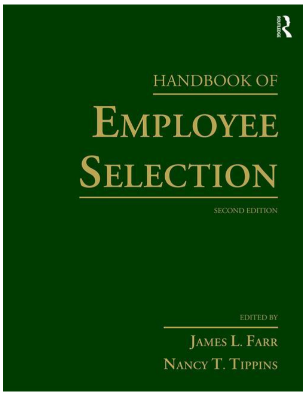

Handbook of Employee Selection

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6

Work Analysis

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The purposes of this chapter are to describe and summarize the current state of the art with respect to work analysis as it applies to employee or personnel selection and to suggest expansions of such applications in light of emerging and anticipated changes in the world of work. We use the term "work analysis" broadly to refer to any systematic process for gathering, documenting, and analyzing information about (a) the content of the work performed by people in organizations (e.g., tasks, responsibilities, or work outputs), (b) the worker attributes related to its performance (often referred to as knowledge, skills, abilities, and other personal characteristics, or KSAOs), or (c) the context in which work is performed (including physical and psychological conditions in the immediate work environment and the broader organizational and external environment). Other terms, such as "job analysis," "occupational analysis," and "job specification" are often used, sometimes interchangeably and with somewhat varying definitions in different contexts, to refer to one or more of these activities. Our use of "work analysis" reflects our preference for a broader term that does not connote a focus on any particular aspect or unit of analysis in the study of work.

This chapter is organized into major sections, including "Traditional Selection-Related Applications of Work Analysis" examines the primary applications of selection-oriented work analysis. "A Review of Major Work Analysis Methods and Approaches" provides a review and analysis of major historical work analysis methods that have been used to support personnel selection. "Key Work Analysis Practice Issues" is devoted to several key issues that arise in the practical application of work analysis to personnel selection. "Frontiers of Work Analysis: Emerging Trends and Future Challenges" discusses several emerging trends, issues, and challenges that we see as critical to the continuing and future relevance and utility of selection-oriented work analysis; we also consider applying work analysis techniques that have yet to be used for selection. "Synopsis and Conclusions" summarizes and draws some general conclusions on the basis of the material presented in the main sections.

TRADITIONAL SELECTION-RELATED APPLICATIONS OF WORK ANALYSIS

Work analysis is seldom an end in itself but is almost always a tool in the service of some application, a means to an end. We view it as axiomatic that options or alternatives regarding specific work analysis methods and practices cannot be meaningfully considered without also specifying their context or application, because this drives every facet of work analysis. Organizational goals and strategy should drive selection system goals and strategy, which in turn should drive work analysis strategy, which then serves as the basis for the many specific decisions involved in designing a particular work analysis system, program, or project.

Broadly speaking, the purpose of work analysis for personnel selection applications is to ensure that selection systems are work- or job-related, and hence valid, and thereby have value or utility for the organization, as well as being legally defensible. Within this context, four general categories of work analysis application can be distinguished, as follows.

Work Analysis for Predictor Development

There are two phases to this application. First is the use of work analysis to make inferences about the person requirements of work, that is, to determine what worker attributes or KSAOs (perhaps also including at what level of proficiency) are needed to carry out the work. The second phase involves linking appropriate measures to the KSAOs generated in phase one, such as tests of particular abilities or skills.

Work Analysis for Criterion Development

Work analysis provides the information needed to understand the content (work activities, behaviors, or outcomes) and context (both the broader organizational and more specific work setting) of work performance, and in so doing it provides the basis for developing work performance measures or standards. Such measures or standards can, in turn, serve as criteria for formally evaluating individual employee selection tools or an overall selection system; for example, in the context of a criterion-related validation study. These criterion measures often take the form of specific dimensions of work activity, along with associated rating scales, but can also take the form of more objectively observable indices (production or error rates) or work sample measures.

Work Analysis for Domain Sampling

This refers to the application of work analysis to the development of content-related evidence in support of a selection procedure's validity (more commonly referred to as "content validity"). For such applications, work analysis is used to define a work domain or a job's content domain in terms of the important tasks, activities, responsibilities, or work behaviors performed and their associated worker requirements, or KSAOs. Measures of the work content, or a selected subset of associated KSAOs, are then developed and judgmentally linked back to the content domain by subject matter experts (SMEs). Essentially, an argument is made that the test content samples the job domain in a representative way. Validity is a function of the strength of these (measure-content domain) linkages, which in turn are a function of the quality of the original work analysis, the quality of the experts, and the rigor of the linkage process.

Work Analysis for Validity Evidence Extension

This refers to the application of work analysis to methods for inferring a selection procedure's validity for a given job or work setting without actually conducting a validation study in the new setting. Three distinguishable approaches for justifying such inferences are commonly recognized: (a) validity generalization or meta-analysis, (b) synthetic or job-component validity, and (c) validity transportability (McPhail, 2007). Validity generalization, a form of meta-analysis applied specifically to the personnel selection context (Pearlman, Schmidt, & Hunter, 1980), involves a series of statistical analyses performed on a set of criterion-related correlation coefficients accumulated from archival sources to determine (a) a reliable estimate of association for the predictor-criterion (or job) combination represented in the set and (b) the degree to which this estimate varies by location (see Chapter 4). Synthetic validity encompasses several methods that involve the use of structured work analysis questionnaires that can be scored in terms of work dimensions or job components, each of which has pre-established relationships (generally via prior criterion-related validation work or expert estimation) with one or more predictor constructs or measures (e.g., cognitive abilities). When a new job is analyzed with this questionnaire and its component dimensions are scored, predictor measure validity for the new job can be inferred or computed from these known predictor-criterion relations (McPhail, 2007). Validity transportability refers to use of a specific selection procedure in a new situation based on results of a validation study conducted elsewhere.

Work analysis is fundamental to establishing the strength of the inference of job-relatedness in all three approaches to validity evidence extension, albeit in different ways. For validity generalization and validity transportability, the key issue is establishing similarity between a job (or job group) for which validity evidence has been obtained in one setting and the target job to which one wishes to generalize or "transport" that evidence. Consequently, the key question is, "How similar is similar enough?" Research suggests that a relatively molar or high-level work analysis (e.g., sufficient to classify the target job into a broadly defined job family) may be sufficient for some applications, because even relatively large task differences between jobs do not moderate the validity of many types of ability tests (Schmidt, Hunter, & Pearlman, 1981); however, data are sparse for tests of more specific knowledge, skills, and other characteristics. By its nature, synthetic validity requires a fairly detailed work analysis; however, the precise form of the work analysis is dictated by the characteristics of the focal work analysis questionnaire on which the predictor–job dimension relationships were originally established. Validity transportability applications legally require the target job to consist of "substantially the same major work behaviors" as that (or those) on which the focal validation work was conducted (Equal Employment Opportunity Commission, 1978), implying the need for at least a somewhat detailed level of work analysis. Such issues, as well as various approaches to job similarity evaluation, are considered in depth elsewhere (Harvey, 1986; Pearlman, 1980; Sackett, 2003).

A REVIEW OF MAJOR WORK ANALYSIS METHODS AND APPROACHES

Work Analysis Information Framework

Work analysis methods can be broadly differentiated in terms of the process they use to compile, analyze, and present work analytic information and the content of such information. Work analysis *processes* can in turn be broadly differentiated in terms of whether they are primarily qualitative or quantitative. Qualitative approaches build up work or job information, often from scratch (e.g., on the basis of observing or interviewing job incumbents to determine specific tasks performed) and generally one job at a time, yielding detailed, narrative information that is customized to individual jobs or specific work within an organization. Quantitative approaches are generally based on the use of structured work analysis questionnaires or surveys consisting of pre-established lists of different types of work or job descriptors (i.e., work characteristics or units of analysis, such as work behaviors, worker functions, or KSAOs). These usually include rating scales that permit subject matter experts (SMEs; incumbents, supervisors, or job analysts) to quantify their judgments about individual descriptors along dimensions of interest (e.g., performance frequency, importance, level of complexity, and consequences of error).

