



**U.S. Department of Labor (DOL)  
Employment and Training Administration (ETA)**

**Job Content and Skill Requirements  
in an Era of Accelerated Diffusion of Innovation:  
Modeling Skills at the Detailed Work Activity Level  
for Operational Decision Support**

Prepared by:  
**Marc Anderberg**  
SkillsNET Foundation  
Waxahachie, Texas

This paper was funded, either wholly or in part, with Federal funds from the U.S. Department of Labor, Employment and Training Administration (ETA) under Contract Number DOLB101A21549. The contents of this publication do not necessarily reflect the views or policies of the Department, nor does mention of trade names, commercial products, or organizations imply endorsement of same by the U.S. Government. This paper was one of three prepared under the 2010 ETA Research Papers Program, which competitively awarded funding to conduct original research and prepare scholarly papers on topics relating to the workforce investment system.

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## Executive Summary

Meaningful labor market intelligence is integral to the articulation of education, employment and training programs supported by the publicly-funded workforce development system. One has to measure what matters in order to deliver what counts. This paper outlines recent developments in an evidence-driven approach to talent management and delivery that is agile in responding to employer-identified evolving and emerging skill requirements. The approach is built around research on the dynamics of supply and demand for knowledge, skills and abilities at the detailed work activity (DWA) level. Analysis of DWAs provides a bridge between macro-level data (e.g., on economic growth, industry staffing-patterns, occupational employment, unemployment rates, etc.) and micro-level decision-making (e.g., individual career exploration, informed choice in the selection of education and training options, job search, employment and advancement). Redesigning research around the DWA construct can provide actionable information for using policy levers and decision-support tools to: clear labor markets more efficiently; make the most economic use of individual human capital.

Until very recently, most of the standardized labor market intelligence used in the public workforce system was built around longitudinal sample surveys (e.g., through collaborative efforts of the states and federal entities such as the Bureau of Labor Statistics and the Census Bureau) & administrative records (e.g., employers' quarterly wage reports to the Unemployment Insurance system, training providers' reports to state and federal education agencies as in the Integrated Postsecondary Education Data System). Scientifically sound *ex post* data collection methods are coupled with taxonomic frameworks (e.g., North American Industry Classification System, Standard Occupational Classification system, and the Classification of Instructional Programs) for organizing and cross-walking time-series data to support inferences and

generalizations about trends in the labor market and their impacts on relevant, service-eligible populations. Such generalizations and inferences historically have been used to drive policy formation and strategic planning (e.g., such as fiscal policy to incentivize economic development and job creation in targeted industry clusters or extending the duration of unemployment insurance benefit payments during demand-deficient periods).

But inherent shortcomings in traditional macro-level data limit their usefulness in decision support at the individual level. First, labor market information gleaned from traditional sources is dated by the time surveys and administrative record reporting periods are closed out, the data are vetted/edit checked, compiled, and publicly released. Secondly, for public release, individual and firm-specific data are aggregated to upper (more abstract) levels within hierarchical taxonomies to avoid disclosure of confidential and proprietary information. While one can make assumptions about underlying job, worker/seeker and education and training characteristics from the general descriptors of lower level categories in those taxonomies, deductive logic will mask and miss: a) nuances in individual endowments of human capital; and b) the relationship between the learning content of actual courses taken and prior work experience relative to permutations in the requirements for actual jobs. Moreover, the descriptors used at lower levels in the respective taxonomies are refreshed relatively slowly: intentionally, to preserve comparability, continuity, conceptual rigor and standardization essential to the shelf-life on longitudinal/time-series data and, pragmatically, given the time, effort and cost required for traditional observational methods and subject matter expert reviews.

Decision-support at the micro-level requires more granular and higher resolution analysis of employment demand and the stock & flow of human capital supply in real time for: individual case management of unemployment insurance claimants, dislocated workers, trade-affected

workers, out-of-work youths and other service-eligible persons; higher fidelity job matching; and more efficient use of the scarce dollars available for training referrals and on-the-job training supports. Use of real-time data grows ever more important as: 1) the accelerated pace in the diffusion of innovation creates new jobs while destroying others; and 2) concomitant changes in the way productive activities and effort are organized at establishment-level create discontinuities between workers' current stock of human capital and their capacity to perform emerging and/or significantly altered work assignments.

Changes in the workplace are driven by product, technology and business process innovations. The creative-destruction and discontinuities come about as knowledge, skill and ability (KSA) requirement change at the sub-occupational level as innovations adopted by businesses are adapted by managers to establishment-specific contexts and modified as necessary to adjust to changes in competitive advantage among rivals. That is, skill requirements change at varied rates at the detailed work activity level from one specific position in ongoing efforts by establishment managers to make ever more productive uses of the human capital on hand. That's where KSA sets are being unbundled, capital is substituted for some and others are off-shored to be performed by cheaper labor, and KSAs are re-bundled into new sets of requirements for existing jobs and new positions. Those dynamics in workflows and detailed assignments at the establishment and position levels are at the heart of discontinuities in the returns to the stock and flow of individual human capital.

Aggregate supply and demand mismatches, well documented by macro-level data, are manifest in individual circumstances. Incumbent workers are dislocated when they can't or won't update their KSAs to handle decoupling and reconfiguration of the DWA bundles comprising current job opportunities. Dislocated and trade affected workers can't be matched

successfully to openings – even in the same industry under the same occupational title of their prior employment – if surviving firms now hiring in their commute shed have recently adopted innovative technology, redesigned their workflows and implemented new, leaner business processes and/or value chain integration practices. The talent pipeline to critical vacancies is empty when training providers (in-house or external) aren't prepared to impart employer-identified new job-skill requirements. Meanwhile, impacts of individual discontinuities percolate back up to the macro-level: businesses forego opportunities to create wealth for want of appropriately skilled talent; civic angst and taxpayer malaise spread as unemployment rates persist at above “normal” levels and wage disparities sharpen; productivity rates and growth curves flatten as under-utilized human capital sits on the sideline; and increased financial burdens fall on the shoulders of businesses to fund safety net measures.

In a free market economy, government does not control individual labor market transactions but it can influence them by providing decision support through collection, analysis and dissemination of timely, relevant and actionable labor market information. In particular, high resolution analysis of job requirements at the DWA level is necessary to identify the unbundling of skill sets, capital substitution for some KSAs, off-shoring of others, and mash-up & re-bundling the of the remainder into new sets. Without that level of granular and detail supply and demand information, strategic planning for the articulation of workforce preparation and economic development is ineffective: the data expected to drive education and training providers' responses don't signal employers' talent requirements clearly and unambiguously; case management tools for matching of job-seekers' skills (ascribed to prior occupational employment and educational attainment) to those required in job postings don't work well when the former are obsolete or severely depreciated and latter are unprecedented; and conventional

pathways which historically led individuals through typical career progressions are confounded by significant changes in staffing patterns, workflows and concomitant job skill requirements.

