company-specific job groupings. Job clustering can provide a means to determine career ladders and provide employees with information on career development opportunities, as well as inform organizational succession planning. Finally, human resource managers and researchers in organizations might use O*NET information to compute various occupational statistics for internal workforce planning purposes.

Supplemental Information

A final use of O*NET descriptor information in a job analysis capacity would be as supplemental or starter information for internal job analysis efforts. O*NET information has been consulted to structure job analysis interviews (DeLuca and Hirsh, 2009), to develop preliminary content for job analysis questions (e.g., Reiter-Palmon et al., 2006), and to generate job descriptions for subsequent review and editing (Ryan and Pearlman, 2009). Among those who provided information to the panel, this was the use of O*NET data mentioned most frequently. In one of these many examples, Reiter-Palmon et al. (2006) described how the U.S. Navy used O*NET Generalized Work Activities as the basis of a web-based job analysis process developed for internal use. The evidence suggests that O*NET data are frequently used, not as a standalone source of data for organizations, but as a starting point to be supplemented by further collection of data tailored to the individual organization's context and needs.

Person-Job Matching

While the use of O*NET for person-job matching may be more widely employed by career and workforce development experts (see Chapter 6), individual organizations and organizational units also make use of O*NET for internal person-job matching purposes. Organizations may have internal career development programs that have been built using O*NET information. O*NET has played a role in developing self-assessment and exploration tools specific to a particular organization's job set, or the O*NET interface itself has been promoted for employees' use in their own career exploration (Ryan and Pearlman, 2009). For example, although the U.S. military's Armed Services Vocational Aptitude Battery Career Exploration Program did not use O*NET ratings directly for developing its career match information, O*NET data were used as a starting point in generating skill importance ratings for various occupations. As another example, Dorman (2009) described the use of O*NET in developing a transferable skills index used by Manpower, Inc.

Organizations also use O*NET information in employee development programs (Ryan and Pearlman, 2009). For example, Converse et al. (2004) describe using O*NET data to match individuals to occupations on the basis of abilities using a multiple-aptitude test battery. As mentioned earlier, O*NET information might be used to develop career ladders for employees that show possible paths in an organization for those with certain skill sets, although we did not find documented examples of that specific use.

As Chapter 6 describes, O*NET data also can play a role in outplacement activities of organizations. It is also used by the military and by veterans groups to identify civilian jobs and career paths for transitioning military personnel (National Center for O*NET Development, 2009b).

In sum, O*NET information is widely used for individual career planning and career decision systems development by workforce development agencies and career development professionals. Human resource managers in individual establishments also appear to use it, both for internal career management purposes and for outplacement.

Strategic Planning

O*NET has the capacity to be used by organizations in strategic HRM, although the panel found only a few documented examples of such use. For example, organizations can use O*NET in determining recruitment needs, identifying where retention incentives might be needed, and selecting locations for facilities by forecasting available labor supply in specific geographic regions. Using O*NET for such projections, organizations can align recruitment strategies with available supplies of workers. They might

mine O*NET data to identify trends in the availability of skilled workers, in order to increase or decrease recruitment activities as appropriate. Organizations might also examine O*NET data to identify potential "feeder jobs" and target recruitment activities toward individuals in these jobs to fill high-demand skilled positions. For example, Anderson et al. (2007) used O*NET data to analyze recruitment needs in the transportation industry. Similarly, O*NET data might inform succession planning—the process of preparing for the retirement of top managers by identifying and developing younger people who might replace them in the future.

O*NET is often used by states and the federal government to analyze skill gaps and identify appropriate education and training programs to fill these gaps. Similarly, it might be used by an individual organization's human resource managers to better understand the capabilities of the internal workforce. O*NET information on trends can point to jobs that will require fewer or lower levels of skills in the future, as well as jobs that will be upgraded in skills or require different ones as a result of technological advances (National Research Council, 1999). Such information can help organizations better anticipate training needs and shifts in the workforce and to plan accordingly.

Although this discussion has identified many different ways O*NET data could potentially be used to support strategic human resource planning, the panel found only a few documented instances of such use of O*NET data. The available evidence did not point to any specific barriers to this use of O*NET information.

Worker Health and Safety Programs

A final area of use of O*NET by those in HRM is in the context of worker health, stress, and safety programs. O*NET data might be used to identify safety needs for a given job, as well as common safety issues across jobs, and thereby inform worker selection and training for those jobs. O*NET data can be mined to identify similarities in health concerns across jobs and inform the development of educational or informational programs and materials appropriate for those jobs. The O*NET database provides information on similarity in job stressors (e.g., emotional demands), allowing for the clustering of jobs to provide appropriate programming and training materials (Liu, Spector, and Jex, 2005). Anderson et al. (2004) used O*NET as a basis for making expert ratings regarding the effects of seasonal allergies on job performance.

Although the panel did not find wide documentation of uses of O*NET for workforce health and safety purposes, the research literature on occupational health issues appears to increasingly report the use of O*NET data in establishing links between occupational conditions and activities and

worker health and safety (see Chapter 9). This suggests that O*NET data may be increasingly used for workplace health and safety research.

Summary

The panel found evidence that O*NET data are used for a variety of HRM purposes by public- and private-sector organizations. However, we did not uncover concrete evidence of the use of O*NET data for some potential purposes, such as for strategic human resource planning. This may indicate that O*NET data are not useful for such purposes. Alternatively, they may indeed be used for these purposes, but they are difficult or impossible to document or verify. Another interpretation of the lack of concrete evidence of some uses is that the costs of understanding and using O*NET data prevent their wider use in HRM applications.

STRENGTHS AND LIMITATIONS FOR HUMAN RESOURCE MANAGEMENT

Most of the comments about O*NET from the HRM community were oriented toward taking a system that is useful and making it better. Descriptions of use often came with significant caveats, reflecting some users' frustration with O*NET's unrealized potential. For example, a number of users holding favorable views of O*NET's content and data quality said that deficiencies in the O*NET websites created barriers to use of the data or hindered access to content and data. More broadly, different types of human resource specialists, such as practitioners and researchers, focused on different aspects of the O*NET system when identifying strengths, limitations, and opportunities for improvement. Even within these categories, there was a range of opinions. For example, some viewed the use of analysts to provide certain descriptor ratings as an asset, and others viewed it as a liability.

Human Resource Management Views of O*NET Strengths

The aspects of O*NET frequently cited as strengths or advantages by HRM users can be roughly categorized into those involving O*NET content, O*NET data, and the general O*NET system. For the most part, these correspond to many of the capabilities for which O*NET was explicitly designed, as described by Peterson et al. (1999).

O*NET Content

Features of O*NET content cited favorably by users include the following (Anderson, 2009; DeLuca and Hirsh, 2009; Jeanneret, 2009; Morgeson, 2009; Ryan and Pearlman, 2009):

- The comprehensiveness and theoretical basis (e.g., Fleishman's taxonomy) of the O*NET content model and its various component descriptor taxonomies. The breadth and variety of O*NET descriptors enable both work and worker requirements to be described in multiple ways (e.g., in terms of skills, knowledge, abilities, tasks, work styles, work context, and the education or training required). This in turn permits substantial flexibility and versatility in how the system can be used.
- The hierarchical organization of many of O*NET's descriptors, allowing for occupational description at different levels of analysis.
- The standardized descriptors used to collect and report data for all occupations. The use of descriptor taxonomies facilitates cross-job comparisons both within and across organizations, industries, and economic sectors.

O*NET Data

Features of O*NET data cited favorably by users include the following (Handel, 2009; Morgeson, 2009; Ryan and Pearlman, 2009):

- The degree of rigor in the design and execution of the data collection operation as a whole (planning, execution, data cleaning, and quality control).
- The multifaceted sampling strategy underlying the collection of descriptor rating data, involving different rater types (analysts, incumbents, occupational experts) and multiple respondents from multiple establishments, yielding high cooperation rates and reasonable survey response rates, thereby resulting in useful information about occupations.
- The ratings relate to other data (for example, wages) in meaningful and expected ways, resulting in logical within- and across-occupation descriptor rankings.
- The ability to significantly reduce the cost of occupational information gathering when used to provide starter job analysis, interview, and questionnaire development information.

O*NET System

O*NET system or general features cited favorably by users include the following (Anderson, 2009; Morgeson, 2009; Ryan and Pearlman, 2009):

- The ability to link to multiple types and sources of data and information (e.g., the provision of Bureau of Labor Statistics wage and labor market information by occupation).
- The availability of and easy access to the O*NET OnLine website, especially its search facilities, which allow for quick searches of the database for occupational information presented at different levels of detail or customized in different ways for different needs.
- The provision of extensive specific job titles as part of the summary page for each occupation, as well as links to lay titles commonly associated with each occupation.

Human Resource Management User Views of O*NET Limitations

The aspects of O*NET frequently cited as weaknesses or limitations by HRM users primarily involve either O*NET content or O*NET data.

O*NET Content

Features of O*NET content cited unfavorably by users include the following (Anderson, 2009; Dierdorff, 2009; Handel, 2009; Harvey, 2009; Morgeson, 2009; Ryan and Pearlman, 2009):

- Many O*NET descriptors are viewed as too generic—or not sufficiently specific—for some applications (e.g., defining training needs). In conjunction with the brief occupational description and limited associated task information provided, occupations are primarily defined in O*NET by cross-job descriptors rather than by job-specific content, making it difficult to readily understand how a job is performed.
- Occupational information is not customized for jobs in a particular organization. This inability to describe a specific job in detail can limit O*NET's utility for the legal defensibility of personnel selection procedures. It also means that O*NET realistically cannot serve as an organization's only source of information about its own jobs for many applications. This issue may be exacerbated by the fact that the National Center for O*NET Development does not clearly describe or market O*NET as an input

or source of data, rather than a ready-made solution for human resource management applications requiring organization-specific job information.

- Some specific descriptor elements appear to be redundant or overlapping both within and across descriptor taxonomies or domains (see Chapter 2 for examples).
- Some of the descriptors, at least as labeled, do not have obvious meaning or relevance to many HRM professionals (e.g., the Extent Flexibility and Static Strength abilities), do not readily lend themselves to measurement, and may hence be of limited practical value.
- Some descriptors of potential relevance or value are not represented in any domains of the content model. For example, certain medical and health-related abilities, such as finger, hand, arm, or leg strength or flexibility, and some technology-related skills and knowledge (such as advanced knowledge of information technology, IT) are missing. Some work context variables, especially those that may be useful in the characterization of "high-involvement" or "high-performance" workplaces, are missing. Although some such variables are included in the Organizational Context domain of the content model, data are not currently collected in this domain. These omissions can limit O*NET's utility for HRM applications in organizations for which such attributes or variables are relevant.
- Some content model descriptors (for example, in the Work Styles and Work Context domains) may be too organizationally specific to make sense as stable, appropriate, or generalizable occupational descriptors (for example, Work Context items concerning the effects of one's decisions on others).
- Some occupational areas are not adequately represented or are not well differentiated. Frequently mentioned examples of this are professions related to health care and IT, in which superficially similar jobs may have very different knowledge and training requirements. The absence of military-specific occupations also was mentioned as limiting the use of O*NET by the various military service branches and components (Styer, 2009).