Work analysis *content* refers to the types of work descriptors used and the level of analysis or detail represented by these descriptors. McCormick (1979) has usefully distinguished among three broad descriptor categories, including (in slightly adapted form) (1) *work-oriented content descriptors*, in which the descriptive frame of reference is the work to be done, including the purpose, steps, tools and materials, required resources, and conditions under which work is accomplished (e.g., tasks, activities, duties, responsibilities, working conditions, and work outputs); (2) *worker-oriented content descriptors*, in which the descriptive frame of reference is what workers do to carry out work (e.g., worker functions, processes, or behaviors); and (3) *attribute requirement descriptors*, in which the descriptive frame of reference is the attributes needed by a worker to

TABLE 6.1
Work Analysis Information Framework

Work Descriptor Category	Level of Description/Analysis: Broad	Moderate	Specific
Work-oriented content	Major duties Major responsibilities	Task clusters or work activities Work functions or processes Material, equipment, tool, and machine categories	Tasks or work steps Work outputs Specific materials, equipment, tools, and machines Work-content-based performance standards Specific work environment features and working conditions
Worker-oriented content	Position/job/ occupational titles	Generalized work behaviors Worker functions or processes	Worker-behavior-based performance standards Behavioral indicators
Attribute requirements	Personality traits, values, and interests Aptitudes and abilities	Generic or cross-functional skills	Specialized/technical skills Specialized/technical knowledge

do the specified work (e.g., skills, knowledge, abilities, and temperaments or dispositions). Distinctions among these categories can at times be blurry because of some natural overlap and the unavoidable imprecision of language (e.g., the second and third categories are sometimes considered as a single "worker-oriented" or "attribute" category); nonetheless, they have proven to be conceptually useful.

Work descriptors can be further differentiated in terms of the level of analysis or description reflected by a particular category of descriptor. Work-oriented content descriptors can range from narrow and specific (such as tasks performed) to broad and general (such as major duties or responsibilities), as can worker-oriented content descriptors (ranging from specific behavioral performance indicators to broad position or job titles). Similarly, attribute requirement descriptors can be represented by very narrowly defined characteristics (specialized skills or knowledge) or very broadly defined human attributes (such as aptitudes and abilities or personality traits).

Table 6.1 illustrates how type of content and level of detail of work analysis play out in terms of specific descriptor types. It provides examples of descriptors representing each work descriptor category within each of three levels of analysis. Note that the qualitative-quantitative work analysis process distinction is not represented here but is represented in our later expansion of this table and associated text discussion of specific work analysis methodologies.

Review of Specific Work Analysis Methods, Systems, and Approaches

Because of space limits, our review considers "tried and true" methods only briefly. There are many sources of information on such methods (Brannick, Cadle, & Levine, 2012; Brannick, Levine, & Morgeson, 2007; Gael, 1988; Gatewood, Feild, & Barrick, 2008; Peterson, Mumford, Borman, Jeanneret, & Fleishman, 1999; Wilson, Bennett, & Gibson, 2012). Additionally, several authors provide a historical account of the development of work analysis (Mitchell & Driskell, 1996; Primoff & Fine, 1988; Wilson, 2007). Thus, rather than providing details of each technique, we provide a brief description of several of them, along with a summary table and a set of more specific references for the interested reader.

TABLE 6.2
Work Analysis Information Framework

Work Descriptor Category	Level of Description/Analysis: Broad	Moderate	Specific
Work-oriented content	Job Diagnostic Survey PPRF Work Styles PIC Checklist	Minnesota Job Description Questionnaire	TI/CODAP[a]
Worker-oriented content	*Dictionary of Occupational Titles* classification structure	Position Analysis Questionnaire	Cognitive Task Analysis[a] Critical Incident Technique[a]
Attribute requirements	Fleishman Ability Requirements Scales Holland Interest Taxonomy	SCANS Work Keys	Job Element Method[a] CIP-2000 Knowledge Taxonomy
Hybrid (multidescriptor and/or multilevel)	Competency Modeling[a] Functional Job Analysis[a] MOSAIC[a] O*NET[a] SHL Universal Competency Framework Strategic Job Modeling[a]		

[a] Method generates some or all of its information using qualitative processes (see earlier text discussion).

Table 6.2 illustrates how work analysis methods correspond to our framework; the methods contained in the table are intended to show the diversity of what is possible rather than to prescribe methods to the reader. Table 6.2 contains a row that Table 6.1 does not in order to account for hybrid methods that cut across contents. Some tabled items represent specific and well-defined instruments, methods, or programs, whereas others represent more general systems or approaches. The process aspect of these methods, discussed earlier, is represented in Table 6.2 by footnotes following methods that, partly or wholly, use qualitative data generation techniques; all other (nonfootnoted) methods use entirely quantitative methods.

Work-Oriented Content

At the broad end of the spectrum, the Job Diagnostic Survey (JDS; Hackman & Oldham, 1976) considers broad characteristics of jobs, such as the degree to which the job is autonomous. At the narrow end of the spectrum, Task Inventory/Comprehensive Occupational Data Analysis Programs (TI/CODAP) refers to a collection of computer programs and applications that analyze quantitative data collected from standardized task inventories. Following initial implementation in the U.S. Air Force in 1967, it was eventually adopted as the primary work analysis tool for all branches of the military and has expanded into widespread use in academia, business, industry, and federal, state, and local governments (Christal & Wiessmuller, 1988). An example of a moderately detailed method is the Minnesota Job Description Questionnaire (Dawis, 1991; Doering, Rhodes, & Kaspin, 1988; Tinsley & Weiss, 1971), which, like the JDS, contains a scale for autonomy but also contains related but more fine-grained scales such as independence, creativity, and achievement.

Worker-Oriented Content

The *Dictionary of Occupational Titles* (*DOT*) occupational classification structure that came to fruition in the *DOT*'s third edition (U.S. Department of Labor, 1965a) represents the synthesis of two classic work analytic methods—the Labor Department's analyst-based methodology

(Droege, 1988) and the Data-People-Things scales of Functional Job Analysis (Fine & Cronshaw, 1999). The *DOT* contains descriptors that would allow us to place it in multiple spots in the table, but it is placed in its current position because of extensive worker requirements information (education, aptitudes, knowledge, interests, temperaments, and physical demands) (U.S. Department of Labor, 1965b).

The Position Analysis Questionnaire (PAQ) is a structured questionnaire that describes jobs in terms of 27 standardized worker-oriented dimensions that are neither highly specific nor extremely broad and are common across nearly all jobs (McCormick, Jeanneret, & Mecham, 1972). It thus lends itself well to quantitative cross-job comparisons, job family development, and validity evidence extension applications; in particular, synthetic validity and validity transportability.

The Critical Incident Technique (Flanagan, 1954) involves SMEs recalling actual incidents of notably good and poor performance (observed behavior) in a target job, and analysts subsequently sorting and grouping these incidents by theme to develop job-specific selection tools (as well as performance measures, training programs, and other applications). Cognitive task analysis (Schraagen, Chipman, & Shalin, 2000) is a collection of techniques aimed at understanding how experts represent and process information during task performance (e.g., troubleshooting). Because they are closely coupled with specific tasks, cognitive task analyses tend to be job specific.

Attribute Requirements

The Fleishman Ability Requirement Scales (ARS) methodology is an outgrowth of several lines of programmatic research involving task characteristics and human ability taxonomies begun in the 1960s (Fleishman & Quaintance, 1984). This led to the development of a highly construct-valid set of 52 cognitive, physical, psychomotor, and sensory abilities, along with associated rating scales based on empirically calibrated task or behavioral anchors used to evaluate the ability requirements of tasks, broader job components, or entire jobs. Another broad set of individual differences intended to apply to all jobs is the Holland interest taxonomy, which sorts occupations into broad categories based on the kinds of interests that people share within the occupations (Holland, 1973, 1997). A taxonomy particularly well suited to managerial work is the SHL Universal Great 8 Competencies and sub-competencies (Bartram, 2005), which focuses on managerial functions such as analyzing and interpreting, creating and conceptualizing, and organizing and executing. Two approaches were designed to analyze jobs by personality requirements: the Personality-Related Position Requirements Form (PPRF; Raymark, Schmit, & Guion, 1997), based on the Big Five personality theory, and the Performance Improvement Characteristics (PIC) Checklist (J. Hogan, Davies, & Hogan, 2007), which aligns with the Hogan Personality Inventory (R. Hogan & Hogan, 1992). Moderately detailed approaches to identifying attribute requirements include the Secretary's Commission on Achieving Necessary Skills (SCANS, 1992) and Work Keys (McLarty & Vansickle, 1997). Finer-grained approaches include the Job Element Method (Primoff, 1975) and the CIP-2000 knowledge taxonomy, which is embodied in the U.S. Department of Education's current *Classification of Instructional Programs* (U.S. Department of Education, 2002).

Hybrid Systems

Several work analysis approaches aim to be useful for more than one purpose. Hence, they incorporate both work-oriented and worker-oriented descriptors. Functional Job Analysis (Fine & Wiley, 1971) generates carefully structured qualitative information about what a worker does (tasks) and quantitative information about how a task is performed in terms of the cognitive, interpersonal, and physical functions of a worker, as measured by hierarchically organized rating scales for data (information or ideas), people (coworkers, customers), and things (machines, equipment), as well as by additional rating scales for "worker instructions" (degree of work discretion) and general educational development, including reasoning, mathematical, and language demands (Fine & Cronshaw, 1999).