Now, more powerful (and affordable) automation tools are being developed and refined for accessing labor supply and demand data in real time and for doing deep analytics to better align placement (i.e., for more effective use of the current stock of human capital) and the skill-object content of learning events manifest in the classroom or through work experiences (for more efficient and relevant efforts to reshape the flow of human capital development) with employer-identified requirements and qualifications to perform critical DWAs. Most of this kind of essential micro-level information resides in unstructured natural language text in the digital world outside the boundaries of highly structured, standardized time-series data and administrative records. By taking advantage of semantic web capabilities for data mining of unstructured but machine readable artifacts, information is gathered, tagged, chunked & classified, parsed and analyzed in real time to keep pace with changes wrought by the accelerated diffusion of innovation and discontinuities in the returns to human capital.

- For example, “spidering” techniques modeled after those used by large search engine providers and e-commerce firms (e.g., Google, Amazon) to drive in-house marketing strategies, are being used to scrape job notices from the publicly-funded labor exchanges (e.g., WorkinTexas supported by the Texas workforce Commission), commercial job banks, social networks (e.g., Craigslist and LinkedIn) and corporate sites. “Aggregator” (such as HelpWantedOnline, Burning Glass and Geographic Solutions), deliver the information to state workforce agencies, local workforce investment boards and One-Stop Career Centers.
- In a parallel development, semantic analysis capabilities and artificial intelligence imbedded in new web-based toolkits and utilities translate information from both sides of the labor

demand and supply equation into a shared skills-based language that serves as the common currency for mapping, cross-walking and matching one to the other.

- For example, job analytic tools originally developed by for driving human-system integration and cross-branch human interoperability for the Department of Defense were automated during the first Gulf War to keep pace with the accelerated pace of change in warfare technology and the fluid dynamics of theater and battlefield deployment.
- Such tools and techniques were refined and adapted over the past decade for equally rapid analysis of civilian job requirements for individual businesses in the private sector and gap analysis to drive firm-level succession planning & training, recruitment and human resource management.
- By applying those automated, semantic analysis tool to real-time data on job postings, the kind of micro-level data required to support individual level decision-making is becoming more reliable and readily available for managing publicly-funded education, employment and training programs.

Several states, regional consortia and individual workforce investment boards already have piloted the use of these tools and techniques. They have proven successful in Texas, for example, for mapping employer-identified job skill requirements to core learning objectives in: the state-wide career cluster initiative for public education's career and technology education programs; in the Texas Higher Education Coordinating Board's Workforce Education Course Manual; individual course offerings at pilot school district and community college sites; and standard skill certifications in industry clusters targeted for economic development. Based on evidence from demonstration projects (combined with lessons learned from the "qualifications

framework” movements in Australia, Great Britain and the European Union), it is likely that states and workforce investment board regions will quickly adopt best practices in real time labor market data collection, micro-analysis and evidence-based decision support. In the upcoming reauthorization of the Workforce Investment Act, policy-makers should consider revising processes, rules and funding allocations for improving labor market information. Very granular, real-time labor supply and demand data can be gathered and analyzed to support micro-level decision-making. These kinds of data could be added to, rather than intended to replace, the repertoire of lagged indicators of supply and demand from standard longitudinal surveys and administrative records currently used to help frame macro-policy formation and workforce program administration. Trials aimed at scaling up and extending recent pilot efforts likely will demonstrate that the application of such innovative tools and techniques will result in captured savings (through more efficient job matching and training referrals, for example) to offset the upfront investments required for deployment, workforce intermediaries’ training, on-going data development, and creating schemas for delivering actionable information in formats tailored to the diverse needs of various user populations.

## **Introduction**

### **Overview**

Three forces have converged to drive an agenda for making the public labor market information (LMI) more useful for operational decision-making. Persistently high unemployment in the face of structural change indicates a pressing need for high resolution micro data on skill demand and supply to drive person-job matching and individual decisions about human capital investments. Returns to specific skills are significantly impacted by the accelerated pace of innovation and its diffusion. That necessitates using real-time data for analysis of gaps between job skill requirements and individual skill endowments on a scale that has never previously been attempted. Computational capacity has improved and costs have decreased enough to change the landscape of what is doable and affordable regarding the scale of effort required in collecting and analyzing micro data in real-time. This paper lays out a new model, what data would be needed to populate it, and the technical developments which may remove cost and capacity-related obstacles to enhancing the public LMI system to better serve operational and individual decision-making.

### **Purpose of the Paper**

The purpose of this paper is to examine the data requirements in decision support for employers, job seekers, workforce intermediaries and education and training providers to better align the demand for and supply of skills. Problems of reemployment and employability are triaged at the individual level. Macroeconomic analysis can identify the broad results of creative and destructive forces at play as innovations drive economic growth. Aggregate statistics are useful in detecting maladjustments in the labor market. But uptake and implementation of innovation vary widely at the establishment-level where job content and work assignments are

determined. Moreover, uptake and mastery of new knowledge and skills required to adjust to new work arrangements varies at the worker level. Highly aggregated information organized around the concept of occupations masks the variance at the job level in skill requirements and at the person level in the stock and flow of their skills (endowments and acquisition). Case management and individual decisions by employers and job-seekers in consummating employment transactions requires more sensitive decision support tools built around micro data.

Efforts are underway to devise alternative ways of mapping skill demands at the job level to the supply of skills at the person level and to skills imparted by programs in the training inventory. Highly specified data are needed in all three areas for identifying job content, worker characteristic and learning objects. Sources of information other than standard survey-based data are being tapped in real-time in an effort to build effective decision support tools for operations and individual decision making. This paper explores whether skills modeling of detailed work activities (DWAs) can be used to supplement today's occupation-centric, survey-based labor market information system for the purpose of improving the employability of individuals and filling job vacancies.

### **Organization of the Paper**

This paper examines the evidence of maladjustments in the labor market that result from the uneven impacts of innovation on demands for, and supply of, skills. Macroeconomic tools for taking the pulse of the labor market are used to drive monetary and fiscal policies aimed at ameliorating the harsh effects of economic downturns. But persistent high unemployment indicated that macroeconomic levers (fiscal and monetary policy) have not worked rapidly to address the maladjustments.