O*NET Data

Features of O*NET data cited unfavorably by users include the following (Anderson, 2009; Handel, 2009; Harvey, 2009; Jeanneret, 2009; Karman, 2009; Morgeson, 2009; Ryan and Pearlman, 2009):

- O*NET's occupations represent too broad a level of aggregation for some applications (e.g., personnel selection). In other words, these occupations represent too heterogeneous a collection of specific jobs or job titles. As a result, O*NET's occupational-level data—and, consequently, inferences based on such data—may not be valid for some or most of the more specific jobs or titles encompassed by the occupation. This could be problematic for HRM applications that involve establishing linkages between O*NET data and jobs in specific organizations, such as job analysis/job description applications.
- Various aspects of the quality of O*NET descriptor ratings are questionable, based on such issues as:

  - the possibility of rating inflation because of use of incumbents as raters for many descriptor domains;
  - the possibility of inaccurate ratings because of the use of analysts who do not perform the job;
  - low interrater reliability for some descriptors;
  - lack of descriptor or scale validity, especially for more abstract attributes, such as abilities, because of the use of single-item scales, occasionally unclear or jargon-laden item or anchor wording, and questionable validity of rating scale value intervals between some descriptor anchors;
  - potentially useful types of rating data that are not collected, such as frequency or time spent (for tasks or generalized work activities), "needed-at-entry" (often very important for personnel selection applications), consequences of error, and depth of required knowledge or degree of required skill/expertise (for tools and technology items); and
  - a variety of concerns about the utility of the "level" rating scales used for some descriptor domains (see Chapter 3).

Some of these user concerns comport with the panel's evaluation of the content model in Chapter 2. Although some of these concerns have been disputed (Tsacoumis, 2009), the panel thinks that they warrant further systematic examination and evaluation. Such examination would serve the long-term interests of both DOL and the O*NET user community. The areas the panel views as most in need of such evaluation are outlined in the following section.

CONCLUSIONS AND RECOMMENDATIONS

The panel has identified gaps in the available information on the uses of O*NET data for HRM purposes.

Recommendation: To address the lack of systematic information on uses of O*NET, the Department of Labor should, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, establish and execute a framework for evaluating uses of O*NET that includes

- **Development of evaluation metrics aligned with various uses of O*NET.**
- **Review of the usefulness and accuracy of existing information on O*NET uses.**
- **Development of methods to systematically evaluate the adequacy of existing methods for obtaining feedback from O*NET users.**
- **Development of new methods to systematically and continuously obtain information about who uses O*NET, how and how frequently it is used, reasons it is not used or might not be appropriate for certain suggested uses, user community awareness of O*NET, the specific applications it is used for, user satisfaction, and objective measures of effectiveness or success in meeting user needs.**

The panel recognizes that the O*NET Center currently collects and analyzes a variety of user input and feedback, such as O*NET OnLine site visit and search frequency data, customer service request/inquiry data, and user e-mails. However, these appear to primarily serve relatively narrow internal program feedback and day-to-day operational needs rather than broader system review/analysis needs and issues involving a longer term or strategic focus. Nonetheless, as noted above, we encourage evaluation of these existing user feedback mechanisms in terms of their potential utility in contributing to a more broadly targeted, and publicly available, O*NET usage and evaluation base of data and information.

The panel received a great deal of feedback from the HRM community focusing on perceived weaknesses of the O*NET content model, specifically on the domain taxonomies, such as Abilities, Skills, Knowledge, Work Styles, Generalized Work Activities, and Tasks. These concerns, combined with questions about some of the descriptors, imply that the content model is not as parsimonious as it could be, and that the content of some domains could be reduced or simplified. This community has expressed concerns

about factors that cast doubt on the reliability and validity of existing descriptor ratings, rating data that are not currently collected but could be useful, and issues specific to the "level" ratings completed for some descriptor domains.

The HRM community echoes the panel's conclusion that there is a need for research on the content model.

Recommendation: The Department of Labor should, as part of its research on the content model and with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, commission research and analysis directed to either mitigate or dismiss concerns raised by the human resource management community. Among other concerns, this research should explore the potential need for:

- **Descriptor modernization and updating, particularly in domains (such as Knowledge and Work Context) directly affected by technological change and other ongoing changes in workplace and workforce dynamics.**
- **More emphasis on descriptors reflecting the cognitive, social/interpersonal, and other changing requirements of work in an economy that has continued to shift from a manufacturing and agricultural base to a knowledge and service base.**
- **Improved linkages to broader world-of-work information that would expand on the labor market data information currently provided for each occupation—such as industry trends and forecasts and technological, demographic, and geographic trends affecting occupations. This type of information could enhance O*NET's value for human resource strategic planning applications.**

O*NET users in the HRM community have raised questions about the ability of the O*NET occupational classification system to accurately reflect the changing nature of jobs and employment relationships. Ten years ago, a National Research Council review of work and occupational classification systems noted that the boundaries between jobs were becoming more fluid and the range of choices around how to structure work was increasing (National Research Council, 1999). These trends, which have continued since that time, should be considered in the study of the O*NET occupational classification system recommended in this report.

Recommendation: As part of the research on the occupational classification system recommended in Chapter 3 and to meet the needs of human resource managers and promote seamless integration of O*NET

with industry competency models, the Department of Labor should commission research on:

- **Methods to describe or represent hybrid jobs (i.e., jobs effectively comprised of the work of two or more separately defined occupations);**
- **Methods to expand the current sampling frame to better represent smaller establishments, as well as self-employed, part-time and contract employees;**
- **Other potential sampling frames to better represent the changing labor market; and**
- **Methods to appropriately capture or otherwise represent the increasing variability in how work is done and the increasing fluidity in job boundaries.**

The available data overwhelmingly point to the need for improved communication and outreach about O*NET to the HRM community. There is a lack of awareness in this community about O*NET's existence and capabilities. The current O*NET Toolkit for Business contains few of the specifics, examples, or illustrations that would be of practical value to HRM practitioners.

Recommendation: The user advisory board should advise the Department of Labor on the development of new materials and tools for knowledge dissemination about O*NET to the human resource management community. These materials and tools might include an instructional resource depository of business cases or exercises, lecture overheads for use in higher education and training, and toolkits, checklists, interactive tools, and illustrated user guides that clearly and simply demonstrate how O*NET can be used for a variety of human resource management applications.

In keeping with the panel's recommendation that most development of O*NET tools and applications be conducted by external developers, these materials should be developed in collaboration with, and marketed by, professional associations, such as the American Society for Training and Development, the Society for Human Resource Management, and the Society for Industrial and Organizational Psychology.

In carrying out this recommendation, DOL and the O*NET Center can draw on their existing procedures for making O*NET data and information freely available for use by public and private developers, described in the previous chapter. These procedures, including a formal user agreement and voluntary registration system, provide models for similar procedures

to govern the process of providing information about O*NET to professional associations for use in creating and marketing educational materials and tools.

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8

Disability Determination

This chapter discusses the use of occupational information for determination of Social Security disability benefits. Although O*NET was envisioned as a replacement for the *Dictionary of Occupational Titles* (DOT), the Social Security Administration (SSA) continues to rely on the DOT when making disability determinations. The chapter first reviews the history of the use of occupational information in the process of disability determination. It then discusses prior interagency efforts between the Department of Labor (DOL) and SSA to develop an occupational information database suited to the process of disability determination and prior research on the use of O*NET for disability determination. The third section evaluates the potential use of O*NET data vis à vis the specific types of occupational information required in the disability determination process, and the final section presents the panel's conclusions and recommendations in this area.

OCCUPATIONAL INFORMATION NEEDS OF THE SOCIAL SECURITY ADMINISTRATION

The Social Security Act (Section 223(d)(2)) establishes that disability determination requires that an individual's physical or mental impairment is of such severity that she or he is not only unable to do his or her previous work but cannot, considering his or her age, education, and work experience, engage in any other kind of substantial gainful work that exists in the national economy. "Work that exists in the national economy" is defined as work that exists in significant numbers in either the region where the

individual lives or in several regions in the country. To answer the question of whether or not "work exists in significant numbers" in the national economy, the SSA took administrative notice of the DOT. That is, under the assumption that only occupations that existed in significant numbers were reflected in the DOT, this O*NET predecessor served as a primary tool for determining whether a Social Security claimant had the capacity to work.

In 1996, SSA requested that the Institute of Medicine, in collaboration with the National Research Council's Committee on National Statistics, conduct an independent review of the statistical design and content of its research plan for redesigning the disability decision process. The study committee concluded that the DOT replacement (i.e., O*NET), "will not meet SSA's needs to define the functional capacity to work without major reconstruction" (Institute of Medicine, 2002, p. 9). The report continues:

> *Barring some resolution, SSA will be left with no objective basis upon which to justify decisions concerning an individual's capacity to do jobs in the national economy*. SSA might be cast back into the era when it relied extensively on the testimony of "vocational experts" or their written evaluations. [emphasis in the original]

Given that occupational information is critical for use in disability determination, our panel invited Sylvia E. Karman, a representative of SSA, to make a presentation on this issue. SSA appears to think that O*NET is not able to fulfill the needs of vocational experts and disability adjudicators involved in the process of disability determination. In a letter to administrators of disability determination services, SSA advises disability adjudicators and reviewers not to use O*NET when making disability decisions (Social Security Administration, Office of Disability, 1999). Sylvia Karman (2009) indicated that this view is widely shared, presenting a list of four reports (Government Accounting Office, 2002a, 2002b; Social Security Advisory Board, 2001; Institute of Medicine, 1998) which, she said, either state that "both SSA and DOL acknowledge that O*NET cannot be used in SSA's process" and/or "recommend that SSA investigate other alternatives."

THE FUTURE OF OCCUPATIONAL INFORMATION FOR DISABILITY DETERMINATION

Having ruled out the use of O*NET for disability determination purposes, SSA has begun taking steps to develop its own occupational information system. In December 2008, the commissioner of social security established the Occupational Information Development Advisory Panel. The advisory panel was charged with providing independent advice and recommendations on plans and activities to replace the DOT currently used in the SSA disability determination process (Astrue, 2008). The panel's report,

issued in September, 2009, recommends the creation of a new "Social Security Administration Occupational Information System" for use in disability determination (Social Security Administration Occupational Information Advisory Panel, 2009). The panel recommends development of an initial, empirically derived work taxonomy and data elements for the content model; research to examine various job classification methods; creation of internal and external research capacity at SSA; basic and applied research on work-side and person-side job attributes and demands; development of scales and measures for the dimensions of the taxonomy; and communication with users, the public, and the scientific community.[1]

SSA has concluded that, in its current form, O*NET does not fulfill the needs of the disability determination process. At the same time, DOL has concluded that O*NET fulfills its needs for occupational information; other chapters of this report show that O*NET meets many other occupational information needs. However, disability determination was an important use of the DOT and because O*NET was created to replace the DOT, it seems fair to conclude that O*NET has failed to replace the DOT in this particular usage.