The U.S. Office of Personnel Management's Multipurpose Occupational Systems Analysis Inventory-Close-Ended (MOSAIC) system (Rodriguez, Patel, Bright, Gregory, & Gowing, 2002), which has become the federal government's primary work analysis system, is a multipurpose, automated, survey-based work analysis approach used to simultaneously collect information (from incumbents and supervisors) on many jobs within a broad occupational area.

The Occupational Information Network (O*NET™), treated in depth elsewhere in this volume (see Chapter 40), was developed by the U.S. Department of Labor in the mid-1990s (Peterson et al., 1999). O*NET was premised on the need for a comprehensive, theoretically based, and empirically validated common language that represented a hierarchical, taxonomic approach to work description and would therefore be capable of describing the characteristics of work and workers at multiple levels of analysis. Its centerpiece is the O*NET Content Model, which serves as the blueprint and integrating framework for the various descriptive components of the system. The content model encompasses six major domains of job descriptors representing some 20 individual job descriptor categories or taxonomies that reflect more than 270 work- and worker-oriented descriptors on which data are collected from trained analysts and job incumbents by means of structured questionnaires and surveys.

Strategic Job Modeling (SJM) is a term coined by Schippman (1999) to describe an approach to work analysis that can serve as a basis for integrated HR systems. Its core is a conceptual framework outlining the key descriptive elements on the work and person sides of the performance equation. The approach consists of a series of steps, suggested guidelines, procedures, and work aids for obtaining information on these descriptors within the context of a given SJM project.

Competency modeling (Schippman et al., 2000) is a form of work analysis that attempts to define constructs that apply across jobs and that distinguish superior performers; it attempts to connect the values of the organization to the behaviors of its employees. We describe this method in more detail in a later section. Here we merely note that competency modeling describes a host of activities that vary in rigor and managerial intent.

Work Analysis Methods Review: Some Practical Implications and Broader Perspectives

The preceding review indicates that practitioners have many choices when considering what method will best support a particular personnel selection application. There are several possible ways to narrow these choices. One is to view the specific selection-related applications discussed previously in terms of our work analysis information framework, as illustrated in Table 6.3. Broadly speaking, predictor development applications are likely to be best served by attribute requirement descriptors at any level of analysis, because selection tools are most commonly designed as measures of work-related KSAOs. Criterion development applications are best served either by work-oriented content descriptors at any level of analysis or worker-oriented content descriptors at a relatively specific level of analysis, because such information provides the most useful basis for developing relevant work performance measures. Validity evidence development (content validity) applications are best served by work-oriented content or attribute requirement descriptor information at a specific or possibly moderate level of analysis in which the necessary linkages between specific work content and attribute measures can be most readily made and documented. Existing research suggests that validity evidence extension applications are likely to be best served by worker-oriented content or attribute requirement descriptors at moderate or broad analytic levels for validity generalization and work- or worker-oriented content descriptors at a moderate level of analysis for synthetic validity, whereas legal considerations suggest that worker-oriented content descriptors at specific or moderate levels of analysis are most appropriate for validity transportability.

TABLE 6.3

Descriptor Appropriateness for Selection-Related Work Analysis Applications

	Level of Analysis		
Work Descriptor Category	*Broad*	*Moderate*	*Specific*
Work-oriented content	CD	CD, VD, VE-SV	CD, VD
Worker-oriented content	VE-VG	VE-VG, VE-SV, VE-VT	CD, VE-VT
Attribute requirements	PD, VE-VG	PD, VD, VE-VG	PD, VD

Note. CD, criterion development applications; PD, predictor development applications; VD, validity of domain sampling (content validity) applications; VE, validity evidence extension applications; VE-VG, encompassing validity generalization; VE-SV, synthetic validity; VE-VT, validity transportability.

Reflecting more broadly on this review, it appears that work analysis is at a crossroads—one rooted in the fact that whereas work in many economic sectors has been changing a lot, work analysis methodology has been changing only a little. The general phenomenon of the changing nature of work, workers, and the workplace resulting from broader economic, demographic, and technological changes has been extensively described and documented for at least the last 20 years (Coates, Jarratt, & Mahafie, 1990; Johnston & Packer, 1987), as has its specific ramifications for many organizational and HR practices, including personnel selection and work analysis (Offerman & Gowing, 1993; Pearlman & Barney, 2000; Sanchez, 1994). Rather than slowing down or stabilizing, the pace of such changes, if anything, appears to be accelerating (Landy, 2007). However, for work analysis, after periods of substantial innovation in the mid-20th century, with a few exceptions the last several decades have been largely ones of methodological refinements, variations, and new combinations of tried-and-true methods.

Like all organizational practices, work analysis must continue to adapt and evolve to maintain its relevance and utility. Although the traditional concept of a job may not be "dead," as some have argued (Bridges, 1994), its changed settings and dynamics have created new and formidable challenges for traditional work analysis assumptions and practices. Among those who have speculated about this (Cunningham, 2000; Fogli & Whitney, 1998; Levine & Sanchez, 2007; Pearlman & Barney, 2000), there has been some consensus that such challenges imply the need for work analysis methods with a greater ability to capture such things as (a) strategic and future work requirements that are based on a more macro, top-down (i.e., organization-level) than a micro, bottom-up (i.e., individual- and job-level) orientation; (b) broader and multiple work roles and work processes rather than individual jobs and work content; (c) broader sets of worker attributes (e.g., personality, attitudes, and values) relevant to contextual performance (Borman & Motowidlo, 1993), team and organizational performance outcomes, and task and individual performance outcomes; and (d) important elements of the broader work and organizational environment, as well as incorporate interdisciplinary perspectives and methodological innovations that would facilitate and enhance such pursuits. (We elaborate on many of these points later in this chapter.)

KEY WORK ANALYSIS PRACTICE ISSUES

Data Collection Issues in Work Analysis

Work Analysis Data Sources

The choice of data sources, like all methodological decisions in work analysis, should be driven by the specific purposes and goals of the analysis. Among the more commonly used sources of work analysis data (incumbents, supervisors, higher-level managers, job analysts, training specialists, or other technical experts), job incumbents are by far the most frequently used. However, there is an important distinction to be made between a job and its incumbents. Jobs are social and organizational constructions, abstractions based on specific sets of responsibilities required of one or more job incumbents, such that each incumbent of the same job is charged with performing the same set of responsibilities. Hence, jobs are actually highly dynamic (sets of responsibilities change over time, and all incumbents do not carry them out in the same way) and relativistic—a single task for one incumbent ("making sandwiches" for a short-order cook in a diner) may constitute an entire job for another ("sandwich-maker" in a specialized gourmet deli). However, most traditional methods of work analysis implicitly assume the existence of an absolute, or reasonably stable, job as at least a "convenient truth." It is therefore not surprising that large numbers of observers of this "job reality" often have been enlisted in the work analysis process so as to mitigate the bias and idiosyncrasies of individual observers by combining and averaging observations of the same "object" (their job) from multiple vantage points. Under the assumption that those closest to the behavioral realities of the job are its most objective sources, incumbent ratings of work-analytic units such as job tasks and KSAOs are often preferred to the ratings of nonincumbents (e.g., trained analysts, supervisors, and psychologists) because of their higher "face validity" and acceptability among the end users of such data. In other words, there is a widespread assumption in work analysis that job incumbency is necessary and even sufficient to ensure valid ratings. However, there is no convincing body of evidence backing such a belief. That is, selection procedures based on incumbent ratings have not been found more valid or effective than those based on nonincumbent ratings (Sanchez, 2000). Moreover, several logical arguments can be made regarding the potential disadvantages of using incumbents (greater susceptibility to various social influence and impression management biases) and the potential advantages of using nonincumbents (greater objectivity) as sources of work analysis ratings under different circumstances (Morgeson & Campion, 1997).

The argument for expanding the range of data sources beyond incumbents is further strengthened by several characteristics of many contemporary work settings, such as the need for workers to span functional boundaries and an emphasis on teamwork and customer service. This in turn suggests that internal and external customers, suppliers and vendors, and other colleagues and points of coordination along a product or service delivery chain could add value as sources of information about a given job, work function, or work process in a more broadly conceived, 360-degree approach to work analysis. However, when nonincumbents are used to provide work analysis ratings, it is important that they have sufficient opportunity to gain first-hand familiarity with the focal job (or other unit of analysis involved), such as through job observation or interviews, rather than making judgments based solely on review of written material (lists of tasks, duties, and responsibilities) that is unlikely to provide the insights necessary to make well-informed judgments (e.g., when estimating KSAO requirements).