Problems of unemployment and employability are manifest in skills gaps that must be addressed at the individual level since no two cases are identical. Since there is no one size fits all strategy, case management in the workforce development system has become a matter of triage. But the labor market information available to case managers is chiefly occupation-centric and survey based. Decision support tools build around those data are not sufficiently sensitive to the underlying heterogeneity in job content and individual skill endowments to drive triage case management. Tools for supporting training referrals and informed choice of training options are not sufficiently sensitive to heterogeneity in learning objects at the course level to determine which options can remedy individual skills gaps or to estimate the cost-effectiveness of alternatives as individuals try to make informed choices.

Alternatives currently are being explored to map different aspects of skill supply and demand interaction. One approach entails using real-time data at the detailed work activity level DWA for building Artificial Intelligence (AI) tools to support operational decisions and guiding individual decision-making by employers and workers. The DWA-based approach entails collecting relevant information in real-time about fluid and dynamic workflow and job content reconfigurations at the job level and the knowledge, skills and abilities (KSAs) workers need to have (or acquire) in order to be employable as innovations ripple through the economy at an ever accelerating rate. Gap analysis derived from skill demand and supply comparisons at the micro level can be translated into actionable information for employers, job-seekers, intermediaries and education and training partners in the workforce development system.

Pilot and demonstration projects have served as proof of concept. Ideas for expanding and refining decision support tools for case management might be found in similar exploratory activities currently underway in other domains (e.g., military context, vocational training, skill

assessment and certification) here and abroad. Additional research, data development and tool refinements are needed to flesh out the model and for designing decision support tools for delivering actionable information in a variety of human capital development, deployment and management contexts.

The primary objective is to identify opportunities to augment occupation-centric, time-lagged survey data in the current LMI system with real-time analysis of skill demand and supply at the person and job level. The DWA concept is currently used in at the occupation level for deductively imputing content to jobs and characteristics to workers. If taken to the job opening/person level of specificity, the DWA construct might serve well as the common element for inductively organizing and linking micro data about job content and worker characteristics to better inform case management and individual decision making. Further development and implementation have both funding and policy implications that need to be further explored before committing more resources to a skills-based approach.

### **Microeconomic Decisions in a Context of Accelerated Diffusion of Innovation**

Disruptive product and process innovations have the potential to create, alter, and destroy jobs. Incremental innovations impact comparative advantage among rival firms. While uptake is a firm-level decision, implementation of innovation is an establishment-level activity. In adopting innovation and adapting to the fluidity of comparative advantage, managers dynamically reconfigure the mix of human capital and technology in the workplace. Reconfiguring the way human effort is organized and workers' time is appropriated for productive use changes job content and required worker characteristics. Similarly, the diffusion of innovation has the potential to impact the aggregate supply of skills, but skill acquisition is a highly variable person-level activity.

By and large, the concept of creative-destruction wrought by innovation has been used to describe economic development at relatively high levels of abstraction at the national, regional or industry level. But the dynamics of innovation and diffusion play out in the labor market as establishment-level work arrangements and individual job-person employment transactions. Occupation, the primary construct used today for organizing the public LMI system, is too abstract to describe individual choices made by employers and workers as uneven diffusion of innovations and knowledge create skills gaps. And sample surveys which gather data on past occupational employment transactions do not yield information that is timely enough for managing workforce operations as the pace of the diffusion of innovation accelerated. To respond effectively to rapid and increasingly frequent changes at the micro-level, employers, workers and the workforce intermediaries who serve both need real-time data on the demand for, and returns to, skills rather than time-lagged, occupation-centric data gathered through sample surveys.

### **Creative Destruction of Innovations**

Joseph Schumpeter (1934) is generally given credit for developing a theory of the creative and destructive aspects of innovation to explain general economic development and patterns in business cycles. The birthdates of inventions or novel business ideas prior to Schumpeter had been used as milestones in the history of economic growth (e.g., linking the steam engine to the industrial revolution; Henry Ford's assembly line to mass production). But Schumpeter made a distinction between inventions and innovations, between inventors and the entrepreneurs who took them to market. Innovation in Schumpeter's view consists of not only marketing new commodities and ideas but also using new supply sources, rearranging production, managing inventories, and adapting an organization to changing conditions. For

Schumpeter, the creative destruction of innovation worked to drive economic growth and improve the standard of living for all in the long run by weeding out old inventories, technologies, and equipment that were obsolete and inefficient business practices.

Schumpeter was less concerned with naming stages of economic development than with examining how the adoption/implementation of innovative products and business practices manifest in the birth and growth of firms (and in the death of firms which fell behind their rivals in establishing comparative advantage). Unemployment was a natural consequence of both firm deaths and the displacement of workers from businesses that changed their workflows and production processes. Just as a business's inventories could be rendered obsolete by an innovative product, some or worker's entire skills inventory (legacy endowments) could be rendered obsolete by innovations. Business cycles, to Schumpeter, reflected:

- 1) the periodic (but fairly regular) occurrence of innovations;
- 2) latency in:
  - a. responses at the firm level to new forms of competition and comparative advantage;  
and
  - b. an individual's acquisition of the skills necessary to perform emergent roles in new work contexts.

The destructive effects of innovation are felt most immediately as obsolete inventories go unsold, or businesses fail or stagger while overcoming obstacles to change. But the creative effects play out more gradually as firms learn to imitate, duplicate and improve upon a disruptive innovation and as workers acquire necessary skills to meet new job requirements. Periods of duplication are followed by consolidation which flattens out growth until the next innovation come along to disrupt the economy again. Similarly, individual learning activities eventually

saturate the demands for skills to the point where the market value of (or returns to) skills diminishes.

In looking at the impact of innovations on the economy, the chief thing that Schumpeter's theory of creative destruction did was to put the entrepreneur and the manager at the center of attention. In doing so, he provided a crucial link between macroeconomic analysis of aggregate economic activities and microeconomic explanations of firm deaths, birth and growth and of concomitant employment demands. While Schumpeter stopped short of doing microeconomic analysis, his work did point out to differences in employment opportunities for groups of workers (e.g., farmers, crafts persons, artisans, and factory workers). Thus, his work hints at skill deficits and skill acquisition as key variables in employability, employment and earnings.