Given public demand for budgetary restraint and efficient government, which acquire additional importance in times of economic recession and slow economic growth, duplication in government functions should be prevented. Therefore, the development of parallel, possibly redundant, occupational information systems, one for general purposes termed O*NET and the other tailored to the needs of SSA, is of concern to taxpayers. In addition, dual data collection processes would seem unnecessarily expensive.

The panel is not advocating the adoption of O*NET by SSA or the development of a hybrid O*NET-Disability system in the disability determination process. However, we conclude that a considerably modified and expanded O*NET may be capable of informing the disability determination process. There are also some potential economies of scale to be derived from the development of a single occupational information system to be used by both agencies, which may allow cost-sharing of resources in such functions as data collection and system maintenance.

An occupational information system that facilitates the process through which individuals with disabilities obtain gainful employment would help relieve the financial pressure on the SSA system and also contribute to the mental health of those who become productive members of society.

Not all stakeholders share the opinion that O*NET cannot be amended to meet the needs of those involved in disability determination. In fact, the Committee to Review the Social Security Administration's Disability Decision Process called for interagency collaboration (Institute of Medicine,

[1]The NRC panel completed its deliberations prior to the release of this SSA panel report.

1998). Its 1998 report encouraged SSA to explore some interagency agreement "to initiate a version of O*NET that would collect information on minimum as well as average job requirements to better serve SSA's needs to assess ability to engage in substantial gainful activity" (p. 24).

We found evidence suggesting that these calls for collaboration between DOL and SSA were heeded. In 2000, vocational rehabilitation professionals initiated discussions with DOL and SSA which led to the creation of the Inter-Organizational O*NET Taskforce with representatives of 16 associations of physicians, psychologists, therapists, counselors, insurers and educators (Cannelongo, 2009). The group met for 4 years and proposed development of a modified version of O*NET called O*NET–D (for Disability) that would incorporate occupational information gathered in the field by rehabilitation professionals trained in job analysis, using standardized questionnaires. A pilot study of the feasibility of training rehabilitation professionals to conduct job analyses funded by DOL yielded promising results (Lechner, Cannelongo, and Keener, 2002).[2]

At around the same time, SSA commissioned the American Institutes for Research (AIR) to examine the suitability of O*NET for the disability determination process (Gustafson and Rose, 2003). Based on an analysis of the initial O*NET database (the "occupational analyst" database), the AIR research team found that reliability, definitional, and anchoring issues could lead to problems if O*NET data were used for disability determination. At the same time, however, the authors identified specific steps for addressing these problems. For example, they suggested that a disability decision maker could use O*NET task lists and other descriptive information to help determine the activities of claimants' current jobs and described an approach to using selected O*NET descriptors that would adjust for the positively skewed distributions of ratings of these descriptors. Gustafson and Rose (2003, p. 15) concluded that "SSA could implement into the [disability determination process] a version of O*NET that is legally defensible and acceptable to decision-makers and claimants alike."

Another piece of evidence, suggesting the continued possibility of collaboration between DOL and SSA, is the testimony provided by former O*NET director, James Woods, to the Social Security Advisory Board on January 13, 2009 (Woods, 2009). In his address, he regretted that earlier efforts to accommodate the SSA needs into O*NET did not bear fruit; however, he remained hopeful that O*NET

[2]The measures of physical abilities included in the proposed approach were never validated.

> may provide a basis to help SSA focus on a specific set of data needs and to organize data within the O*NET framework—for SSA's specific needs. O*NET, or at least the lessons learned in developing the O*NET system, may provide a starting point rather than SSA starting from scratch.

In spite of such past interagency efforts, communication and collaboration between DOL and SSA regarding a common occupational database now appears quite limited. An inspection of their most recent communications suggests that both agencies have reached the implicit conclusion that DOL will not modify O*NET to accommodate disability determination users, and that SSA will build an entirely different occupational information system for its purposes. The fact that SSA's Occupational Information Development Advisory Panel does not include a DOL liaison suggests that the development of an SSA-sponsored system may proceed relatively independent of O*NET.

It is important to consider why SSA and other stakeholders deem O*NET inadequate for disability determination purposes. In the next sections, we present the primary issues that preclude the use of O*NET in the disability determination process in the eyes of stakeholders, the available evidence, and our conclusions regarding the type and the extent of the O*NET modifications called for by each of the issues.

MEASUREMENT OF FUNCTIONAL REQUIREMENTS

In recent years, the concept of disability has shifted its focus from diseases, conditions, and impairments to the functional limitations caused by these factors (Institute of Medicine, 2002, p. 4). A key element implicit in the contemporary view of the disability determination process is the need for an increased understanding of the physical and social factors in the work environment that may impact the Social Security claimant's functional capacity.

There are a number of mental, physical, and psychosensory disabilities that affect the capacity to work. In the context of disability determination, the role of occupational analysis is to determine the important job behaviors and the type and level of ability that is required to perform them.

In spite of their importance for job performance, physical abilities have not received as much attention as cognitive abilities have in the occupational analysis literature (Guion and Highhouse, 2006). Much of what is known about physical abilities appears to have its origins in the work of Fleishman and his associates (Fleishman and Reilly, 1992). An overall summary of this work (Hogan, 1991) suggests that physical abilities can be subsumed into three general fitness factors: (1) muscular strength, or the ability to apply or

resist force by contracting muscles; (2) cardiovascular endurance, or aerobic capacity; and (3) coordination, or quality of movement.

Physical abilities are not the only type of ability impacted by disability. Cognitive, psychomotor, and sensory/perceptual abilities can also be impaired. Fleishman's approach to abilities is particularly important because his measures of ability requirements—including cognitive, physical, psychomotor, and sensory abilities—were adopted in O*NET (Fleishman and Quaintance, 1984). For example, the 52 ability scales used in O*NET were drawn almost verbatim from Fleishman and Reilly (1992). Even though all of these 52 abilities conceivably have implications for disability determination, the panel heard from stakeholders who questioned their utility in the disability determination process.

Comparing the O*NET and SSA Approaches

Sylvia Karman pointed out a series of shortcomings related to disability determination in the O*NET approach to the measurement of physical requirements (Karman, 2009). These shortcomings, along with a critical examination of their rationale, are reviewed below.

Physical Abilities Versus Functional Capacity

Fleishman's physical and sensory-motor measures use rating scales to assess occupational requirements along each physical ability dimension. As incorporated into the O*NET content model, these scales provide a definition of the ability as well as examples of tasks or job behaviors situated at various points on the scale.

This approach is most useful for a construct or a criterion-related approach to the validation of measures of physical requirements that are used for selection purposes (Hogan, 1991). For example, a number of tests are available to assess each of these abilities that can be used to identify capable individuals and can be validated in criterion-related studies (Fleishman and Reilly, 1992). However, from the point of view of disability determination, these abilities represent nonspecific, psychologically worded, or unobservable constructs that cannot be easily tied to specific disabilities or specific groups of muscles, such as those involved in lifting, kneeling, etc.

Consider, for example, the O*NET ability, Static Strength, which is defined as "the ability to use muscle force in order to lift, push, pull, or carry objects. It is the maximum force that one can exert for a brief period of time using the hand, arm, back, shoulder, or leg" (National Center for O*NET Development, no date; see Figures 4-1 and 4-2). Clearly, this physical ability construct cuts across very different muscle groups and

different body limbs. In contrast to this type of definition of a physical construct, the SSA disability determination process relies on the notion of Residual Functional Capacity (RFC), which measures the ability to perform specific physical tasks, such as lifting 20 pounds with hands and arms.[3] In the RFC assessment of the claimant, the focus is on specific and observable functions or behaviors related to lifting, standing, sitting, and pushing, as well as similarly verifiable (medically and otherwise) postural limitations regarding balancing, crouching, and crawling (Form SSA-4734-BK, 08-2008).

There is a series of O*NET work context descriptors related to how much time the occupation requires sitting, standing, climbing, walking or running, and keeping one's balance (items 34 through 39 in the work context O*NET questionnaire—National Center for O*NET Development, no date) that have conceptually parallel items in the RFC assessment, even though the anchors placed at the various points of these scales are quite different in the two approaches. For example, SSA uses specific time ranges (e.g., "about 6 hours in an 8-hour workday"), whereas O*NET uses relative scales (e.g., "about half the time"). The panel also observes that some O*NET descriptors, such as item 38 in the work context questionnaire, collapses occupational requirements across posturing, such as kneeling-crouching-stooping-crawling, whereas the RFC assessment breaks down each one of these postural limitations.

Sensory and Perceptual Abilities

In contrast to the noticeable differences found in the domain of physical abilities, the panel identified smaller differences between the O*NET and SSA approaches with regard to sensory and perceptual abilities. Note for example the almost perfect equivalence between the O*NET descriptors of near vision, far vision, visual color discrimination, and depth perception and the RFC assessment (descriptors of near acuity, far acuity, color vision, and depth perception). The scales and definition of scale points, however, are still quite different between the two scales.

Environmental Conditions

The RFC assessment involves an evaluation of the claimant's ability to sustain environmental factors, such as extreme heat, extreme cold, wetness, humidity, noise, vibration, and others, using scales ranging from "unlimited" to "avoid all exposure." Although the panel did not find perfectly

[3]The SSA disability determination process also includes assessment of mental Residual Functional Capacity.

equivalent descriptors in O*NET, the O*NET Work Context domain involves a number of conceptually similar items related to exposure to either very hot or very cold temperatures (item 23), such contaminants as gases and dust (item 25), and whole-body vibration (item 27). The anchors in these O*NET scales range from "never" to "every day," and the anchors in the RFC range from "unlimited" to "avoid all exposure."

Use of Behavioral Anchors

O*NET uses the scale format known as Behaviorally-Anchored Rating Scale (BARS), in which behavioral anchors representing differing degrees of a construct are placed along the scale continuum (see Chapter 4). The various degrees of the continuum represented by these scales are illustrated through "anchors" situated at the corresponding scale points. These anchors are short statements describing tasks purportedly representing the level of the construct: "light a candle" is placed next to the scale point 2 in the Ability scale termed Arm-Hand Steadiness," "thread a needle" is placed next to the scale point 4 in the same scale, and "cut facets on a diamond" is placed next to the point 6 in the scale.

Clearly, there are variations in the degree of arm-hand steadiness lying between any of these pairs of proximal anchors. If the O*NET occupational unit score on arm-hand steadiness is 3 (requiring a level of arm-hand steadiness between 2–light a candle and 4–thread a needle), it seems nearly impossible to determine the type of task that a potential claimant should be able to complete to be deemed capable of performing work in this occupation unit. For example, two Social Security disability claimants, both of them capable of lighting a candle and unable to thread a needle, may or may not be able to perform an occupation with a score of 3 on this ability. This could be true because the two claimants have different limitations in their degree of arm-hand steadiness, despite the fact that both of them are unable to thread a needle.