Work Analysis Data Types and Level of Analysis

Although many content approaches were described in Table 6.2, the analysis of highly cognitive and highly interpersonally oriented work content remains a challenge, because these domains involve processes that are not easily observed (but we discuss cognitive task analysis later in this chapter). The personality requirements of work also have not been well represented in traditional work analysis methods, although there are signs of progress in this area, as described earlier.

Finding ways to represent and capture the dynamic nature of work has been a longstanding problem in work analysis. Methods from other disciplines are available for describing dynamic work processes, such as the flow, interaction, and strategic impact of work processes across functions and time. One such method is work process mapping (Brannick et al., 2007), in which relationships of tasks and work roles to one another and to specific work goals are displayed in flowchart form. Several innovative approaches along these lines have been detailed by Barney (2000), such as impact mapping and "strategic modeling scales," analytic methods for linking work tasks and worker attributes to an organization's broad strategic goals. Such techniques could be helpful supplements to more traditional work description but have not as yet found their way into mainstream work analysis practice.

Work Analysis Data Collection Methods

An overarching issue affecting any data collection processes involving human sources is the potential for distortion of job information, with or without conscious intent (Morgeson & Campion, 2000). For example, incumbents may be motivated for various reasons to present a positive image of their jobs and are thus prone to inflating their ratings of task or KSAO importance. The reverse is also possible, as in the case of information sources such as supervisors or second-level managers underrating the importance of their subordinates' job responsibilities so as to elevate the importance of their own roles. We recommend the use of more than one data collection methodology whenever possible (e.g., interviews followed by a structured questionnaire), making it possible to check for convergence between the information gathered through different methods. This may not be as impractical as it might initially seem, because the development of a structured work analysis survey generally requires the collection of qualitative data via interviews or job observation as input into the survey development process. When sources agree on the nature of the job, all is well. When sources disagree, some detective work may be needed to understand why. When quantitative information is gathered from different sources (e.g., incumbents and supervisors), some means of combining or blending the information may necessary. For example, if either incumbents or supervisors deem a skill to be important, then it should be included in screening applicants. However, we are unaware of research that provides guidance in such matters.

Inferential Leaps and Linkages in Work Analysis

Four types of inferential leaps come into play when work analysis is applied to employee selection: (1) the translation of work content information into worker attribute information, (2) the translation of work content information into work performance or criterion measures, (3) the translation of worker attributes into actual selection instruments, and (4) the inferential leap between selection instruments and performance measures (Gatewood et al., 2008). Each of these leaps is illustrated in the context of domain sampling (i.e., content validity) applications of work analysis. For example, the development of professional or occupational certification or licensure tests typically begins with a detailed analysis of a job or occupation in terms of its tasks, duties, and responsibilities. Subsequently, this information is used to infer the important knowledge components (and their relative weights) of the occupation (inference 1) and may at times be used to develop one or more performance or criterion measures (inference 2) for use in future criterion-related validation studies conducted to augment the content validity evidence. The knowledge requirements are then translated into a test plan intended to measure all of the required knowledge areas in the appropriate proportions (inference 3). The test's content validity may be established through several means, including appropriate documentation of all the steps and judgments just described, the use of one or more statistical indices (Lindell & Brandt, 1999) available for evaluating the strength of the test-performance relationship (inference 4) on the basis of item-level job-relatedness judgments of SMEs and eventual examination of the empirical relationship between test and job performance (also inference 4).

Content validity applications notwithstanding, inference (1)—the use of job or work information to determine the worker attributes needed to effectively carry out a job's activities and perform its required behaviors—has received the most attention in the general application of work analysis to predictor development. The basic idea is to analyze both the job and the person into components (tasks for the job, abilities for the person) such that lawful patterns emerge, confirming hypothesized job requirements. In some applications, such as in the O*NET system, the importance of various attribute requirements is estimated directly by incumbents with the aid of task- and behavior-anchored rating scales. Other researchers have proposed an explicit set of "linkage" ratings (Goldstein, Zedeck, & Schneider, 1993) for determining KSAO importance on the basis of the strength of the judged relationship between individual tasks and individual KSAOs. Research has shown that SMEs are indeed capable of reliably estimating linkage ratings, although analysts' judgments may be somewhat more reliable than those of incumbents (Baranowski & Anderson, 2005). Still another stream of research has explored the covariance between task and KSAO ratings, even suggesting the possibility of empirical derivation of KSAOs from task ratings (Arvey, Salas, & Gialluca, 1992; Goiffin & Waycheshin, 2006; Sanchez & Fraser, 1994). Fleishman and colleagues showed how abilities can be mapped (through judgment) onto empirically derived dimensions of task content (Fleishman & Quaintance, 1984), whereas McCormick's PAQ research (McCormick et al., 1972) uncovered empirical relationships between job elements and worker attributes via factor analysis. More recent research along similar lines using the initial O*NET database also found meaningful linkages among a wide range of work and worker characteristics, including abilities, generalized work activities, work styles, knowledge, occupational values, skills, and working conditions such as a requirement to work during holidays (Hanson, Borman, Kubisiak, & Sager, 1999). In summary, there is strong evidence of meaningful covariation between ratings of different work-, worker-oriented, and attribute-oriented descriptors, suggesting that SMEs' inferences about attribute requirements are well grounded in their judgments of work activities or job tasks. Such findings provide reasonably strong underpinnings for the various methods and techniques that have been developed and used to make such linkages in practice.

Evaluating Work Analysis Quality

Discussion of how best to evaluate the accuracy, quality, and meaning of work analysis data has been going on for a long time, but has it been given more recent impetus by various empirical studies (Wilson, 1997) and conceptual/theoretical work (Morgeson & Campion, 1997, 2000) illustrating how difficult it may be to collect accurate and valid job or work information—or even to agree on what this means. For example, is accuracy best indexed by inter-rater agreement, convergence among different data sources, or convergence between work analysis output and some external standard or benchmark? Despite such ambiguity, the effectiveness or utility of such data for making sound personnel decisions remains crucial.

Within the context of personnel selection, the inferences at issue range from those that are immediately supported by work analysis data (such as inferring worker attributes from task importance ratings) to those that are more distally supported by such data (such as inferring the validity of work-analysis-based selection instruments by examining their correlations with performance measures). Although we recognize that such consequences provide only partial information about the impact of work analysis on decision making, we nonetheless believe there is considerable value in thinking of work analysis in terms of its more broadly conceived consequential validity, because this provides a framework for demonstrating and documenting to organizational leaders and stakeholders its pivotal role in linking personnel selection (as well as many other HR practices) to critical aspects of work performance (as revealed through work analysis). This value is further enhanced to the degree that such practices can be shown to produce significant "returns on investment" (Becker, Huselid, & Ulrich, 2001), for example, in the form of individual- or organization-level performance improvements.

FRONTIERS OF WORK ANALYSIS: EMERGING TRENDS AND FUTURE CHALLENGES

Work Analysis in Support of Selection for High-Performance Workplaces

The concept of high-performance (or high-involvement) organizations (HPOs; Lawler, Mohrman, & Benson, 2001) is a direct outgrowth of the sweeping work and workplace changes to which we alluded earlier that have been occurring over the last 20 years or so. It refers to organizations that have incorporated into their strategy, culture, and structure various elements believed to maximize the performance of people in those organizations so the performance and ability of the organization to compete effectively in the global economy is also maximized. These include such workplace practices as (a) worker empowerment, participation, and autonomy; (b) the use of self-managed and cross-functional teams; (c) commitment to superior product and service quality; (d) flat organizational structures; (e) the use of contingent workers; (f) flexible or enriched design of work that is defined by roles, processes, output requirements, and distal criteria (customer satisfaction, contribution to organization values), rather than by (or in addition to) rigidly prescribed task- or job-specific requirements; (g) rigorous selection and performance management processes; and (h) various worker- and family-friendly HR policies that reward employee development and continuous learning and support work-life balance. A growing body of evidence (Cascio & Young, 2005; Gibson, Porath, Benson, & Lawler, 2007) shows that such workplace practices can contribute to important organization-level outcomes (e.g., financial performance, productivity, and customer satisfaction; Boselie, Dietz, & Boon, 2005; Staw & Epstein, 2000).