### **Diffusion of Innovations**

Everett Rogers's work on diffusion provides additional insights regarding variability in the take up (adoption) and implementation of innovations. (Rogers, 1983) While adoption of some innovations are mandated by authorities (i.e., changes in the rules), the vast majority are optional. Adoption is a firm-level decision, such as acquiring intellectual property rights; authorizing technology/equipment purchases; redefining goals, objective and performance measures. The rate of adoption varies between firms according to the decision-maker's exposure and attentiveness to new ideas; access to communication channels containing more detailed information; and the subjective perception of the evidence regarding relative advantages of adoption or rejection.

Implementation of innovations is an establishment-level variable, such as reorganizing workflows and procedures; adjusting staffing patterns; assigning detailed work activities.

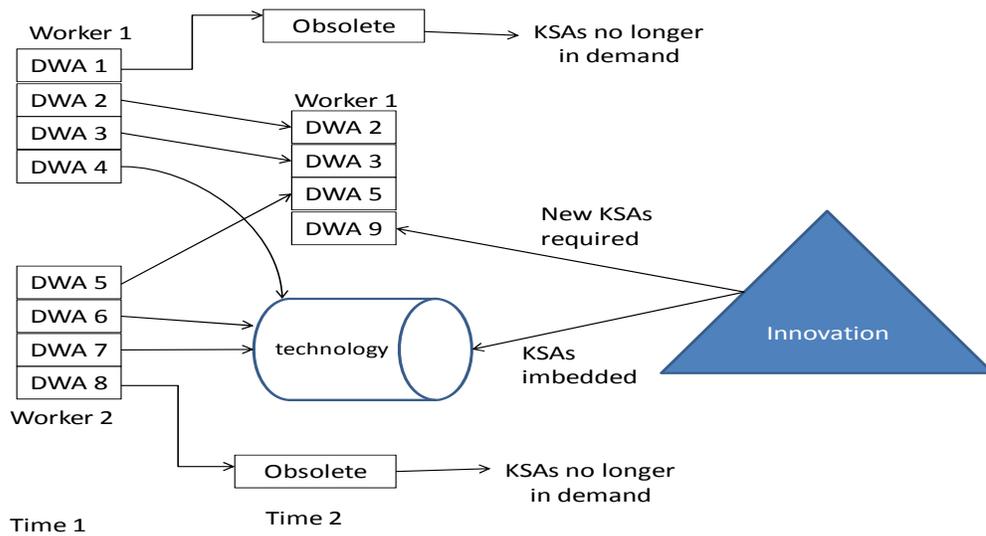
Implementation details will vary from one establishment to another depending on the complexity

and scalability of the innovation; the innovation's compatibility with existing operations; access to resources to cover the cost of change; and the individualistic evaluations made by the agent in charge.

The primary management challenge in today's knowledge economy is determining how to make the most productive use of knowledge inputs or knowledge assets (Machlup, 1962; Machlup, 1984; and Drucker, 1969). Knowledge asset include those possessed by humans and those imbedded in technology (e.g., numeric process control devices; the programming of computer-assisted manufacturing devices; and "smartware"). Detailed work assignments make human knowledge assets (including skills and abilities) useful "through arrangements to appropriate [the worker's] time in activities directed toward production" (Bourlieu, 1986). While knowledge has intrinsic value, Bourlieu points out that it is through this "convertibility" that a "priceless thing" is given its price and is rewarded in the marketplace.

Peter Drucker used the phrase "age of discontinuity" to describe the frequent disruptive innovations and almost continuous incremental changes in the imitation and refinement phases of the life cycle of innovation. He suggested that scientific management in an age of discontinuity entails continuously improving work arrangements and processes to gain and sustain competitive advantage. Human effort and technology are remixed (through revisions in detailed work activities) as more knowledge is imbedded in the technology and the price differential between human effort and capital equipment fluctuates. (Drucker, 1959; Drucker, 1969; Drucker, 1993; and Drucker, 1999).

### Reconfiguration of DWAs (the “mash up”)



By changing the job content, a reconfiguration of DWAs also changes what knowledge, skills and abilities are required of the worker and their market value. Kenneth Boulding (1996) noted that the market value of a unit of knowledge can change over time even though its “truth value” is unchanged. The same logic would hold for skills in that their market value may decrease even if one’s proficiency level stays the same or even increases. And the market value of a particular ability may decrease even if the ability itself is undiminished. Workers must adapt to the discontinuities to remain employable and to bolster their earnings potential.

### The Diffusion of Knowledge

The market value of skills to a worker is a matter of supply and demand. Boulding draws a useful analogy between “bits” in the computer world and units of knowledge which he labeled “wits.” The value of wit, as with bits, fluctuates with supply and demand. An eight bit microchip has a fixed capacity to hold information even though it is rendered obsolete by the thirty-two bit chip. And, as rival firms ramp up production of thirty-two bit chips, competition drives down the

unit price of each. Indeed, the market for thirty-two bit chips eventually is saturated. Producers either consolidate or move on to produce something else according to pricing signals from the market. Boulding (1996) suggests that entropy occurs when marketable knowledge is “spread out into a “thin brown soup”. That is to say, that as the knowledge to do a particular job becomes less scarce, the unit value decreases.

Just as the diffusion of innovation entails different take-up rates by firms and variance in implementation at the firm level, the diffusion of the knowledge required for work is not acquired uniformly by individuals. Take-up rates and absorption will depend on individual attentiveness and access to channels of information; the compatibility of the new knowledge with one’s legacy endowments; the complexity and clarity of the information being disseminated; and selective perception or individualistic interpretation of the market signals. Bourlieu (1986) suggests that selective perception is particularly important since two factors go into the individual decision to put forth the effort to acquire new knowledge. The “calculated estimate of financial gain” by individuals as rational actors can be distorted by their “emotional investment” in what they already know and can do. At the individual level, that means uneven adjustment to the discontinuities.

### **Accelerated Diffusion**

The diffusion of both innovations and knowledge are accelerating along with greater variation in business and individual adjustments to the discontinuities. J. Quinn (1997) wrote about the “innovation explosion.” Dismukes (2005) provides a long list of factors contributing to the accelerated diffusion of innovation, including collaborative research; expedited technology transfer and licensing of intellectual property (IP) rights; mergers and acquisitions to acquire IP; rapid design, prototyping and testing; reverse engineering and workarounds; open source

development; improved information retrieval, data mining and more sophisticated pattern detection. Indeed, government itself, recognizing that innovation is an engine of growth, is incentivizing accelerated diffusion of innovation (e.g., Innovate America initiative). The combination of intensified scientific push (e.g., search of knowledge) and consumer market pull (manifest in intensified applied research) has moved the time horizon of innovation from 50 years in the Nineteenth Century to five years in today's knowledge economy. He estimates that the joint efforts of academic researchers, government incentives and engineering efforts will shorten the time horizon to three years.