Still another issue related to the behavioral anchors employed in the O*NET physical ability scales is whether ability requirements are scaled at the level of the ability required by the most demanding task or the typical (average) task. For example, a Social Security claimant may be capable of performing the occupation because she or he has enough arm-hand steadiness to thread a needle, so long as threading a needle represents the maximal level of ability that would be required on the job; however, that same claimant may be unable to perform all the work in the occupation if threading a needle represents the level required by the typical, average, or everyday task.

Source of Physical Requirements Information

Another concern is about the source of the ability requirement information. Karman viewed the National Center for O*NET Development's use of trained occupational analysts to judge ability requirements, using solely a written description of the occupation, as an obstacle to relying on this information for disability determination purposes (Karman, 2009). This concern may be accentuated when physical requirements are being determined, because many of them lend themselves to job observation. The process of disability determination can be quite litigious, and those in charge of making the determination prefer to minimize the risk of legal challenges by relying on occupational information gathered directly by trained vocational or job analysts. As noted in Chapter 1, trained occupational analysts gathered information directly from job incumbents for inclusion in the DOT.

Level of Aggregation in Occupational Categories

According to Karman (2009), the number of occupations included in O*NET is too small for disability determination purposes, because each occupation involves multiple, heterogeneous jobs that may have different physical and education requirements. If her assertion is correct that there is a wide range of physical and education requirements of jobs within the same O*NET occupation, then SSA would find it nearly impossible to determine whether or not a given disability precludes a claimant from performing a specific job in the occupation.

The process used to create and write descriptions for the 1,122 original O*NET occupations, referred to as "occupational units" was complex, according to a report of the National Center for O*NET Development (1998). It entailed the use of the occupational classification system adopted by the Bureau of Labor Statistics to administer the Occupational Employment Survey, the development of crosswalks to DOT title codes, cluster analyses of DOT data, analysis and aggregation of DOT task statements, and multiple reviews by subject matter experts. As described in this report, even though DOT titles and task data contributed to the original formation of these occupational units, the occupational units were not the outcome of a simple clustering of DOT titles, nor were they meant to represent simple aggregations of DOT titles. It is not unreasonable to conclude that, at the end of this process, each occupational unit had its own identity independent of—though partially informed by—DOT titles and task content.

Since that time, the O*NET occupational classification system has been revised several times, so that the current O*NET-SOC 2009 occupations may exhibit less within-occupation variability than did the occupational units created by the research team in the late 1990s. Nevertheless, the

reduction from over 12,000 occupational titles in the DOT to the current 1,102 occupations in O*NET-SOC 2009 will inevitably be accompanied by some increase in within-occupation variability.

Karman presented a chart indicating wide variability in education and physical requirements across 553 DOT titles that she said were clustered into a single O*NET occupational unit (51-9198, Helpers-Production Workers) (Karman, 2009). Harvey (2009) presented similar data and drew similar implications regarding what in his view constituted excessive aggregation in the original O*NET occupational units for the purpose of disability determination. However, as noted above, the occupational units were not intended to be merely aggregated DOT titles. The question of the extent of variability in current O*NET occupations deserves further study.

CONCLUSIONS AND RECOMMENDATIONS

The SSA's disability determination process currently relies on assessment of the residual functional capacity of a claimant, focusing on physical functions or behaviors and postural limitations as well as on mental functions, if indicated. Matching the results of the RFC to the descriptors of physical ability and occupational context employed in O*NET is inherently difficult. Nevertheless, there are commonalities in the descriptors used in these two systems, even though substantial differences remain in the level of detail, specificity, and types of scales employed to measure them. The evidence indicates that occupational descriptors involving exposure to unusual environmental demands, such as heat or cold, exist in both O*NET and the RFC assessment used by SSA. However, there is no clear, one-to-one correspondence between the two types of environmental descriptors, because some environmental factors are defined and grouped quite differently in the two models. Taken together, the differences and similarities suggest that continued collaboration between DOL and SSA is in the interest of efficient use of government resources.

Recommendation: SSA and DOL should create an interagency task force to study the viability of potential modifications of O*NET to accommodate the needs of SSA with regard to disability determination. Before implementing these or similar modifications, however, we recommend that the task force conduct (1) an in-depth needs analysis of the occupational information required by the current disability determination process and (2) an interagency cost-benefit and cost-sharing analysis of the additional resources that would be needed to make O*NET suitable to the disability determination process.

The reduction from over 12,000 occupational titles in the DOT to the

current 1,102 occupations in O*NET-SOC 2009 has been accompanied by some increase in within-occupation variability in the physical and mental requirements of the work included in these two different types of occupational categories. Because the extent of this variability has important implications for the usefulness of O*NET in disability determination, it should be studied.

Recommendation: As part of the research on the occupational classification system recommended in Chapter 3, the Department of Labor should commission research to determine whether and to what extent O*NET occupations represent excessively heterogeneous clusters of jobs (in terms of their physical and cognitive requirements) for the purpose of disability determination. This research should include gathering evidence from firsthand observations regarding physical requirements and verifiable survey responses from well-informed sources capable of assessing cognitive requirements.

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9

Uses in Research

This chapter opens with a discussion of the importance of research on changes in the skill requirements of jobs. It then presents a brief overview of recent applications of the O*NET to timely, policy-relevant topics in labor market research and human resource management research. The next sections consider the major limitations of the O*NET as a research tool. The final section presents the panel's conclusions and recommendations related to the use of O*NET in research.

Researchers, educators, public officials, and private employers are keenly interested to understand how the skill requirements of jobs in the United States are changing. Such information is critical for developing education and workforce training policies; for assessing the impact of potentially disruptive economic forces, such as the rise of international offshoring; for evaluating how recent technological changes, such as the computer revolution, are reshaping job skill requirements; and for understanding the degree to which U.S. natives and foreign immigrants compete or, alternatively, occupy distinct and potentially complementary niches, in the labor market.

Answering such questions requires, as a starting point, data that accurately characterize the attributes of jobs performed in the United States. Such data have not always been readily available. Standard labor force survey data sets, such as the Current Population Survey, the Decennial Census, and the American Community Survey, provide two types of information that are commonly used to measure U.S. job skill requirements and their changes over time: (1) measures of the human capital of the workforce, in particular, the distribution of educational attainment and experience of

employed workers, job-seekers, and labor force nonparticipants, and (2) measures of the share of overall employment consisting of various broad (or detailed) occupational categories, such as professional and technical occupations; clerical, administrative, and sales occupations; precision production, craft, and repair occupations; operators, fabricators, and laborers; service occupations; and farm occupations.

Both types of measures have strengths and limitations. Human capital variables, such as schooling or experience, measure the credentials that workers bring to the job. These measures are useful for roughly comparing education and experience requirements among various occupations, but they do not tell us why these occupations employ workers with these credentials—that is, what job tasks the workers in these occupations perform that demand the levels of educational attainment or experience that they possess.

Broad occupational categories, by contrast, provide a more precise sense of what tasks workers do on the job—for example, accountants perform bookkeeping and other quantitative and analytical reasoning tasks—but these occupational categories do not facilitate comparisons of job skill requirements across jobs. For example, how do the skill requirements of operators, fabricators, and laborers compare with those of workers in farm occupations? To answer this question rigorously requires a common metric or taxonomy that classifies occupations into their constituent task requirements. Such a taxonomy should be based on sound social science and grounded empirically in direct measurements of the job tasks, aptitudes, and duties of incumbents in each occupation.

Since its inception in 1999, O*NET has become the primary database used by labor market researchers to assess how the skill requirements of jobs in the United States have changed over the recent past and how these requirements are likely to evolve. Relative to human capital measures and occupational categories, O*NET has three key strengths for this kind of research:

1. It offers the only contemporaneous U.S. data source that comprehensively measures what workers in America do at their jobs. That is, to the panel's knowledge, O*NET does not have any close substitutes or close competitors as a source of information on the content of jobs performed by the U.S. workforce.[1]

[1]Two additional sources of data on job task requirements are: (1) the Skills, Technology, and Management Practices (STAMP) written and fielded by Handel (2007, 2008a, 2008b); and (2) the Princeton Data Improvement Initiative Survey (PDII), which contains a number of questions on job tasks, many of which are adapted from the STAMP (see Autor and Handel, 2009). These data sources have the virtue of offering respondent-level (rather than exclusively occupational-level) measures of job tasks. However, both STAMP and PDII are essentially

2. O*NET provides a tool for comparing job attributes and skill requirements across occupations at a point in time—for example, operators, fabricators, and laborers relative to farm occupations—and for evaluating changes in these job attributes over time.
3. O*NET provides an exceptionally rich set of scales for assessing job content along numerous dimensions.

RESEARCH USES OF O*NET

Human Resources and Organizational Behavior Research

The O*NET database has been employed in research on human resource and organizational behavior topics with increasing frequency over time, as researchers have become aware of its potential and accessibility. O*NET is involved in basic research in these areas in three primary ways.

The most frequent use of O*NET in human resource research has been to provide data on job characteristics in studies on a wide range of human resource and organizational behavior topics. These topics include job autonomy levels (e.g., Andresassi and Thompson, 2007), job control (Lie, Spector, and Jex, 2005), work context (Dierdorff and Ellington, 2008; Dierdorff and Morgeson, 2007), knowledge and skill training retraining time (AIR research), occupational literacy requirements (AIR research), skill level estimations (Wiita and Palmer, 2009), and job level (Tracey, Sturman, and Tews, 2007). Studies focus on a wide range of topics, such as work-family conflict, personality testing, stress, emotional labor, and others, indicating that researchers in different domains see O*NET as a potentially valuable resource for providing job or occupational characteristics information that may play a role in understanding a wide range of organizational phenomena. Most of this research is relatively recent (i.e., the past 3 years), so this use of O*NET may be growing, as more researchers become aware of the database and how it might benefit their research.

Second, O*NET questionnaires have been used by human resources researchers in exploring issues in job analysis and other topics (Dierdorff and Rubin, 2007; Morgeson, Reider, and Campion, 2005). In these cases, the Skills, Abilities, Generalized Work Activities (GWAs), Tasks, Work Styles, and Work Context measures have all been employed by researchers collecting their own data but wishing to examine a research question

pilot surveys. They offer small samples and are not slated to be refreshed on an ongoing basis to provide information on changing job skill requirements. Other approaches to providing job task measures include the German IAB/BIBB dataset and the British Skills Survey, which are repeated cross-sections of workers over one or two decades (Dustman, Ludsteck, and Schönberg, in press; Felstead et al., 2007; Spitz-Oener, 2006).

involving one or more aspects of the content model. The accessibility of all O*NET measurement tools allows researchers the opportunity to use these questionnaires to address specific, emerging research questions. It also provides an opportunity for feedback to the O*NET Center, in that with independent researchers using the tools, suggestions for improvement may be gathered. Also, data collected by researchers using the same tools as those underlying O*NET may serve in a comparative capacity for some occupations.