Particularly relevant for our discussion is evidence within this larger body of research that links such HPO-oriented workplace practices and outcomes with the individual worker attributes and behaviors needed to effect them (Boselie et al., 2005; Guest, Conway, & Dewe, 2004; Guthrie, 2001; Huselid, 1995; MacDuffie, 1995; Spreitzer, 1995). For example, formerly individual-contributor scientists who have been reorganized into cross-functional teams with engineering and marketing staff to improve a product delivery cycle may need social and communication skills in addition to research skills (a sort of work context "main effect"). Work that has been redesigned to create greater worker autonomy may improve motivation, and hence performance, among individuals with high growth need strength but not in others, which is a work context "interaction effect" (Hackman & Oldham, 1976). It is not enough for employees at Disneyland ("the happiest place on earth") to simply work; they must "whistle while they work"—literally for seven particular work roles and figuratively for all others—so as to contribute to one of that setting's most critical outputs (cheerfulness). In other words, different organizational strategies—and how they are reflected in an organization's culture and structure—imply potential needs for additional or different (or different configurations or weightings of) worker KSAOs, the measurement of which could enhance existing selection systems. Moreover, HPO-associated strategies have, in many cases, increased the organizational value of various non-job- and non-task-specific performance criteria, such as contextual performance; employee satisfaction, commitment, engagement, and retention; and avoidance of employee withdrawal and counterproductive behaviors.

Most of the relevant literature considers typical employment relations (Cappelli & Keller, 2013). However, organizations have significant numbers of workers in nontraditional roles, including contract workers, temporary workers, telecommuters, and subcontractors working shoulder-to-shoulder with regular employees. Workers on contract must provide deliverables, but management has no control over the production process for such workers. For telecommuters, management has authority to direct the worker's means of production, but the actual direction may be nominal. Management's inability to specify actual worker behavior creates a problem for traditional job analysis methods.

Such developments imply the need for work analysis methods that incorporate measures of a greater variety of work context factors—particularly those associated with or driven by an organization's vision, mission, strategy, structure, culture, and values—than are addressed in conventional methods, which, if present at all (e.g., as they are in FJA, PAQ, and O*NET), tend to be limited to those associated with specific jobs and work settings (work schedule, working conditions, environmental hazards) rather than the broader organizational and external context (business strategy, competitive environment, market conditions). Absent such measures, we may fail to detect the need for potentially important or useful worker attributes and potentially critical selection procedure validation criteria. For example, it is plausible that areas where noncognitive attributes (such as personality traits, attitudes, and values) might have their greatest predictive value remain largely unexplored because of our historical focus on more conventional (job- and performance-oriented) criteria that ignore the broader organizational context of work. We would go so far as to argue that the definition, measurement, and mapping of the work environment—in effect, creating a "common language" of work context—at multiple levels of analysis is the next major frontier in work analysis. This is not a small challenge. It is a problem of long standing in psychology as a whole (Frederiksen, 1972) and continues to be one of acute importance in I-O psychology today (Johns, 2006). However, models for explaining and understanding context are beginning to emerge (Tett & Burnett, 2003). Context variables such as organizational climate and culture may have implications for selecting people with compatible personal characteristics (see Chapter 5 in this volume).

WORK ANALYSIS FOR HIGH-PERFORMANCE INDIVIDUALS ("STARS")

A series of articles by Aguinis and colleagues (Aguinis & O'Boyle, 2014; Aguinis, O'Boyle, Gonzales-Mule, & Joo, 2014; O'Boyle & Aguinis, 2012) have argued that performance outputs (e.g., number of articles published, goals scored, Emmy nominations, dollar amounts of sales) show very skewed distributions. In such distributions, a few individuals show outstanding performance, and may be labeled "stars." They also argue that organizational programs designed to impact the average employee are likely to be misguided because "most performance outcomes are attributable to a small group of elite performers" (O'Boyle & Aguinis, 2012). However, Beck, Beatty, and Sackett (2014) described several features of the way in which the distributions are collected (e.g., whether the time period of performance is the same for all of the individuals in the distribution) that may affect the shape of the distribution. Others have noted that outputs and performance are not synonymous, and that stars might be conceptualized instead as expert performers (Campbell & Wiernik, 2015). Aguinis et al. (2016) also investigated a number of other characteristics (cumulative advantage, or "rich get richer" factors) that may influence the tails of the performance distribution. Regardless of the degree to which their arguments about the importance of the majority of workers are ultimately confirmed, attention to recruiting, hiring, and maintaining performance stars has a clear potential to benefit many organizations.

Aguinis and Boyle (2014) stated that "a focus on results rather than behaviors is most appropriate when (a) workers are skilled in the needed behaviors, (b) behaviors and results are obviously related and (c) there are many ways to do the job right" (p. 316). From the standpoint of job analysis, the possibility that there is no one best way to accomplish the job is an issue. Hierarchical task analysis (Annett, 2003) describes a set of steps designed to accomplish a task. If there is more than one way to do something, then the most efficient way will be chosen. If the problem is complex, then a series of approaches might be employed, but there will be rules about what to try under which circumstances.

In some instances it may not be clear what the best method for task accomplishment is. For example, as surgery evolves, new tools and techniques become available, and as these have not been used previously, it is not obvious how best to use them in an operation. However, as experience accrues, evidence becomes available about their advantages and disadvantages. Where performance data are available, it becomes possible to investigate whether some uses are better than others, and some studies have linked job-analytic data to job behaviors (Morrison, 1994; Sanchez & Levine, 2012; Sanchez, Prager, Wilson, & Vishwesvaran, 1998).

A domain in which performance data are routinely collected and scrutinized is sales, where part of performance is determined by features external to the employee, such as geographic location (Blickle, Wendel, & Ferris, 2010), part to previous, relatively distal employee behaviors

(behaviors related to repeat customers, referrals, etc.), and part to the current or proximal behaviors of the employee (Jaramillo & Grisaffe, 2009). Despite the best efforts of organizations (selection, training, compensation, and management), sales data typically show a heavy-tailed distribution such that top performers may exceed average performers by a factor of two or more. In other words, there is a large variability in performance and there are identifiable performance stars. Part of the difference in outcomes may be essentially due to luck. For example, the Jaramillo and Grisaffe (2009) study reported correlations in the .30s (.29 to .43) for sales data across four quarters. We would expect that if the same individuals were consistently in the tails of the distribution (and often outliers), we would see a high correlation over time periods. However, correlations may be higher over longer periods because performance may be more reliable when aggregated over longer periods.

There are data from the study of stockbroker performance suggesting that time spent on different tasks (time allocation strategies) may distinguish superior performers (Borman, Dorsey, & Ackerman, 2006); the same study also showed evidence of differential relations between time spent and performance for more and less experienced stockbrokers. A study of computer salespeople also showed a relation between time spent and sales data (Kerber & Campbell, 1987). However, other studies (not sales jobs) have shown no relationship between time spent and performance (Conley & Sackett, 1987; Welxley & Silverman, 1978). A study of auto salespeople showed an interaction between motivation (achievement striving facet of Type A) and time management (planning at the beginning of the day) for the prediction of performance in a sample of auto sales workers (Barling, Kelloway, & Cheung, 1996). It seems likely that autonomy is necessary but not sufficient to produce differences in the relations between time spent on tasks and performance outcomes. Also, as Borman, Dorsey, and Ackerman (2006) noted: "Performance is probably in large part a function of *how* stockbrokers carry out activities over and above *what* activities they allocate time to and emphasize" (pp. 774–775).

We suggest two possible avenues of research that might advance our understanding of selecting future stars. First, rather than conducting a garden-variety task analysis and then comparing the responses of those with better and poorer performance outcomes, we might start with the better and poorer performing groups (analogous to the novice vs. expert distinction in cognitive task analysis) and systematically explore the differences in what they do, how they do it, and what personal qualities distinguish them. To the best of our knowledge, a cognitive task analysis has not yet been conducted on sales jobs.

Second, as we have emphasized throughout the chapter, we suggest better partnering of psychologists with professionals from other areas (e.g., operations management, economists) to create better models that predict performance outcomes. Sales is an area in which the job behaviors and the value of the outcomes are closely connected because performance is closely tied to dollars (unlike the performance of the janitors and accountants employed by the same organization). Factors that influence sales such as geographic location can be explicitly incorporated into a statistical model along with individual difference variables such as personality, motivation, or emotional intelligence. It is plausible that early in the stockbroker's career, more time must be allocated to prospecting for clients, but in later career stages, more time must be allocated to maintaining relations with existing clients. In short, by incorporating both business variables and individual differences in the same model, it should be possible to do a better job of predicting performance outcomes than is currently the case.