Journalists have painted scenarios to show how the diffusion of knowledge also is being accelerated. Barnet and Muller (1974) described the world as getting smaller because of advances in transportation (transatlantic flights) and communications (the transoceanic telephone cables and facsimile machines). Thirty years later, Thomas Freidman (2005) added a litany of factors making the world "flat." Essential they were describing the proliferation of channels of communication, increased access to them, and the faster distillation of knowledge into less complex chunks that could be codified, even reduced to binary decision trees – making it easier to apply.

Nonetheless, diffusion of knowledge lags slightly behind the diffusion of innovation because of what Cesar Maldonado (2008) describes as "informational latencies." It simply takes time for the "tacit knowing" of the inventor (the "Ah ha!" epiphany of discovery) to be articulated and shared with peers as tacit knowledge. Additional time is required to crystallize tacit knowledge into explicit knowledge so it can be communicated more efficiently and clearly through formal instruction; codification as standard operating procedures; and, in many cases to binary decision rules (Nonaka & von Krogh, 2009). But the availability of new knowledge does

not translate into uniform and immediate uptake or absorption. Maladjustments in demand and the supply can occur as reconfigurations of DWAs at the establishment-level change job content and the required KSAs faster than workers are willing to invest in, and capable of mastering them. Problems in filling jobs or performing work assignments are compounded if workers have not fully adjusted to discontinuities caused by one wave of innovation before the next innovation is upon them. The accelerated diffusion of innovation necessitates the constant mining of micro data to identify emerging job skill requirements in order to provide information individuals need to make timely adjustments.

## **Understanding the Labor Market at Different Levels: Maladjustments and Discontinuities**

### **Macroeconomic Signs of Maladjustment**

Various aggregate statistics are used as the vital signs of the economy and general maladjustments between labor supply and demand. Macroeconomists look for trends in aggregate employment to determine what effect various policy levers are having on shaping responses to maladjustments at various stages of businesses cycles. When the economy is in recession, analysis is done at the macro level to forecast how long before recovery returns the economy to “*normalcy*”: V-shaped curve (rapid and steady return to normal); U-shaped (steady but slower); or W-shaped (staggered, “*double-dipped*”). And what will indicate that normalcy has been reached? Some now assert that the “*new normal*” rate of unemployment has risen from 5% to somewhere between 6.25% and 7.55 (Peck, 2003; Weidner & Williams, 2011; Daly, and Hobijn & Valletta, 2011).

The macro-economic levers at policy-makers' disposal for achieving other economic policy objectives<sup>1</sup> are not equally effective in stimulating the labor market. While an economic downturn can manifest quickly as a generalized or pervasive “*negative demand shock*” to the labor market, it is not uncommon for aggregate employment to rebound at a slower rate than income growth and aggregate output after a recession. With each recession since 1980 job cuts have gone deeper and employment rebounds have been ever slower (Goshen and Potter, 2003).

Aggregate data are used by policy-makers to formulate economy-wide solutions which might ameliorate the harsh impact of employment demand-deficiencies during downturns in the business cycle. Changes are made periodically in unemployment compensation benefit amounts and duration of eligibility to give affected workers more time to adjust. Industry focused or geographically targeted incentives are provided to stimulate job creation. Caps on H-1B visas are altered. And efforts are made to create jobs indirectly through incentives intended to stimulate consumer demand. Concerted effort by government academic and research institutions and entrepreneurs to accelerate innovation as a driver of economic growth and job creation (Dismukes, 2005) have the unintended consequence of creating more discontinuity at the establishment- and individual-level.

The jobless nature of recoveries since 1980 prompted some Federal Reserve Bank analysts, including the president of the Minneapolis Bank, Narayana Kocerlakota, to question whether persistently high unemployment is “amenable to monetary policy” (Reamer, 2010b; and Kuang & Valletta, 2010). Monetary and fiscal policy can directly incentivize production (such

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<sup>1</sup> The Full Employment Act of 1946 was amended by The Full Employment and Balanced Budget Act of 1978 to weigh the use of monetary and fiscal policy levers to achieve concurrent policy objectives (such as growth in production, price stability, balance of trade and a balanced budget) while keeping unemployment within natural bounds.

as through counter-cyclical government procurement)<sup>2</sup> and indirectly stimulate consumption.<sup>3</sup>

Macro-economic levers can only induce employment demand. But they have almost no effect on shaping individual management decisions about how to organize work, define job content and assign detailed work activities to appropriate the individual's time to productive uses.

Maladjustments are evident in data from the current business cycle. The National Bureau of Economic Research (NBER) officially declared that a recession began in December of 2007. They declared that it had ended in June of 2009<sup>4</sup> as economic output and productivity showed signs of growth (NBER, 2010). But as the second anniversary of the recession's official end approaches, the U.S. Bureau of Labor Statistics (BLS) reports that the national unemployment rate continues to hover around nine percent. An estimated 13.7 million Americans are out of work.<sup>5</sup> Of those, more than 43 percent (5.8 million) are considered long-term unemployed.<sup>6</sup>

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<sup>2</sup> The stimulus package funded infrastructure improvements (e.g., road construction projects) that otherwise would have been put on hold as state and local governments – required by law to balance their budgets – faced revenue shortfalls. The stimulus also mandated moving forward to retrofit federally-owned structures with energy-saving technology. And it included financial incentives to entice consumers to weatherize their homes, trade in their “clunkers” in for new, better mileage cars and to buy Energy Star rated home appliances. The stimulus also was touted as “*saving jobs*.” In some instances, the number of jobs saved could be measured directly (e.g., through federal grants to state education agencies to cover budget shortfalls that otherwise would have led to teacher layoffs). But to date no agreed upon method has been developed for calculating the total number of jobs saved.

<sup>3</sup> Income supports (such as unemployment compensation) and capital infusions for faltering businesses help them make payroll provide the wherewithal for consumers to continue spending on basic, nondurable goods (e.g., groceries) and services in the short run. Eventually, they are said to “*spend their way out of a recession*.”