Finally, the O*NET content model and database have been examined by human resources researchers as an object of research in themselves, as detailed in Chapter 2. Research on O*NET itself is a continued focus of human resources researchers interested in understanding the nature of work, the effectiveness of various job analytic methods, and the similarities and differences among jobs. That is, O*NET has become a useful tool in enhancing understanding and advancing theory and practice in the area of job analysis.

In sum, the O*NET database as well as the O*NET questionnaires have been used by researchers in human resources and organizational behavior to address a wide range of questions regarding job characteristics, such as how job characteristics relate to worker satisfaction and health and how they inform selection and training of workers.

Economic and Labor Market Research

The O*NET database is used with increasing frequency and prominence by economists and sociologists studying the evolution of the labor market. Three areas of particular focus have been the effects of computerization on labor demand, the susceptibility of U.S. jobs to international offshoring, and the impact that low-skilled immigrants have on the employment and earnings of U.S. natives.

Howell and Wolff (1991) were the first researchers to study the impact of computerization on the labor market using job task measures. Their work predates O*NET and thus relies on the *Dictionary of Occupational Titles* (DOT). Autor, Levy, and Murnane (2003) extended the work of Howell and Wolff by offering a formal hypothesis for how the spread of computerization shapes the demand for workplace skills and tested this hypothesis using DOT data. Stated simply, their core hypothesis is that computerization leads to the automation (with a concomitant reduction in their share of total national employment) of a large set of "middle education" routine cognitive and manual tasks, such as bookkeeping, clerical work and repetitive production tasks. Although the initial work of Autor,

Levy, and Murnane relied on the DOT, recent work exploring the same hypothesis has extended this analysis using O*NET. Notably, Goos, Manning, and Salomons (2009) have applied O*NET job content measures to analysis of data from numerous Organisation for Economic Co-operation and Development countries.

A second research topic of substantial recent interest has been the potential impact of international offshoring on U.S. employment. Blinder (2007) argues that the major constraint on the outsourcing of U.S. jobs is the degree to which these jobs must be performed in person; jobs that do not suffer substantial quality degradation when performed at a distance are likely to be increasingly sourced offshore, where employers can take advantage of lower labor costs. To gauge the susceptibility of U.S. jobs to offshoring, Blinder (2007) used O*NET to classify occupations according to their need for in-person interactions. The major conclusion of this work is that between 22 and 29 percent of all U.S. jobs are or will be potentially offshorable within one to two decades. A number of recent papers follow up on this work, including Smith and Rivkin (2008) and Blinder and Krueger (2009).

A third prominent topic in which the O*NET database has found application is the analysis of the impact of low-skilled immigrants on the employment and wages of U.S. natives. A voluminous and contentious literature, commencing with Card (1990), studies the economic consequences for U.S. workers of rising immigration flows from Central and South America. The bulk of this literature concerned itself primarily with employment rates and wages of natives. Recent contributions by Cortes (2008) and Peri and Sparber (in press) have advanced the debate by using O*NET to document substantial differences in the patterns of occupational specialization of immigrants and natives with similar levels of education and experience. An intuitive but nonetheless important finding of both studies is that, for given levels of education and experience, U.S. natives are much more likely than immigrants to be employed in language- and communication-intensive occupations, whereas immigrants are more likely to be employed in occupations demanding physical labor. This finding in part helps to explain why similarly educated immigrants and natives do not appear to compete more directly in the labor market.

In sum, these research examples highlight the broad applicability of the O*NET to core and emerging topics in labor market research. Without O*NET (and its predecessor, the DOT), empirical analysis of these topics would be substantially impoverished. By providing a tool for looking within occupations, O*NET affords researchers the opportunity to better assess how computerization, offshoring, and immigration differentially affect distinct job categories according to their core task requirements.

SHORTCOMINGS OF O*NET AS A RESEARCH TOOL

Although O*NET has unique value as a research tool, it has not reached its full potential. These shortcomings fall under three headings: (1) the O*NET survey instrument, (2) the data collection effort, and (3) the dissemination of O*NET data. Some of the issues identified would require substantial rewriting of the survey instrument to amend. Others are readily addressable, requiring only better dissemination of data already collected.

The O*NET Survey Instrument

This section briefly highlights a subset of the weaknesses in the survey instruments that are most salient to labor market researchers (see also Chapter 4).

Redundancies and Ambiguities

As noted in Chapter 2, the O*NET content model reflects the earlier content model of the Advisory Panel for the Dictionary of Occupational Titles (1993) incorporating "everything about jobs that had been studied, in the name of explaining occupational choices, occupational performance, and work/occupational satisfaction." The result is an array of survey questions, which, to researchers not deeply versed in the history of O*NET, appear redundant or, at best, not obviously distinct. Chapter 2 points out that "problem solving" appears as an item on four separate O*NET questionnaires: Abilities, Skills, Work Styles, and GWAs. Confronted with this ambiguity, researchers who wish to analyze problem-solving requirements of occupations must either choose among the four alternative scales or develop some aggregation of two or more scales. Neither approach is preferable to having a single, unified problem-solving scale in O*NET or spurring O*NET developers to provide clearer conceptual distinctions among these problem-solving measures.

Intrinsic Redundancies

Another weakness of the survey lies in its inclusion of both the Level and Importance scales in four of the seven O*NET descriptor domains (Abilities, Knowledge, Skills, and GWAs). As discussed in Chapter 4, the responses to these scales are highly correlated and largely redundant. To cut through these redundancies, researchers have little option but to make arbitrary choices about which scales to employ and which to discard.

Complexity of Survey Questions

Two of seven questionnaires (Abilities and Skills) for evaluating occupations are completed by occupational analysts, rather than job incumbents. These questionnaires include many technical terms that research has shown to be unfamiliar to most employees (see Chapter 4). For example, although the Abilities questionnaire was originally intended to be completed by job incumbents (Peterson et al., 1999), it contains many technical terms like "fluency of ideas," "category flexibility," "speed of closure," and "rate control" that are unlikely to be familiar to laypersons.

The question of whether job incumbents' or analysts' ratings most accurately reflect the actual requirements of the occupation remains open and warrants further study (see Chapter 4).

Vague Job Content Measures

Some O*NET job content measures are so complex and vague as to leave doubt as to whether they measure a single, well-defined construct. For example, Item 30 of the Skills questionnaire asks respondents to rate the importance of Systems Evaluation, defined as "Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system" (National Center for O*NET Development, no date). Setting aside the question of whether lay respondents understand this definition, the panel is unsure whether "systems evaluation" is a specific job skill or a loosely defined admixture of a number of other, more generic skills. In fact, the Systems Evaluation skill appears to combine a handful of comparatively well-defined, specific building-block job tasks from the GWAs questionnaire. These GWAs include information-gathering, monitoring, evaluating information to determine compliance with standards, and making decisions and solving problems.

Problematic Survey Anchors

As detailed in Chapter 4, many of the behavioral anchors offered to guide respondents in rating aspects of their jobs are problematic. Hubbard et al. (2000), observe that numerous anchors offer examples from specialized occupations that may not be well known to a substantial share of job incumbents (e.g., computer programmers, loan evaluators, managers of road repair crews). Even anchors drawn from commonplace occupations may be sufficiently specific to their occupational domain to impede ready comparison to the incumbent's own occupation. Returning, for example, to the Systems Evaluation question, the O*NET survey anchors include

Level 2, determining why a coworker was unable to complete a task on time; Level 4, understanding why a client is unhappy with a product; and Level 6, evaluating the performance of a computer system (National Center for O*NET Development, no date).

It is difficult for the panel to conceive of a well-defined metric that would unambiguously place the level of systems evaluation required for "evaluating the performance of a computer system" either above or below the level of systems evaluation required for "understanding why a client is unhappy with a product." These tasks appear to us noncomparable on any ordinal scale of the "level" of occupational performance. In addition, it seems unlikely that the typical worker performing customer service would be sufficiently well versed in computer engineering to determine whether the level of systems evaluation required in her job is above or below that required for a computer systems engineer (and vice versa for a typical systems engineer).

The O*NET Data Collection Effort

The following section focuses on data collection issues that are most relevant to research uses of the O*NET. See Chapter 4 for a general discussion of data collection issues.

Respondent Burden

The questionnaires used to populate the previous database, O*NET 13.0, contained 277 survey questions, many of which invite respondents to rate both the Level and Importance of various descriptors. This amounts to a burdensome data collection effort, both for the U.S. Department of Labor (DOL) and O*NET respondents themselves.

While respondent burden is a necessary cost of surveying, excessive length and complexity erode the quality of survey results in two ways. First, all else equal, greater respondent burden reduces survey responses rates, thus shrinking the sample size and potentially skewing its representativeness. Second, because the O*NET job incumbent questionnaire must be completed by three different sets of respondents, the reliability of comparisons of responses across domains within an occupation is reduced. For example, if the GWA responses for an occupation do not tightly correlate with the Knowledge responses for that occupation, is that because the two questionnaires have truly distinct content, or because different occupational incumbents answered each survey?

Survey Detail, Sample Size, and Refresh Frequency

In addition to respondent burden, the O*NET survey data collection effort faces trade-offs along three dimensions that affect data quality: the size of the sample collected for each occupation, the number of detailed occupations individually surveyed (rather than subsumed within broader occupation categories), and the time interval between successive waves (or refreshes) of the data. Improving O*NET along any one of these dimensions increases the total cost of data collection; holding constant data collection costs, improvements on one dimension necessitate cutbacks along either or both of the remaining dimensions.

While it is not possible for us to stipulate the optimal trade-offs without further study, the panel found little evidence that these trade-offs were carefully considered in the design of O*NET or that they are currently weighed on an ongoing basis. Most importantly, it appears that disproportionate precedence has been given to respecting the integrity and completeness of the O*NET content model over other dimensions of survey quality—that is, depth, precision, frequency. The prototype content model attempted to follow the very wide-ranging content model of the Advisory Panel for the Dictionary of Occupational Titles (1993). To address the low response rates in the field test of the prototype, DOL charged a study group with "making changes that would reduce the respondent burden (thereby increasing response rates) while keeping intact the Content Model" (Hubbard et al., 2000, p. 5). As a result, the current content model is largely unchanged from the prototype content model. This history suggests that DOL may not have given due consideration to the costs that a lengthy and complex survey instrument would impose on other dimensions of data quality. The fact that DOL currently must, for each occupation, survey three different sets of job incumbents and also occupational experts and occupational analysts, to obtain the requisite data on the seven primary domains substantially elevates the cost of administering O*NET for any given sample size or refresh interval. Similarly, it makes any increase in sample size or survey frequency more costly.

The panel's conclusion in Chapter 2 that the O*NET survey includes a substantial number of redundant questions makes it less costly to address the problem of an unduly burdensome survey instrument. Eliminating redundant material through the research recommended in that chapter would allow for improvements along other quality dimensions with no significant loss of quality on any relevant dimension.

Treatment of New and Emerging Occupations

It is imperative that O*NET collect data on new and emerging occupations. These occupations are often of substantial interest to policy makers. A leading example is the recent policy interest in green jobs.