COGNITIVE TASK ANALYSIS

Definition and Recent History

The rise of cognitive psychology promoted unobservable phenomena (e.g., the decision-making process) as objects worthy of study, and applications of cognitive psychology to task analysis appear in the literature in the 1980s and early 1990s (Cooke, 1994; Lesgold et al., 1988), although the adoption by I-O psychologists appears to be spotty (Berryman, 1993). Cognitive task analysis

(CTA) can be described as a "set of methods for identifying cognitive skills, or mental demands needed to perform a task proficiently" (Militello & Hutton, 1998), and it typically emphasizes the distinction between novices and experts in solving problems and in task proficiency (Clark & Estes, 1996). Cognitive task analysis can supplement a garden-variety task analysis by focusing on mental operations that are not directly observable (Cannon-Bowers, Bowers, Stout, & Ricci, 2013; Clark & Estes, 1996). Thus, particularly for cognitive tasks, CTA can help bridge the gap between what gets done and how it gets done.

During the 1960s, engineers began to focus on automation, where tasks are allocated to machines, and the time and motion study techniques developed by the engineering pioneers (Gilbreth, 1911) were perceived to be inadequate to the purpose (Annett, 2003). Engineers developed *hierarchical task analysis*, which decomposes a task into subtasks of whatever level of detail is needed. Each subtask is composed of four parts: (1) the subtask goal, (2) the input conditions, (3) the action or operation to achieve the goal, and (4) feedback about goal attainment (Annett, 2003). This is similar to garden-variety task analysis except that it explicitly includes the input conditions and task completion feedback.

In the 1970s, multiple strands of research resulted in human factors approaches called *cognitive task analysis* and *cognitive work analysis* (Roth, 2008). Hierarchical task analysis can be supplemented by cognitive task analysis (Phipps, Meakin, & Beatty, 2011) and by cognitive work analysis (Salmon, Jenkins, Stanton, & Walker, 2010), both of which consider cognitive processes that cannot be observed directly. Cognitive task analysis and cognitive work analysis are currently used in the design of equipment and computer interfaces, as well as in training and task allocation to teams (Ashoori & Burns, 2013). Although cognitive task analysis has not been applied to selection, we cover it here because it is a lively area of research that might stimulate developments in more traditional areas of work analysis.

Common Applications

Performance Assessments

Because CTA has been used to develop training, it has also been used to develop performance assessments, which are necessary to evaluate learning (and of course may be relevant to selection). Examples of performance assessments based on CTA include an outline of a rubric for evaluating biology lab reports (Feldon, Timmerman, Stowe, & Showman, 2010) and a description of a think-aloud test of problem solving during two kinds of simulated surgery (Pugh & DaRosa, 2013). Two related examples illustrate the process of developing a test using CTA, one for computer networks (Williamson et al., 2004) and the other for dental hygienists (Mislevy, Stenberg, Breyer, Almond, & Johnson, 1999). In the medical literature, there is a cross-walk of judgments about the levels of expertise and expected performance at different training levels (e.g., medical school vs. certain years in residence; Khan & Ramachandran, 2012).

Guidance on how to use CTA to promote good measures for a task includes eliciting the cues needed for each step, description of typical trainee errors for each step, and specification of observable behavior that allows a judge to determine whether a step is accomplished properly (Cannon-Bowers et al., 2013). Unlike the hierarchical task analysis, which includes every task plus any required subtasks, the CTA typically focuses on a subset of tasks or contexts that distinguish between novices and experts. Cannon-Bowers et al. (2013) describe results of two cognitive task analyses, one for cricothyroidotomy (emergency airway puncture) and one for hemorrhage (bleeding) control. For each task, they list the major step (e.g., insert endotracheal tube), the cues used to perform (e.g., tactile and kinesthetic cues), the typical errors (e.g., excessive force), the observable trainee behaviors used to infer competence (e.g., orientation of the instrument), and the decision-making demands of the step (whether the tube is placed properly). Klein et al. (2015) described a task analysis of dealing with civilians for police and military officers during conflict situations. They were able to link the decision-making strategies to outcomes for the incidents and to develop a list of potential antecedents that might explain differences in the quality of interactions with civilians, including family background, rejection of negative experiences, prior work experience, and drive for excellence (G. Klein et al., 2015).

CTA can provide insight about cognitive processes that would *not* likely be assessed by multiple-choice tests, in which items typically contain all of the required information and a single best answer. For example, in the dental test (Mislevy et al., 1999), participants need to notice that unusual deterioration has happened to a patient's teeth during the previous six months and then make appropriate investigation to determine the cause. That is, the examinee must notice the connection between current data and something seen earlier in the examination and investigate by asking the examiner for additional information, analogous to what should happen in the real situation. Such an approach is essentially a structured means to developing a work sample or content valid test that is explicitly linked to degree of expertise and thus should be helpful in picking the best applicant.

Training

The most common human resources application of CTA appears to be training (Ryder & Redding, 1993). For example, CTA can provide information that allows for the development of training content, simulators to provide the appropriate stimulus, and also to provide stimuli for assessing proficiency before and after training (Cannon-Bowers et al., 2013; Tjiam et al., 2012). Applications include a very detailed task analysis of interventional radiology (Johnson et al., 2006), a licensure test for dental hygiene (Mislevy, Steinberg, Breyer, Almond, & Johnson, 1999), and training for tracheostomy (Sullivan et al., 2007), central venous catheterization (Velmahos et al., 2004), and nephrostomy (Tjiam et al., 2012).

There are applications of CTA to disciplines other than medicine, including the teaching of biology (Feldon et al., 2010), understanding the resilience of emergency response teams (Gomes, Borges, Humber, & Carvalho, 2014), and differences in police proficiency in handling civilian encounters (G. Klein et al., 2015).

Methods of CTA

Methods of cognitive task analysis have been adapted from the laboratories of cognitive scientists, where they were developed for many purposes. A cognitive task analysis involves the following steps: (a) selection of the participants (experts and possibly novices), (b) knowledge elicitation, and (c) analysis and representation of the knowledge (Craig et al., 2012). There are more than 100 distinct methods of knowledge elicitation (Cooke, 1994; Yates & Feldon, 2011). CTA methods, however, can be categorized as follows: (a) observations and interviews, (b) process tracing, (c) conceptual techniques, and (d) formal models (Cooke, 1994; Wei & Salvendy, 2004). Formal models are mathematical representations of cognitive processes and are not often used in applied settings. The methods most commonly applied to the workplace involve structured interviews (observations and interviews) and think-aloud protocols (process tracing) while performing a task or solving a problem.

Interviews

The Critical Decision Method (G. Klein, Calderwood, & MacGregor, 1989; Hoffman, Crandall, & Shadbolt, 1998) provides the analyst with a series of questions for the expert. The expert reflects on an instance in which an important decision was made and then describes the context of the decision, the cues that were or could have been influential in making the decision, and strategies that could be brought to solve the problem (recall our description of the decision about minimally invasive versus open surgery; also note the similarity to Flanagan's Critical

Incident Technique). A similar method is called PARI, for precursor, action, result, and interpretation (Hall, Gott, & Pokorny, 1995). The PARI method focuses on mundane tasks as they are typically performed.

A related technique is the Knowledge Audit (Craig et al., 2012; Militello & Hutton, 1998), which comprises a series of questions based on the literature concerning differences between novices and experts. For example, the participants may be asked if, during the course of completing a task, they have noticed things that others did not, developed a more efficient way of doing the task, improvised something, and/or noticed something anomalous (Craig et al., 2012).

Protocols/Process Tracing

A commonly used method of CTA is to have experts "think aloud" while solving a problem or performing a task. There are several techniques for doing so. Experts may be asked to imagine doing the task while verbalizing their thinking, or to actually complete the task, perhaps on a simulator (Cannon-Bowers et al., 2013). For some tasks, such as surgery, the expert may be video recorded during the operation and then provide the verbal description later while watching the video (Johnson et al., 2006). Another variant has pairs of experts work together, where one expert poses a problem to the other, who then solves it while thinking aloud (Ryder & Redding, 1993). The verbal protocols are often recorded, transcribed, and analyzed for content.

Issues

CTA is laborious and time consuming, and thus it is expensive. Experts often provide different information, and thus it has been suggested that multiple experts be included in a CTA for any given task (Chao & Salvendy, 1994; Sullivan, Yates, Inaba, Lam, & Clark, 2014). At present, there is little comparative information about the reliability and validity of different methods of CTA, and there is little empirical guidance about what methods are best for specific purposes (Yates & Feldon, 2011). There have been few cost-benefit analyses of CTA, but savings in training time (Clark & Estes, 1996) and better performance results (Tofel-Grehl & Feldon, 2013) suggest that the time and expense of CTA may be wise investments so long as the resulting program can be applied to training sufficient numbers of people. Similar arguments might support the application of CTA to selection. Research is warranted on the conditions in which it is worthwhile to invest in CTA (e.g., whether the job entails time pressure and severe consequences of error). CTA appears to run counter to the business trend emphasizing broad, shallow job descriptions.