<sup>4</sup> The NBER's Business Cycle Dating Committee (BDC) provides the authoritative begin and end dates of recessions. (<http://www.nber.org/cycles/sept2010.html>). The BDC uses a variety of macro-economic indicators in determining the beginning and ending dates of a recession — primarily the Gross Domestic Product (GDP) and Gross Domestic Income (GDI). Two of the seven indicators used by the BDC involve aggregate employment. Technically, NBER can declare that a recovery has begun on the strength of other indicators while the two indicators of employment it uses remain flat or sluggish (Beleiciks, 2010). Ironically, employment demand can remain sluggish even while the GDI *per capita* is increasing<sup>4</sup> (*CalculatedRiskBlog*, 2010).

<sup>5</sup> Not all out-of-work persons are eligible for unemployment compensation. The ETA reported that more than 3.79 million persons received unemployment insurance (UI) benefits in the week ending April 30, 2011. The four week rolling average for the number of new claims filed was 432,250 per week.

Average duration of unemployment exceeded six months for the first time since 1948.

Approximately 2.5 million are considered only “marginally attached” to the workforce. Of those, approximately 989,000 are considered “discouraged workers”<sup>7</sup> (BLS, May 2011).

At a distance from individual employment transactions, macroeconomic levers may be working to rejuvenate the economy as a whole, increase output, restore comparative advantage and move generally towards more productive use of human resources. As aggregate output and productivity increase, the standard of living, on average, will exceed pre-recession measures.<sup>8</sup> Some, like the Chairman of Regan’s Council of Economic Advisors, note that it simply takes time for workers dislocated from inefficient firms or who exit low productivity, declining industries to find new jobs in high productivity, expanding ones (Feldstein, 2003). Eventually, he contends, enough jobs will be created to absorb workers dislocated during the recession as well as new entrants.

For now, despite improvements in many macro-indicators, this rebound is labeled as a “jobless recovery”<sup>9</sup> (*Economist*, 2010; *Economist*, 2009). Innovations may be adopted to increase output but that does not necessarily entail job growth. In a fragile and tentative recovery, risk-adverse businesses are reluctant to resume hiring for fear that early indicators of

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<sup>6</sup> Unemployed for twenty-seven weeks or more.

<sup>7</sup> Out of work, available for work but no longer looking because they believe no jobs are available for them.

<sup>8</sup> When measured in the aggregate or *per capita* – as the mean rather than as the median. Those who believe we should consider the disparate impacts look instead at changes in the Gini Coefficient. That index compares the wealth held by those in the top quintile versus those in the bottom. The Gini Coefficient increases when the top group becomes significantly better off and the bottom significantly worse off even if average income remains constant or increases.

<sup>9</sup> Larry Summers, Director of President Obama’s National Economic Council, used the term to describe America’s recovery from the 2008 recession when he addressed the chief economic advisors of other nations at the World Economic Forum in Davos, Switzerland, in February, 2010.

economic growth may give false hope. An increase in consumer purchases may be only a temporary one in a “*double-dip*” recession.<sup>10</sup> Rather than recall laid off workers immediately or going on a hiring splurge to meet increased demand for their output at the first sign of recovery, risk-adverse businesses might give more hours to part-time workers and overtime to full-time workers retained during the recession. Some firms may use times of slack demand during a recession as an opportunity to reorganize the workplace (e.g., substituting capital equipment and technology for labor; reconfiguring workflows). Firms that outsourced non-core activities,<sup>11</sup> shortened production runs<sup>12</sup> and reorganized work processes to reduce labor costs might never return to their pre-recession staffing levels. Others may seize on the opportunity to assign work activities to lower cost labor offshore as the diffusion of knowledge expand the global talent pool. If positive signs of recovery persist, employers may use temporary help and contract labor for increasing output to meet demand<sup>13</sup> (Holden, Luo, & Mann, 2010; Froeschle, 2011, slide 31).

Some employers wait until macroeconomic indicators of recovery have been positive for several consecutive months before they have confidence enough to recall workers they laid off and to create new jobs. Even then, they may exercise caution in offering shorter employment contracts. By shifting toward greater reliance on an at-will workforce and shorted work

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<sup>10</sup> For example, some forecast that new car sales would decrease again once the “*cash for clunkers*” money was exhausted or orders for home improvement projects would decline once stimulus incentives for weatherization expired.

<sup>11</sup> One example is subcontracting with a food service company to operate an on-site employee cafeteria.

<sup>12</sup> For example, building-to-order (i.e., producing only enough to fill purchase orders as they arrive) rather than building-to-stock (i.e., producing large quantities in long production runs, warehousing them and paying carrying charges on the inventory while awaiting orders).

<sup>13</sup> Changes in employment can be tracked by sector and for some select bell-weather industries through monthly BLS data releases at <http://www.bls.gov/news.release/empsit.t17.htm>. The American Staffing Association extracts data from those BLS reports then computes the percentage of new jobs added to the economy each month by the staffing industry (NAICS 6056) at <http://www.americanstaffing.net/statistics/bls.cfm>.

arrangements, businesses leave themselves flexible and “nimble” enough to change staffing levels quickly if and when the next shock hits the economy as a whole. It also leaves them flexible enough to change staffing patterns and job content if and when the next innovation or demand shock impacts their industry sector.

Macroeconomists pour over summative statistical data looking for evidence that the labor market as a whole has adjusted to make better economic use of human capital by reallocating labor supply to more efficient sectors and establishments. Risk-adverse businesses look for signs that will restore their confidence. But for those who lost their jobs during the recession (or whose dealing with discontinuity between their skills endowments and market demands) the question is whether jobs of the future will be suitable for them in terms of demanding the skills they possess and offering a replacement wage.

Aggregate statistics, analysis of supply and demand equilibrium, and discussions about unemployment compensation’s distorting effects on market signals or better economic use of human resources are of little use to those on the front line in, and customers of, One-Stop Career Centers who deal with the concrete reality of persistently high unemployment. While quantifying trends in total output, aggregate income, and system-wide maladjustments in labor supply and demand, macroeconomic indicators do not provide specific guidance for unemployed individuals looking for suitable reemployment. Workforce intermediaries operate case-by-case to find solutions. They focus their efforts on helping unemployed persons access the public labor exchange, make sense of the available LMI, and use it to guide their decisions. But operating in the arena of micro-economic as help individuals who are jobless to recover, they need different kinds of labor market information. In particular, they need to identify skills gaps before they can devise a strategy for addressing discontinuities at the individual level. They also need to

understand how returns to their skills can decline as diffusion makes the particular KSAs they possess less scarce — per Boulding’s imagery of knowledge spreading into a thin brown soup.