While identifying new and emerging occupations for inclusion in the occupational classification system is necessary, it is important to avoid a costly proliferation of niche occupations. The DOT featured more than 12,000 occupations, a number far too large to scientifically sample and regularly refresh at current expenditure levels. The question of how new and emerging occupations are identified and selected for inclusion in O*NET deserves careful study and policy development.

Data Dissemination

One of the key shortcomings of O*NET as a research tool could be readily addressed by simply improving data dissemination. Although researchers, especially those in labor market studies and human resource research, increasingly rely on O*NET, they are hindered in their analyses by not having ready access to demographic and other data on respondents—such as education, age, gender, and race—at both the aggregate occupation level and the individual respondent level. In addition, researchers would like to easily access data on when each occupation was sampled or refreshed as well as survey data from prior sampling waves.

These limitations can be readily addressed. Some of the desired data elements are already available. For example, the O*NET Center makes older versions of the database available on request, but many researchers are not aware of this. Other data elements are already available from the O*NET website but are not easily located. Still other data elements probably cannot be released to researchers without first establishing safeguards to protect respondent confidentiality.

The panel thinks that DOL and the O*NET Center should strive to make O*NET source data accessible to researchers and to end users, provided that this does not compromise confidentiality or entail substantial costs. Such data sharing increases the value of the O*NET resource and generates knowledge that is potentially invaluable to researchers, policy makers, and ultimately the O*NET Center itself.

This data sharing must be governed by transparent and consistently applied policies that stipulate what data are available and how they are accessed. Nowhere is this issue more salient than in the provision of individual-level O*NET survey data (also referred to as microdata) for research. O*NET microdata offer a potentially rich research resource; using them, researchers can explore detailed questions that cannot be adequately

addressed using aggregate, occupation-level data available on the O*NET website. Authorizing qualified researchers to access O*NET microdata for purposes of analysis and publication would encourage the growth of a body of research to address these types of important research questions. Such a body of research would complement studies using individual-level O*NET data published by research groups that include one or more members of the O*NET development team (e.g., Dierdorff and Morgeson, 2007, 2009; Dierdorff, Rubin, and Morgeson, 2009; Peterson et al., 1999).

Sharing individual-level O*NET data with outside researchers also entails risks; if researchers breach the survey's confidentiality, this will compromise cooperation between respondents and government surveyors. Thus, data sharing must be thoughtfully managed and carefully overseen. Federal statistical agencies have developed several approaches to managing access to data sets, such as removing all direct and indirect identifiers, making confidentiality edits, restricting access to qualified researchers who agree to confidentiality protections, and establishing disclosure review boards to oversee all data sharing activities (National Research Council, 2007, 2009).

CONCLUSIONS AND RECOMMENDATIONS

Many of the panel's recommendations related to the content model and data collection would address the shortcomings discussed in this chapter. In addition, we conclude that, although researchers, especially those in labor market studies and human resource research, increasingly make use of O*NET, they are limited in their analyses by the lack of demographic and other data on the respondents and the lack of access to individual-level data. They are also limited by lack of access to previous versions of the database, in order to conduct longitudinal studies of changes in the skills and other requirements of jobs.

Recommendation: To increase researchers' access to O*NET data, the Department of Labor, with advice and guidance from the technical advisory board recommended in Chapter 2 and the user advisory board recommended in Chapter 6, should actively inform the research community about the detailed information on samples obtained in each occupation that is currently available and provide additional detailed information including: the survey response rate, the date ranges of survey responses collected, etc.[2]

[2]The wording in this recommendation was slightly modified from the prepublication version to state correctly that DOL does provide information on samples obtained in each occupation on the O*NET website.

Recommendation: The Department of Labor, with advice and guidance from the technical advisory board and the user advisory board, should consider the feasibility of making available additional statistics (in addition to means) for survey responses in each occupation, such as median, standard deviation, 25th percentile, and 75th percentile. In addition, DOL should consider the feasibility of making available data on the demographic characteristics of respondents in each occupation, including income,[3] education, gender, race, and age.

Recommendation: The Department of Labor, with advice and guidance from the technical advisory board and the user advisory board, should explore the possibility of making the availability of successive waves of O*NET survey responses for each occupation (with dates) widely known to the research community, for use in longitudinal analysis.[4]

Recommendation: The Department of Labor and the O*NET Center, with advice and guidance from the technical advisory board and the user advisory board, should draw up policies allowing researchers to access individual-level data and communicate these policies clearly to DOL and O*NET Center staff, contractors, and outside researchers. These policies should include appropriate techniques to protect individual privacy, such as restricting access to qualified researchers who agree to confidentiality protections.

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[3]According to officials at DOL, income information is not currently collected in O*NET surveys.

[4]The wording in this recommendation was slightly modified from the prepublication version to more accurately reflect that DOL currently does retain successive waves of O*NET survey data and to emphasize the importance of making that information more widely known.

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Part III

Recommendations

10

Recommendations for the Future of O*NET

The preceding chapters have reviewed evidence related to the quality of the O*NET database and its uses, offering many specific recommendations for improvement. Because it may not be possible for the U.S. Department of Labor (DOL) to immediately implement all of these recommendations, this chapter presents the panel's perspective on the relative importance of its various recommendations. The recommendations are divided into two categories, reflecting the twin goals of O*NET, to develop a high-quality database and to enhance service to O*NET users. The following section presents recommendations for a high-quality database, ranked in order of importance, and the second section of the chapter presents recommendations to enhance service to users, also ranked in order of importance. Although the recommendations can be roughly divided into these two categories, it is important to note that many recommendations are designed to improve database quality and enhance service to users simultaneously.

RECOMMENDATIONS FOR A HIGH-QUALITY DATABASE

The panel offers two primary recommendations aimed at the goal of developing and maintaining a high-quality database of occupational information.

Recommendation: The Department of Labor should focus O*NET resources on the core functions of collecting, maintaining, and publishing high-quality data, leaving development of most new applications and

tools to the private sector, state and local governments, and educational institutions.

Recommendation: The Department of Labor should establish and support an external technical advisory board, comprised of senior scientists, to develop a research agenda for O*NET that will prioritize research suggestions from its members, the department, the O*NET Center, the user advisory board recommended below, and other sources. At a minimum, it should meet twice yearly, once to establish research priorities for the coming year and develop requests for proposals reflecting these priorities and once to review and rank proposals submitted by academic researchers or contractors.

The panel views these two recommendations as offering the greatest potential for enhancing the quality of the database. In particular, establishing an external technical advisory board will assist DOL in managing the research agenda as changes in the labor market, O*NET user needs, the scientific research, and agency goals lead to changes in research needs and priorities.

Research and Development Agenda

The following list of research recommendations represents the panel's best judgment of current research needs, based on its review of the evidence. Although the list is presented in order of perceived importance, as viewed by the panel at this time, it is not immutable. Other factors, such as costs and contingencies associated with the research, in addition to its perceived importance, should be considered in defining the order in which the research is undertaken. The panel expects that, in the future, the proposed technical advisory board will assist DOL in making decisions about which of these proposed research activities may be most important to undertake in any given year.

The panel views three specific research activities as most important:

1. **Conduct research on the content model, beginning with the Skills and Knowledge domains (Chapter 2).**
2. **Assess benefits and costs of changing the occupational classification system (Chapter 3).**
3. **Study the behaviorally anchored rating scales (Chapter 4).**

The panel also recommends investigation of eight other issues, presented below in order of importance:

1. **Explore development of Detailed Work Activities (Chapter 6).**
2. **Review the sampling design (Chapter 4).**
3. **Explore ways to increase response rates (Chapter 4).**
4. **Research frequency of refreshing the survey data (Chapter 4).**
5. **Review content model for descriptor completeness and other concerns of the human resource management community (Chapter 7).**
6. **Investigate within-occupation variation in physical and cognitive requirements (Chapters 3 and 8).**
7. **Develop profiles at each level of each domain (Chapter 2).**
8. **Investigate methods to describe changing jobs, including new sampling frames (Chapter 7).**

RECOMMENDATIONS TO ENHANCE SERVICE TO USERS

The panel offers two primary recommendations, which it views as having the greatest potential to enhance service to O*NET users:

Recommendation: The Department of Labor should establish and staff an ongoing, external user advisory board, including at least one representative of each major user group, as well as representatives of potential users in the U.S. military and in K-12 and higher education. The board should meet regularly to provide advice and recommendations to the Department of Labor regarding processes for identifying users' evolving needs and communicating information about O*NET and its uses. New marketing and educational strategies must be aligned with the reality that, for many users, O*NET provides building blocks (rather than ready-made solutions or final answers) toward more complete solutions.

In addition, DOL should ask the user advisory board to review proposals for modifications, enhancements, and applications of O*NET from a user's perspective and provide advice to DOL regarding the potential benefits and adverse effects of these modifications and enhancements to the user communities.

Recommendation: The technical advisory board, in consultation with the user advisory board, should establish and execute a framework for evaluating uses of O*NET that includes

1. **Development of evaluation metrics aligned with various uses of O*NET.**
2. **Review of the usefulness and accuracy of existing information on O*NET uses.**

3. **Development of methods to evaluate the adequacy of existing processes for obtaining feedback from O*NET users systematically.**
4. **Development of new methods to systematically and continuously obtain information about the users of O*NET, the ways in which it is used, the frequency of use, reasons it is not used or might not be appropriate for certain suggested uses, user community awareness of O*NET, the specific applications it is used for, user satisfaction, and objective measures of effectiveness or success in meeting user needs.**

The panel views three activities as valuable to enhance service to O*NET users, presented below in order of importance, as ranked by the panel:

1. **Update the crosswalk to the Classification of Instructional Programs (Chapter 6).**
2. **Create an interagency task force on disability determination (Chapter 8).**
3. **Make the database available in SQL (Chapter 5).**

Additional user recommendations, while valuable, are not viewed as equally important to those above. These recommendations are presented below in order of importance, as ranked by the panel:

- **Develop new tools for dissemination of O*NET information in the human resource management community (Chapter 7).**
- **Evaluate crosswalks with military occupations (Chapter 6).**
- **Promote use in workforce development community (Chapter 6).**
- **Conduct usability study of web interface (Chapter 5).**
- **Make individual-level data available for research with privacy protections (Chapter 9).**
- **Make additional statistics for survey responses available (Chapter 9).**
- **Provide detailed information on samples within each occupation (Chapter 9).**
- **Make the availability of successive waves of survey responses more widely known to researchers (Chapter 9).**
- **Explore using Wiki to build a user community and gather data that should not be used as a replacement for systematically collected data (Chapter 5).**
- **Explore potential of the Semantic Web to disseminate database (Chapter 5).**

DOL should not wait to initiate the research and development recommended by the panel until the technical advisory board and user advisory boards have been constituted and are fully functioning, but should proceed with continuous improvement initiatives using its traditional advisers until these boards can be established. The department should also establish mechanisms for ongoing communication between the user advisory board and the technical advisory board we recommend.