Application of CTA to Selection

Several authors have mentioned the potential application of CTA to personnel testing and selection (Gordon, Coovert, & Elliott, 2012; Rothkopf, 1986; Wei & Salvendy, 2003). To the best of our knowledge, there are no published examples of CTA being used to develop a selection test.

Work Samples

Based on the CTA literature for training, the most obvious test for selection would be work samples and specially constructed simulations (Cannon-Bowers et al., 2013). The CTA could emphasize the cognitive processes such as planning, noticing connections and anomalies, gathering information, and judgment and decision making. Such exams have the potential to tap cognitive processes that are not usually measured deliberately during selection. How this might be accomplished was illustrated by the dental hygienist case exercises mentioned earlier

(Mislevy et al., 1999). A drawback is that such exams are very labor intensive to develop and to administer. The examiner must have the content knowledge necessary to respond to the examinee in ways that are appropriate for the scenario and accurate for the facts of the case. At some point, computers will be capable of replacing the human examiners in such interactive exams, but this is not currently feasible.

However, situational judgment tests (SJTs) are essentially low-fidelity simulations in which the situation is described narratively on paper or by video (Lievens, Buyse, & Sackett, 2005; Lievens & Motowidlo, 2016). It might be possible to obtain at least some of the same information through SJTs as through higher-fidelity work samples. As Lievens and Motowidlo (2015) argued, the SJT typically lacks much theoretical grounding. CTA might be a way to support the interpretation of SJT scores as a measure of expertise in a particular area.

Reaction Time (Automaticity)

A second approach to testing for selection might involve measures of examinee reaction time to stimulus materials that are representative of the domain of interest. One way in which this might be done concerns the decomposition of reaction time into components representing fundamental processes such as perception, recognition, and solution selection. Cognitive scientists have developed formal models of decision making that might be fit to individual data to estimate examinee standing on individual difference variables (Rothkopf, 1986; Wei & Salvendy, 2004).

Another way in which reaction time might be used is the speeded production of solutions to problems. Experts are able to produce workable solutions to problems very quickly (G. A. Klein, 1998). For example, a chess grandmaster can solve many chess problems within 10 seconds, whereas a weak club player cannot (Campitelli & Gobet, 2004). A test of this sort would be based on a series of problems with known solutions, each of which is presented only for a short while, and then scored for quality of response.

Limits of Expertise

One reason that CTA is more closely associated with training than with selection is the cognitive psychologists' apparent assumption that nearly everyone can learn nearly any task to a desired level of proficiency given sufficient practice (Clark & Estes, 1996). "There seems to be general agreement in cognitive psychology that most human beings are capable of acquiring declarative knowledge, production knowledge or both about any task" (p. 406). However, others have noted an apparent boundary condition, which is the consistency of the stimulus and response required for the task (Ryder & Redding, 1993). The slow, effortful problem-solving approach may be needed if the job causes the worker to encounter situations sufficiently novel that the known solutions may not apply. Jobs such as surgery may foster the development of "fractionated expertise" (Kahneman & Klein, 2009) where experts can automate only part of the required skills (Craig et al., 2012). The implication is that tests based on CTA may need to consider disentangling the learned from the general ability influences on performance assessed by work samples.

Looking Forward

It seems clear that CTA can provide information that would be useful in personnel selection. However, we are unaware of any such applications. One additional step that seems required for such applications is the explicit linkage of cognitive processes to the required job knowledge, skill, or other characteristics.

Strategic Work Analysis and Competency Modeling

Traditional methods of work analysis appear largely rooted in the industrial-age workplace. Such methods (including much of cognitive task analysis) appear designed to support staffing Model 1—the traditional practice of matching people to individual jobs (Snow & Snell, 1993). This bottom-up orientation largely ignores three major top-down elements—organizational strategy, organizational structure, and organizational culture—that reflect an organization's vision and mission, drive much of its daily functioning, and can (in some instances, profoundly) affect the choice, configuration, and relative importance of KSAOs constituting an organization's selection system, independent of the nature of the work performed by individuals across the organization (Williams & Dobson, 1997). Therefore, this latter top-down perspective is highly relevant to the alternative, nontraditional staffing models being adopted by many contemporary organizations that, for example, view staffing as a tool in strategy implementation (Snow and Snell's Model 2, applicable to organizations with clear strategies and known competitors) or strategy formation (Model 3, applicable to organizations that need to develop or change strategies quickly).

Viewing staffing as strategy invites work analysis methods that incorporate various types of organization-level analyses—market and demographic trends, competitive environment, emerging technology, business and strategic plans, organizational culture and style—as is routinely done in work analysis to support training system development and has been similarly recommended for selection-oriented work analysis (Goldstein, 1997). This would provide the critical context to facilitate more specific work analytic efforts, thereby also facilitating the direct generation of worker KSAOs related to broader organizational criteria, strategies, and goals. Such an approach could in turn provide a framework from which other, more broadly conceived, selection-related applications of work analysis might be explored and capitalized on. For example, one such application could be the provision (via ads, realistic job previews, or company websites) of customized information to applicants about various aspects of work and worker requirements (e.g., context factors, career ladders and lattices based on job inter-relationships, and skill or knowledge transferability) that are potentially related to applicant attraction and subsequent organizational commitment. Another example is collecting work analysis data on contextual and other factors relevant to selection for nontraditional or nonperformance criteria, such as successful post-hire assimilation and socialization, or different levels of employee "fit" (Higgs, Papper, & Carr, 2000). Yet another example is using work analysis questionnaires more in the mode of an organizational survey (i.e., as an ongoing or regularly recurring intervention) rather than exclusively as a "one-and-done" tool for work profiling; this could provide a measure of work content and work context stability/volatility and offer insights into the nature of such content or context changes and their potential implications for selection-related worker attributes.

All of this suggests a potentially useful reconceptualization of work analysis as organizational strategy—that is, as a strategic tool—and hence characterized by a strong organization development (OD) component (Higgs et al., 2000; Schippman, 1999). It also suggests the need to bridge a historical and professional disconnect between those who have tended to view jobs and work from a traditional, "micro" perspective (e.g., personnel and industrial psychologists, training and education professionals, cognitive psychologists, occupational analysts, industrial engineers, and human factors specialists) and those who have tended to look at work from a more "macro" perspective (e.g., labor economists; sociologists; business and management consultants; demographers; ethnologists; and clinical, social, and organizational psychologists). In our view, the work analysis enterprise would be better served by an integration of these perspectives, facilitated by much more interdisciplinary work among such professionals than historically has been the case, as some have called for (Barney, 2000; Cunningham, 2000). Such a reframing and associated changes in work analysis practice—and practitioners—underlie what we believe to be a broader and potentially more useful concept of "strategic work analysis" (SWA) as a systematic effort to identify or define current or anticipated work or worker requirements that are strategically aligned with an organization's mission and goals. This would subsume some other related terms and practices in current use, such as future-oriented job analysis, strategic job analysis (which is sometimes used as a synonym for the prior term—and sometimes not), strategic job (or work) modeling, and competency modeling, which, given its substantial impact on contemporary work analysis discussion and practice, we now consider in greater depth.

Competency modeling (CM) is a form of work analysis whose use has become widespread since about the mid-1980s. There appear to be almost as many definitions of "competency" and "competency modeling" as there are users of them (Schippman et al., 2000). Most existing definitions describe a complex and multifaceted concept, such as that offered by Spencer, McLelland, and Spencer (1994). They define competency as a combination of motives, traits, self-concepts, attitudes, values, content knowledge, or cognitive behavior skills and as any individual characteristic that can be reliably measured or counted and that can be shown to differentiate superior from average performers. The difficulty with such definitions is that they lump together in a single construct attributes representing vastly different domains, characteristics, and levels of analysis, which limits its value conceptually (Clouseau-like, it means everything, therefore it means nothing) and practically (as a useful or measurable descriptor or unit of analysis in work analysis).

The typical output of a CM project is a set of worker attributes (competencies) believed to contribute to an organization's broad strategy and goals, culture, or values. As such, these attributes are considered applicable across the entire organization, or within large units or functional areas, and thereby able to serve as a common framework underlying the various components of an integrated HR system, such as training and development, performance management, compensation, and selection/promotion. Each competency is given a name or label and is usually accompanied by a set of behavioral indicators (BIs) that exemplify desirable behavioral manifestations of the competency and thereby serve as the basis for measuring individuals' standing on the competency. Multiple sets of BIs are often developed to address a given competency's manifestation across different job families (sales, engineering), across functional specialties within a job family (account executive, technical consultant, customer service representative), or across occupational levels within a single job. For example, a "systems thinking" competency (defined as "making calculated decisions that take into account impact on other activities, units, and individuals") might have different BIs for sales managers ("evaluates the impact on others before changing work processes") than for account team leaders ("helps staff understand how their function relates to the overall organization"), as appropriate for these different roles.