### **Microeconomic Labor Market Information Needed for Triage to Address Discontinuities**

Unemployed individuals face the same hardships whether they are part of the new normal instead of the old normal. But individuals face different scenarios — requiring different strategies and workforce services — as they collectively ride toward a new equilibrium between labor supply and demand. Macroeconomic concerns about the likely shape of the recovery do little to provide actionable information at an operational level to help those who are currently out of work and unable to find suitable work. Information at the micro-level about one’s stock of skills relative to the flow of job skill requirements is critical to individual employability. Data mining of job postings in time series would better serve inductive modeling of skill demands than deducing them from or imputing them to occupational employment demand analysis of survey data.

Just as Drucker pointed out that there is no one-size-fits-all management solutions for adapting to innovation at the establishment-level, there is no singular solution for individuals to adjust to discontinuities in the skills required of them — particularly if they do not fully recognize what the discontinuity at the personal level implies for their future employability and earnings potential). For some (e.g., older, dislocated workers and low-skill younger workers) one possible post-recession scenario is a personal downward slide from which they will never fully recover. During the recovery (and well-after) they might either remain unemployed or chronically under-employed<sup>14</sup> (cycling through bouts of unemployment, involuntary part-time

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<sup>14</sup> BLS’s updates “*Alternative Measures of Underemployment*” monthly at <http://www.bls.gov/news.release/empsit.t15.htm>.

employment and jobs that do not pay a replacement wage<sup>15</sup>) unless they acquire new skills. For these individuals, recognition of the discontinuity at the personal level can provide the motivation to acquire new skills. Identifying skills gaps and person-to-training matching rather than reemployment are the more immediate challenges to assure their employability. On the other hand, the upward sloping line recovery could well represent a positive scenario for new entrants, i.e., young, college-educated workers who have in-demand skills for jobs in new, high-performance establishments in advancing sectors and immigrants willing to take low-wage, low-skill jobs particularly in the service sector (Alstadt, 2010 and Dorrer, 2010a). They chiefly need help, for now, locating employers with jobs and connecting to them. From a micro-economic perspective, more light needs to be shed on person-specific human capital — and in particular on skill deficiencies among the unemployed when maladjustments in the market are indicated by aggregate statistics about job vacancies going unfilled while there is a numerical surplus of labor.

It is important to unemployed persons to understand whether they are caught in the undertow or on an upward trajectory — it is a matter of both their stock and flow of skill currency. Individual skill stocks and flows also are important to the case manager in crafting reemployment strategies that fit individual circumstances. In addition to looking at an individual's employment at a particular slice in time (a stock issue), it is important to look at their “employability” (a flow issue). Jim Vollman suggests that differentiating between employment and employability (between skill stock and flow) frames a case management triage strategy

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<sup>15</sup> The wage earned in last job prior to becoming unemployed. Performance of job placement effort commonly judged successful if re-employed person achieves an 80% replacement wage set as a goal by Congress in the Trade Act. See p. 15 (*Exhibit A: Draft of Employment and Training Administration Training and Employment Guidance Letter*) Final Order for Dismissal (settlement agreement) in *Association de Trabajadores Fronterios, et. al. v. Department of Labor, et. al.* (December 29, 2005) in the United District Court in the Western District of Texas (El Paso, Honorable Frank Mantalvo presiding). Available on line at <http://www.clearinghouse.net/chDocs/public/PB-TX-0001-0003.pdf>.

which more effectively sequences services, i.e., job search assistance for those whose skills have currency in the labor market or prompt diversion into training for those who do not (Vollman, 2010b). Micro-level data, rather than macro-level data, are essential in triage based on comparing an individual's skill endowment (stock) to current demands for skills in the local market and flow of skill development relative to trends in market demand.

As Maine's LMI director, John Dorrer, told discussants at a Brookings Institution roundtable in 2010, "Skills mismatch is perhaps the most significant workforce development/economic renewal challenge" (Dorrer, 2010a). Andrew Reamer, that Roundtable's chair added, "There are not enough with the cutting edge skills coveted by tech firms; too many people with skills that can be duplicated offshore at a lower cost"<sup>16</sup> (Reamer, 2010b). Increased duration of unfilled job vacancies, high vacancy-to-hire ratios and high ratios of unemployed persons to job openings suggests that skill mismatches are due discontinuities in the way work is organized and how human capital is deployed at the establishment-level (Cappelli, 2011). Micro-level data — rather than aggregate information about employment demand deficiencies — would provide better insight and case management responses to employability in the face of persistent unemployment above the presumed normal rate (Clark; Frummerman, 1979; Nagypal).

This paper asserts that highly aggregated statistical data used for deductive macroeconomic modeling do not provide sufficiently granular information to respond effectively to that portion of unemployment which is due to discontinuities resulting from lags in personal human capital development relative to changes at the establishment-level in job content and the way work is organized. Moreover, given the accelerated pace of change, the need is for micro-

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<sup>16</sup> Relevant data are obtained by the Bureau of Labor Statistics through its Job Opening and Labor Turnover Surveys (JOLTS).

level data in real-time rather than for time-lagged survey-based data (Dorrer, 2011; Vollman, 2010; Alstadt, 2010; Vollman, 2010a; Vollman, 2010b).

Yes, jobs are created during a recovery – but, in an era of structural change, many new jobs are in new industries, in new locations requiring new skills (Goshen & Potter, 2003).

Granted, the workforce development network’s communications channels have been expanded to provide job-seekers easier access to information about the availability about those new jobs.<sup>17</sup>

And, granted, case managers are trained to motivate or incentivize job-seekers to search more intensely<sup>18</sup> and to coach them in using search strategies based on deductive models which impute transferable skills to occupations. But expanded and easier access to job vacancy notices, increased search intensity, and deductive occupation-centric transferable skills models are of little use when individual job-seekers’ legacy skill endowments do not fit job skill requirements specified by employers in their current postings; seekers are too encumbered to move where new jobs are being created; or they overestimate the future value of skills in their individual endowment (stock) of human capital relative to changing workplace demands and increased competitiveness of a global talent supply.

**The fundamental problem from an operational perspective is that workforce intermediaries, operations managers, and individuals lack sufficient micro-level information and refined decision support tools to respond effectively in real-time to**

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<sup>17</sup> Aggregation services such as HelpWantedOnline (HWOL) from the Conference Board and Burning Glass deliver data scraped from general, occupation-specific and firm-specific electronic job boards. The data have been stripped of duplicated postings and are reassembled by geographically for use by state-operated, regional, or subscribing firms’ labor exchanges.