Appendixes

Appendix A

Dissent

Juan I. Sanchez and David H. Autor

ISSUES OF CONTENTION

We believe the report could have provided more expedited solutions on three issues: (1) deletion of scales, (2) weaknesses of descriptors and scales, and (3) whether information on some content domains could be eliminated. In our opinion, none of the recommendations in the report acknowledges that these concerns can be at least partly addressed through immediate modification of the O*NET measurement model without diminishing the utility of the overall database; we believe that such modifications would be supported by the extant O*NET data and do not need to await further research.

ARGUMENTS IN SUPPORT OF THE MINORITY VIEW

We believe the latest O*NET 14.0 database provides empirical evidence of redundancy of descriptors between scales and also within and across domains. First, the data strongly suggest that the importance and level scales are highly redundant. Indeed, their bivariate correlations computed across the various items in each domain and across the 832 occupations included in the 14.0 database are as follows:

Domain	Importance × Level Pearson Correlation
Generalized Work Activities	.92**
Abilities	.97**
Skills	.95**
Interests	.97**
Knowledge	.97**

** = $p < .01$

These correlations suggest that the ranking of items does not change for practical purposes regardless of which scale, importance or level, is employed. Although correlations between the importance and the level scale might be smaller if individual-level data were used, such data are not made available to the public and, therefore, O*NET users rely solely on the aggregate ratings (i.e., average ratings across approximately 25 respondents) extracted from the O*NET 14.0 database for these analyses.

An analysis of variance components using the same database supported the finding that the type of scale, namely level or importance, has practically negligible effects (3 percent or less variance) on the ratings:

Descriptor	Percentage of Variance Accounted for by Scale (i.e., importance versus level)
Generalized Work Activities	.50
Abilities	3.00
Skills	1.54
Interests	1.32
Knowledge	1.31

Between the two scales, the questionable and often disconcerting behavioral anchors (see Chapter 4) placed at the various points of the *level* scale strengthen the case for its elimination. The elimination of the level scale will cut more than 150 items from the surveys, thereby cutting survey costs and possibly increasing response rates. Unlike the level scale, other scales (e.g., frequency or duration) may provide independent, valuable, and incremental occupational information above and beyond the information provided by the importance scale, and their potential inclusion warrants further cost-benefit analysis.

We believe there are compelling reasons for at least the temporary suspension of the procedure currently employed to measure the ability and the skill domains, which are rated by trained analysts on the basis of a methodically assembled yet paper-based description of the job. First, these analysts do not have a chance to interview or observe actual occupational incumbents to help them formulate their ratings. The evidence indicating adequate interrater reliability among analysts suggests that they consistently rate abilities and skills, but interrater agreement does not imply validity. Second, a factor analysis of the ability ratings in the 14.0 database confirms the presence of substantial data redundancy among the ratings of the 52 abilities included in this particular domain. That is, a single factor accounts for 43 percent of the variance in ability ratings. There is also quite a bit of empirical redundancy between the two domains currently populated by analyst ratings, namely the ability and skill domains, on one hand, and

the domains of generalized work activities and work context populated by incumbent ratings, on the other. That is, a statistical regression of any ability or any skill rating on the set of generalized work activities and work context ratings reveals statistically reliable multiple R correlations ranging from .65 to .98, $p < .01$, even after correcting for shrinkage. Therefore, analyst-based ability and skill ratings can be reliably predicted using simple linear combinations of incumbent-based ratings in other domains.

Eliminating analyst-based ratings of abilities and skills would cut almost 90 additional items from the surveys, hence lowering data collection costs and possibly increasing response rates. However, current uses of skill and ability ratings would not need to be disrupted until a better measurement procedure to estimate these domains is developed. Indeed, current users could resort to the mechanical estimates based on incumbent ratings from other domains, which provide practically equivalent values (as mentioned, Pearson R correlations between analyst ratings and mechanical estimates range from .65 to .98). In future waves of data collection, these estimates could be automatically computed and added to the O*NET database in lieu of the analyst-based ratings.

Appendix B

Descriptor Taxonomies Included in the Content Model

ABILITIES TAXONOMY (PROTOTYPE AND CURRENT)

- Cognitive Abilities
  - Verbal abilities
    - Oral comprehension
    - Written comprehension
    - Oral expression
    - Written expression
  - Idea generation and reasoning abilities
    - Fluency of ideas
    - Originality
    - Problem sensitivity
    - Deductive reasoning
    - Inductive reasoning
    - Information ordering
    - Category flexibility
  - Quantitative abilities
    - Mathematical reasoning
    - Number facility
  - Memory
    - Memorization
  - Perceptual Abilities
    - Speed of closure
    - Flexibility of closure
    - Perceptual speed

- Spatial abilities
  - Spatial orientation
  - Visualization
- Attentiveness
  - Selective attention
  - Time sharing

Psychomotor Abilities

- Fine manipulative abilities
  - Arm-hand steadiness
  - Manual dexterity
  - Finger dexterity
- Control movement abilities
  - Control precision
  - Multilimb coordination
  - Response orientation
  - Rate control
- Reaction time and speed ability
  - Reaction time
  - Wrist-finger speed
  - Speed of limb movement

Physical Abilities

- Physical strength abilities
  - Static strength
  - Explosive strength
  - Dynamic strength
  - Trunk strength
- Endurance
  - Stamina
- Flexibility, balance, and coordination
  - Extent flexibility
  - Dynamic flexibility
  - Gross body coordination
  - Gross body equilibrium

Sensory Abilities

- Visual abilities
  - Near vision
  - Far vision
  - Visual color discrimination
  - Night vision
  - Peripheral vision
  - Depth perception
  - Glare sensitivity

Auditory and speech abilities
- Hearing sensitivity
- Auditory attention
- Sound localization
- Speech recognition
- Speech clarity

SOURCE: Adapted from Fleishman and Reilly (1992). Reprinted with permission.

WORK STYLES TAXONOMY (PROTOTYPE, CURRENT TAXONOMY SHOWN USING TRACK CHANGES)

Achievement Orientation
- Achievement/effort
- Persistence
- Initiative

Social Influence
- ~~Energy~~
- Leadership orientation

Interpersonal Orientation
- Cooperative
- Concern for others
- Social orientation

Adjustment
- Self-control
- Stress tolerance
- Adaptability/flexibility

Conscientiousness
- Dependability
- Attention to detail
- Integrity

Independence
- Independence

Practical Intelligence
- Innovative
- ~~Analytical~~ Analytical thinking

SOURCE: Adapted from Peterson et al. (1997). Reprinted with permission.

WORK VALUES TAXONOMY (PROTOTYPE, CURRENT TAXONOMY SHOWN USING TRACK CHANGES)

Factor
Achievement
    Ability utilization
    Achievement
~~Comfort~~ Working conditions
    Activity
    Independence
    Variety
    Compensation
    Security
    Working conditions
~~Status~~ Recognition
    Advancement
    Recognition
    Authority
    Social Status
~~Altruism~~ Relationships
    Coworkers
    Social service
    Moral values
~~Safety~~ Support
    Company policies
    Supervision, human relations
    Supervision, technical
Autonomy
    Creativity
    Responsibility
    Autonomy

SOURCE: Dawis and Lofquist (1984, Table 3-2, p. 29). Reprinted with permission.

KNOWLEDGE TAXONOMY (PROTOTYPE AND CURRENT)

Business and Management
1. Administration and management
2. Clerical
3. Economics and accounting
4. Sales and marketing
5. Customer and personal service
6. Personal and human resources

Manufacturing and Production
7. Production and processing
8. Food production

Engineering and Technology
9. Computers and electronics
10. Engineering and technology
11. Design
12. Building and construction
13. Mechanical

Mathematics and Science
14. Mathematics
15. Physics
16. Chemistry
17. Biology
18. Psychology
19. Sociology and anthropology
20. Geography

Health Services
21. Medicine and dentistry
22. Therapy and counseling

Education and Training
23. Education and training

Arts and Humanities
24. English language
25. Foreign language
26. Fine arts
27. History and archaeology
28. Philosophy and theology

Law and Public Safety
29. Public safety and security
30. Law, government, and jurisprudence

Communications
    31. Telecommunications
    32. Communications and media
Transportation
    33. Transportation

SOURCE: Adapted from Peterson et al. (1997, Figure 4-1). Reprinted with permission.

SKILLS TAXONOMY (PROTOTYPE, CURRENT TAXONOMY SHOWN USING TRACK CHANGES)

BASIC SKILLS

Content Skills
Active listening
Reading comprehension
Writing
Speaking
Mathematics
Science

Process Skills
Active learning
Learning strategies
Monitoring
Critical thinking

CROSS-FUNCTIONAL SKILLS

~~Problem-solving skills~~
Complex Problem-Solving
Complex problem-solving
~~Problem identification~~
~~Information gathering~~
~~Information organization~~
~~Synthesis/reorganization~~
~~Idea generation~~
~~Idea evaluation~~
~~Implementation planning~~
~~Solution appraisal~~

Social Skills
Social perceptiveness
Coordination
Persuasion
Negotiation
Instruction
Service orientation

Technical Skills
Operations analysis
Technology design
Equipment selection
Installation
Programming
~~Testing~~ Quality control analysis
~~Production inspection~~
Equipment maintenance
Troubleshooting
Repairing

Systems Skills
~~Visioning~~
Systems ~~perception~~ analysis
~~Identification of downstream consequences~~
~~Identification of key causes~~
~~Judgment and evaluation~~
Judgment and decision making
Systems evaluation

Resource Management Skills
Time management
Management of financial resources
Managing material resources
Managing personnel resources

SOURCE: Adapted from Peterson et al. (1997, Figure 3-1). Reprinted with permission.

GENERALIZED WORK ACTIVITIES TAXONOMY (PROTOTYPE, CURRENT TAXONOMY SHOWN USING TRACK CHANGES)

Information Input
- Looking for and receiving job-related information
- Getting information ~~needed to do the job~~
- ~~Monitoring processes, materials, and~~ or ~~surroundings~~
- Identifying/evaluating job-relevant information
  - Identifying objects, actions, and events
  - Inspecting equipment, structures, or materials
  - ~~Estimating the~~ quantifiable ~~characteristics of materials, products, events, or information~~

Mental Processes
- Information/data processing
  - Judging the qualities of objects, services, or persons
  - Processing information
  - Evaluating information for compliance to standards
  - Analyzing data or information
- Reasoning/decision making
  - Making decisions and solving problems
  - Thinking creatively
  - Updating and using job-relevant knowledge
  - Development objectives and strategies
  - Scheduling work and activities
  - Organizing, planning and prioritizing work

Work Output
- Performing physical and manual work activities
  - Performing general physical activities
  - Handling and moving objects
  - Controlling machines and processes
  - Operating vehicles and mechanized devices or equipment
- Performing complex/technical activities
  - Interacting with computers
  - Drafting, laying out, and specifying technical devices, parts, or equipment
  - ~~Implementing ideas, programs, systems, or products~~
  - Repairing and maintaining mechanical equipment
  - Repairing and maintaining electronic equipment
  - Documenting and recording information

Interacting with Others
- Communicating/interacting
  - Interpreting the meaning of information for others
  - Communicating with supervisors, peers, or subordinates

- Communicating with persons outside the organization
- Establishing and maintaining interpersonal relationships
- Assisting and caring for others
- Selling or influencing others
- Resolving conflicts and negotiating with others
- Performing for or working directly with the public

~~Coordinating/developing/managing/advising others~~ Coordinating, Developing, Managing, and Advising

- Coordinating the work and activities of others
- Developing and building teams
- Training and ~~Teaching others~~
- Guiding/directing and motivating subordinates
- Coaching and developing others
- Providing advice and consultation to others

Administering

- Performing ~~Accomplishing~~ administrative activities
- Staffing organizational units
- Monitoring and controlling resources

SOURCE: Adapted from Peterson et al. (1997, Figure 6-2). Reprinted with permission.