We believe there is a huge chasm between the CM ideal envisioned by its proponents and the actual practices that, under the rubric of CM, produce the type of output described above (Lievens, Sanchez, & DeCorte, 2004; Morgeson, Delaney-Klinger, Mayfield, Ferrara, & Campion, 2004). In our experience, the majority of such practices fall into one of two categories. The first category involves entirely traditional work analysis, of one form or another, which leads to the development of sets or taxonomies of well-defined, work-related (but not strategy-, culture-, or values-related) person attributes (KSAOs) and associated metrics (behavioral or numerical rating scales, tests, or other instrumentation) that meet accepted professional standards for such work. Such activities are labeled as CM, and the KSAOs called competencies, to satisfy explicit or implicit requirements of organizations or particular leaders. The second category purports to derive attributes related to organizational strategy, culture, and values but entails the use of poorly conceived, incomplete, or otherwise inadequate procedures (e.g., convenience samples engaged in unstructured group discussions conducted without reference to individual or organizational work performance) that lead to the development of ad hoc, idiosyncratic, ill-defined (or undefined) concepts or "folk constructs"—ad hoc or "armchair" concepts or labels devised without reference to existing research or theory—that are often little more than a wish list of desired worker attributes or purported organizational values along with brainstormed (and typically unvetted and unvalidated) examples of good performance for each identified competency.

The above discussion is not meant to impugn the CM ideal of its proponents, but rather to highlight the disconnect we perceive between this ideal and most contemporary CM practice, which is either fairly rigorous but not explicitly "strategic" (the first category described above) or ostensibly strategic but not very rigorous, and hence ultimately unsuccessful in its strategic intent (the second category described above). We would, in fact, classify this ideal as a third (although still mostly unrealized) category of CM practice—one that combines the laudable goals of (a) linking organizational strategy (and other organization-level variables and outcomes) to desired individual employee attributes (McLagan, 1988) and (b) utilizing rigorous development methodologies of both conventional work analysis and other disciplines to ensure the validity of these linkages, much as proposed by Schippman (1999) and Barney (2000). For example, the "traditional" Critical Incident Technique can be readily adapted to the generation of genuinely strategically driven competencies and associated BIs, requiring only a change of frame of reference for incident generation from specific jobs to various organization-level variables, combined with the use of SMEs appropriate for this frame of reference. The unique aspect of this category of CM practice is its explicit strategic organizational focus, without reference to the work performed in any particular jobs. This is why we believe it is most appropriately regarded as simply one particular form of the more broadly conceived SWA concept we proposed above, and why (along with all of the conceptual and definitional ambiguities noted above) it has been argued (Pearlman, 1997) that the terms "competency" and "competency modeling" be abandoned altogether.

The major need going forward, as we see it, is for creative thought and research addressing such potential adaptations (such as the beginning efforts of Lievens et al., 2004, and Lievens & Sanchez, 2007), as well as the development of new data collection methods and approaches, to support all varieties of SWA.

Quest for a "Common Language" and the Challenge of Large-Scale, Multipurpose Work Analysis Systems

The concept seems simple. Develop comprehensive sets of standardized work- and worker-oriented descriptors representing multiple levels of analysis and then determine their interrelationships within a single analytic system that could thereby be used to derive the work content and worker requirements of any job. Such a system, especially when fully automated (as is easily accomplished nowadays), could serve as the basis for a powerful HR data and information system (or "human asset management" system, in today's jargon), underpinning and integrating numerous HR functions, such as selection and staffing (especially validity evidence extension applications, because it is ideally suited for cross-job comparison), training and career development, performance management, and workforce planning. At a broader level it could provide the means for tracking trends and changes in work content and occupational structure across the economy; for assessing and addressing national "skill gaps," and skill transferabililty and occupational portability issues; and for studying selection and talent allocation issues at a national level. From a scientific standpoint, it would constitute a critical research tool for advancing theory development regarding work performance and the structure of work or occupations—in effect, moving us closer to a "unified theory of work" (Vaughn & Bennett, 2002).

This notion of "a complete, universally applicable information system for human resources allocation" (Peterson & Bownas, 1982, p. 49) based on taxonomic information about work, work environments, and human attributes—a "common language" of people and jobs—has long been viewed as something of a "holy grail," enticing work analysis researchers and practitioners for the better part of 80 years. Such a system, when fully realized, would have underpinnings of structure (meaning logical inter-relationships among both descriptor categories and specific elements within those categories) and standardization (meaning common definitions, rules, and metrics) that thereby promote common understanding and usage of system elements among all users and stakeholders. This was the driving vision behind the U.S. Labor Department's Occupational Research Program of the 1930s and its development of the *DOT*, and was reflected to varying degrees in such later systems as FJA, the PAQ, ARS, MOSAIC, and O*NET. In our view, no single system has as yet been able to fully realize this vision, although O*NET probably comes the closest in terms of its scope and analytic capabilities.

Despite the simplicity and elegance of the concept, the practical realization of such a system is enormously complex. This led Higgs et al. (2000) to conclude that "most systems like this . . . have held great conceptual promise but . . . have eventually died of their own administrative weight and expense" (p. 108). Many complex choices and decisions must be made in the conception, design, and implementation of such a system, depending on the applications or objectives at issue, such as (a) descriptor coverage—how many and which work- and worker-oriented attribute domains will be included in the system—and the associated question of whether the common framework will be operationalized as a single set of a relatively limited number of descriptor elements representing a single level of description, or as multiple descriptor sets or taxonomies representing multiple attribute domains and levels of descriptions; (b) descriptor level of analysis (the breadth or narrowness of descriptor definition, as well as whether to allow multiple levels of analysis via the use of hierarchical descriptor element taxonomies); (c) whether descriptor coverage will apply (or will be designed so as to allow or promote application) to work, to workers, or to both; (d) whether individual jobs will be described exclusively in terms of descriptor sets that are used across all jobs in the system or will also include some types of job-specific information (such as tasks or tools/technology); (e) the characteristics of the metrics or scales by which descriptors will be quantified; (f) the policy and deployment questions of how much and which parts (descriptors) of a common framework will be required for use by all organizational units and which parts, if any, can be user-specific, which speaks to the critical issue of gaining the support and cooperation of multiple users and stakeholders, without which the system is unlikely to succeed; (g) devising efficient and effective procedures for ongoing data collection; and (h) devising procedures for maintaining and updating the system's data structure, which involves numerous technical and practical challenges (e.g., the dilemma of changing or incorporating new data elements to respond to changed needs or realities while maintaining comparability and continuity with the prior data structure).

Despite this wide range of options, decisions, and challenges, we believe that the vision of such a system continues to be both worthy and viable, if approached in manageable steps, segments, or prototypes, on the basis of sound professional judgment, and undertaken with broad and high-level organizational support.

SYNOPSIS AND CONCLUSIONS

Work analysis seems to have garnered a reputation as one of the less interesting and challenging areas of I-O psychology and HR practice. It has been noted, in a masterstroke of understatement, that "job and occupational analysis is not a glamorous or high visibility area on which to build a personal career or secure tenure" (Mitchell & Driskill, 1996, p. 129). One possible explanation may lie in the fact that, as we noted at the chapter's outset, work analysis is rarely a destination; it is almost always a road—a way to get from here to there. In the rare instances in which it is a destination (most commonly, in the conduct of work analysis as documentation for an actual or potential lawsuit), it is not an eagerly anticipated one.

We hope that this brief "walk down the road" of work analysis in the context of personnel selection serves to change such perceptions. We believe that, in order to meet the types of challenges described in the previous section, work analysis needs to be reconceptualized more broadly as a strategic, multistep, multifaceted, and interdisciplinary effort that is at least as much a top-down process (i.e., one based on analysis and understanding of macro-organizational strategy and context factors) as a bottom-up process (i.e., one based on analysis of what workers actually do). This implies the need to rethink the conventional boundaries of work analysis—what it consists of, who does it (and with what qualifications and organizational roles), and how it gets done. Such rethinking would promote a transformation of the work analysis enterprise from one of merely gathering information to one of generating insight, meaning, and knowledge about work. This would in turn contribute to theory and practice. We believe that even modest strides in these directions would yield significant returns in terms of improving the efficiency and effectiveness of the (broadly conceived) employee selection life cycle. Although such a shift in orientation may not immediately change the work analysis enterprise from a road to a destination (nor necessarily should it), it will at least make the journey more interesting and productive.

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