WORK CONTEXT TAXONOMY (PROTOTYPE, CURRENT TAXONOMY SHOWN USING TRACK CHANGES)

Interpersonal Relationships
- Communication
- Role relationships
- Responsibility to others
- Conflictual contact

Physical Work Conditions
- Work setting
- Environmental conditions
- Job hazards ~~Demands~~
- Body positioning
- Work attire

Structural Job Characteristics
- Criticality of position
- Routine vs. challenging work
- Pace and scheduling
- Competition

NOTE: The higher order factors within the prototype and current taxonomies are shown. The list does not include the specific descriptors.
SOURCE: Adapted from Peterson et al. (1997, Figure 7-2). Reprinted with permission.

Appendix C

Biographical Sketches of Panel Members and Staff

Nancy T. Tippins (*Chair*) is managing principal and senior vice president of the Valtera Corporation. She manages the firm's development and execution of strategies related to job analysis, competency development, employee selection, assessment, and leadership development. She oversees the teams that develop legally and professionally compliant tools, administrative processes, and delivery platforms to meet client staffing, assessment, and succession planning requirements. She has a long-standing involvement with the Society for Industrial and Organizational Psychology (SIOP), serving as president in 2000-2001. She is a fellow of SIOP and the American Psychological Association and is involved in several private industry research groups. She has authored or coauthored numerous journal articles on assessment, is associate editor for the Scientist-Practitioner Forum of Personnel Psychology, and serves on the editorial board of the *Journal of Applied Psychology*. She has M.S. and Ph.D. degrees in industrial and organizational psychology from the Georgia Institute of Technology and an M.Ed. in counseling and psychological services from Georgia State University.

David Autor is professor of economics at the Massachusetts Institute of Technology. His research specializes in human capital and earnings inequality; labor market impacts of technological change; contingent and intermediated work arrangements; health, disability, and labor supply; and employment protection and labor market operation. His recent work has used the O*NET system as a source of information on skill demands. He is a faculty research fellow at the National Bureau of Economic Research and will soon be editor in chief of the *Journal of Economic Perspectives*.

He has M.A. and Ph.D. degrees in public policy from the John F. Kennedy School of Government at Harvard University.

John P. Campbell is professor of psychology and professor of human resources and industrial relations at the University of Minnesota. For over 30 years he has been involved in research on occupational analysis, individual performance assessment, and personnel selection and classification. He served as associate editor and then editor of the *Journal of Applied Psychology* from 1973 to 1982. He has served as president of the Society for Industrial and Organizational Psychology and received its career award for distinguished scientific contributions to industrial and organizational psychology in 1992. He also has over 20 years of experience as the principal scientist on a series of projects dealing with the selection and classification of U.S. Army enlisted personnel, the most extensive of which was Project A, which is the topic of his most recent book, *Exploring the Limits in Personnel Selection and Classification* (coauthored with Deirdre Knapp). In 2006 he received the American Psychological Association Award for distinguished scientific contributions to the application of psychology. He has a Ph.D. in psychology from the University of Minnesota.

Keith Ewald is director of the Bureau of Labor Market Information in the Office of Workforce Development at the Ohio Department of Job and Family Services. He has over 25 years of experience in public information management and dissemination. Among his major responsibilities is managing the workforce information programs of the state of Ohio for the U.S. Bureau of Labor Statistics and Employment and Training Administration. As part of this process, the Bureau of Labor Market Information is a primary provider of public information regarding industry, occupational, and general workforce statistics. Access to this information has greatly expanded via Internet services. Previously he managed the Office of Research in the Ohio Department of Development. He has a Ph.D. in sociology from the Ohio State University.

Richard Froeschle is deputy director of labor market and career information for the Texas Workforce Commission. He has responsibility for grant programs of the U.S. Department of Education and the U.S. Department of Labor in the areas of labor market and career information, economic development, statistical development, dissemination and training. He had primary responsibility for implementing the O*NET database into the Texas skills transferability system. He has an M.S. in labor and industrial relations from the University of North Texas.

Margaret L. Hilton (*Study Director*) is senior program officer of the Center for Education in the Division of Behavioral and Social Sciences and Education. She recently directed a workshop on science education and 21st century skills, building on the 2008 report, *Research on Future Skill Demands: A Workshop Summary.* She has directed and contributed to studies of high school science laboratories, the role of state standards in K-12 education, foreign language and international studies in higher education, international labor standards, and the information technology workforce. Prior to joining the National Research Council, Hilton was a consultant to the National Skill Standards Board. Earlier, at the Congressional Office of Technology Assessment, she directed studies of workforce training, work reorganization, and international competitiveness. She has a B.A. in geography (with high honors) from the University of Michigan, a master of regional planning degree from the University of North Carolina, Chapel Hill, and a master of human resource development degree from George Washington University.

Les Janis is director of the Georgia Career Information Center at Georgia State University, serving since its inception in 1977. The center, through its Georgia Career Information System, provides occupational and educational information to the schools and agencies throughout the state. In cooperation with the Georgia Department of Education, the center helps conduct the state's Career Resource Network activities. Janis chairs the National Occupational Supply Demand Consortium. He has an M.A. in counseling from Miami University.

Virginia Lesser is director of the Survey Research Center at Oregon State University, where she also serves as associate professor in the Statistics Department. Her research interests are in sampling, survey methodology, environmental statistics, and applied statistics. She has written on nonsampling error, the effects of item and unit nonresponse on nonresponse error, and multiphase sampling. She has a Ph.D. in biostatistics from the University of North Carolina and an undergraduate degree in biology.

Kerry Levin, an experimental social psychologist, is associate director at Westat, Inc., with more than 20 years of project management experience. She is currently managing several blanket purchase agreements for various federal agencies. She is experienced in managing these types of contracts and ensuring the necessary resources are secured for all tasks. She has conducted large web surveys related to customer service and evaluation for agencies that include the National Institute of Standards and Technology (NIST), the Internal Revenue Service, and the U.S. Patent and Trademark

Office. She specializes in survey design, administration, and analysis. She has also been involved in several methodological feasibility studies for the Bureau of Labor Statistics and NIST to identify the most cost-effective procedures for collecting data from individuals in business establishments. She has a Ph.D. in experimental/social psychology from Vanderbilt University.

Kenneth Pearlman, currently in an independent consulting practice in Sarasota, Florida, is an industrial-organizational psychologist who has specialized in research and applications in the areas of personnel selection and assessment, work and skill analysis, person-job matching, and productivity measurement and enhancement. He has been involved in a number of federal and military work analysis and assessment-related initiatives, including revision of the U.S. Department of Labor's *Dictionary of Occupational Titles* (what is now O*NET), and consultation to the National Skills Standards Board. He also serves on review and advisory panels for U.S. Army Research Institute personnel and classification research projects. He is on the editorial boards of *Personnel Psychology* and the *International Journal of Selection and Assessment* and served for 8 years on the editorial board of the Society for Industrial and Organizational Psychology's (SIOP's) professional practice book series. He is coholder of a U.S. patent on an innovative job analysis software tool. At the National Research Council, he was a member of the Board on Testing and Assessment. He is a fellow of the American Psychological Association, the American Psychological Society, and SIOP.

Thomas J. Plewes (*Associate Study Director*) is senior program officer of the Committee on National Statistics in the Division of Behavioral and Social Sciences and Education. He has directed studies of the Agricultural Resources Management Survey, the state and local government statistics program of the Census Bureau, the use of the American Community Survey for the National Science Foundation science and engineering workforce statistics, and international trade traffic statistics. He has supported initiatives with the U.S. General Accounting Office on key national indicators of performance. Prior to joining the National Research Council staff, he was associate commissioner for employment and unemployment statistics of the Bureau of Labor Statistics, where he had responsibility for the nation's labor force and occupational data. In that position, he directed major revisions of the standard industrial and occupational classification systems. He is a fellow of the American Statistical Association and was a member of the Federal Committee on Statistical Methodology. He has a B.A. from Hope College and an M.A. from George Washington University.

Ann Marie Ryan is professor of organizational psychology at Michigan State University. She was employed for several years at Bowling Green State University, where she directed the Institute for Psychological Research and Application. She has published widely on the topics of fairness in organizational decision-making processes, contextual and nonability factors in employee selection, applicant perceptions of fairness, recruitment and job search, diversity in organizations, and employee assessment tools. She is a fellow of the Society for Industrial and Organizational Psychology (and recently completed a term as president), the American Psychological Association, and the American Psychological Society. Currently she serves as editor for *Personnel Psychology*. She has also long maintained consulting relationships with both public- and private-sector organizations. She has a Ph.D. from the University of Illinois at Chicago.

Juan I. Sanchez is professor of management and international business and Knight-Ridder Byron Harless Chair in Management at Florida International University. He has published approximately 60 articles in refereed journals. He has served in the editorial boards of the *Journal of Applied Psychology, Personnel Psychology, International Journal of Selection and Assessment, Group and Organization Management,* and currently serves as associate editor for the *Journal of Occupational and Organizational Psychology.* A Fellow of the American Psychological Association and the Society for Industrial and Organizational Psychology, he has consulted with government agencies and private organizations in the United States, Europe, and Latin America. He has M.A. and Ph.D. degrees from the University of South Florida, Tampa.

William Shobe is director of business and economics research of the Weldon Cooper Center for Public Service at the University of Virginia. His research interests include economic analysis of regulations in Virginia and annual tax rates surveys for Virginia localities. He has developed a distributed data store design for Virginia government and serves as a member of the Unemployment Insurance Trust Fund Advisory Committee of the Virginia Unemployment Commission. He has a Ph.D. in economics from the University of Minnesota.

COMMITTEE ON NATIONAL STATISTICS

The Committee on National Statistics (CNSTAT) was established in 1972 at the National Academies to improve the statistical methods and information on which public policy decisions are based. The committee carries out studies, workshops, and other activities to foster better measures and fuller understanding of the economy, the environment, public health, crime, education, immigration, poverty, welfare, and other public policy issues. It also evaluates ongoing statistical programs and tracks the statistical policy and coordinating activities of the federal government, serving a unique role at the intersection of statistics and public policy. The committee's work is supported by a consortium of federal agencies through a National Science Foundation grant.