<sup>18</sup> Consider, for example, the Worker Profiling and Reemployment Services (WPRS). The intervention identifies UI claimants with weak labor force attachment who are most likely to exhaust benefits before regaining employment. Those claimants are provided more intensive job search assistance such as mandatory workshop attendance as a condition of continued benefit eligibility.

**maladjustments in human capital supply and demand due to structural changes at the establishment-level in the way work is organized and job content is being dynamically reconfigured through variable adaptation to innovations. Resultant skills gaps need to be identified at the individual level before discontinuities can be addressed to help them become employable.**

John Dorrer summed up the situation best when he asserted, “Traditional public data systems must adjust, become more nimble and need to be adequately funded” (Dorrer, 2010a). While those with an operational perspective generally agree that the LMI system must become more nimble and micro-level data are needed to meet their needs, there seems to be no consensus on precisely what adjustments should be made.

### **Making the Most of Today’s Occupation-Centric LMI**

#### **Components of the Public LMI System**

The U.S. Department of Labor (DOL) — in collaboration with the Office of Management and the Budget (OMB), state workforce agencies, local workforce investment boards (WIBs) and various entities within the U.S. Department of Commerce — has established a comprehensive LMI system. At the core of that system, DOL’s Employment and Training Administration (ETA) maintains and operates the Occupational Information Network (O\*NET)<sup>19</sup> which organizes data about work content and worker characteristics around the Standard Occupational Classification (SOC)<sup>20</sup> taxonomy. In the terminology of relational database management, occupation serves as

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<sup>19</sup> The O\*NET Content model is thoroughly described at [http://www.onetcenter.org/dl\\_files/ContentModel\\_DetailedDesc.pdf](http://www.onetcenter.org/dl_files/ContentModel_DetailedDesc.pdf).

<sup>20</sup> <http://www.bls.gov/soc/>

the key field — a field shared in the files structures of the LMI system’s components — which allows other data elements in their respective records to be linked and related to each other. Through the occupational identifier, the O\*NET serves as a portal that that enables users to connect its occupational descriptions to information from DOL’s BLS and ETA, the U.S. Census Bureau, and state agencies on the stock and flow of both jobs and workers.

Descriptive detail on occupations can be obtained by drilling down from SOC titles to the common duties and tasks; general work activities (GWAs) associated with duties and tasks; the detailed work activities (DWAs) performed; required knowledge, skills, and abilities (KSAs); the tools, technologies and resources (TTRs) used; and typical education, training, and experiential. Since the initial release of the O\*NET, structured surveys of incumbent workers (sampled by business establishment) and occupational experts plus analysts’ ratings of survey responses have been used to keep the occupational titles current and their descriptors up to date. Descriptive details are refreshed for 100 occupations each year.

The O\*NET also cross-references lay titles to occupational titles in the SOC taxonomy. Job titles tend to proliferate as firms mash up DWAs and reconfigure them at the establishment-level in response to endogenous forces (e.g., technology development, rivals’ product development and market penetration, and trends in final consumption demand). KSAs required to perform the work and the TTRs involved change as the DWA mix is reconfigured. A human relations department may create a new lay title in order to describe a reconfiguration of a worker’s function and position in the firm’s employee classification and compensation system. Unless the reconfiguration is sufficiently unique and used widely enough to warrant creating a new occupational title, job content and worker characteristics associated with a lay title are rolled into the descriptors of a parent occupation.

## **The Utility of Occupation-Centric LMI**

Consolidation of occupational descriptors into the SOC and development of the O\*NET as a portal to related information spared users the tedious job of locating descriptive detail in the Dictionary of Occupational Titles (DOT)<sup>21</sup>, occupational employment demand data from the Occupational Employment Statistics program<sup>22</sup> derived from sample surveys of employers and information about labor supply data from the U.S. Census Bureau's survey of households<sup>23</sup>. Links in the O\*NET enable users to obtain current employment, employment demand projections and prevailing wages by occupation. Together these collective resources of a comprehensive LMI system provide the foundation for developing context-specific decision-support applications (e.g., web-based career exploration tools, Unemployment Insurance (UI) claimant case management) and information exchange (e.g., to pass data to state-operated electronic labor exchanges and workforce development board strategic planners).

The occupation-centric nature of the current LMI system has intuitive appeal for researchers and top-down policy-makers who want a big picture of the labor market. It makes sense to employers accustomed to using occupational titles in their employee classification systems, organization charts, internal career ladders and payroll management information systems. It makes sense to workers accustomed to compensation based on occupational classifications and performance assessments, accrued seniority therein and advancement along well-established occupation-based career ladders. It makes sense to students who have been

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<sup>21</sup> <http://www.occupationalinfo.org/>

<sup>22</sup> <http://www.bls.gov/oes/>

<sup>23</sup> <http://www.census.gov/cps/>

advised that completing a program of study will improve their prospects for employment and earning potential in a training-related occupation. It makes sense to job-seekers accustomed to seeing minimum qualifications for job vacancies expressed in terms of occupation-based licensure requirements, occupation-related academic credentials and prior occupational employment experiences.

Various utilities that integrate LMI in the system allow occupational data to be browsed by geography and by industry or sector per the North American Industry Classification System<sup>24</sup> (NAICS) taxonomy<sup>25</sup> and attach SOC-O\*NET descriptors to them. For career exploration and training referral purposes, civilian occupational employment demand and supply information housed in other data sets can be linked to elements in the O\*NET and related to aptitude and interest inventories; competency models, career ladder/lattices and job chain patterns; education and training options per the Classification of Instructional Programs (CIP)<sup>26</sup> taxonomy (via a CIP-to-SOC crosswalk); and Military Occupational Specialties (MOS-to-SOC via a crosswalk). Survey-based occupational information that can be linked together from the various data collection activities support employment demand forecasting, labor availability analysis, career exploration and development.

From an operations perspective general purpose occupation-centric data provide “a good starting place” for job seekers to identify the likely range of work opportunities available to them -- if job vacancies are posted with the same title as the occupation of prior employment or in

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<sup>24</sup> <http://www.census.gov/eos/www/naics/>

<sup>25</sup> A matrix of employer-provided data can be used to generate vertical (within-industry/SOC by NAICS) staffing patterns and horizontal occupational distributions (across industry/NAICS by SOC).

<sup>26</sup> <http://nces.ed.gov/pubs2002/cip2000/>

other occupations whose deductively imputed descriptors imply that they share similar job content and worker characteristics. Identifying employment opportunities by occupation works if there is considerable homogeneity in the KSAs required across occupational workers and in the tools, technology and resources TTRs that are deployed vertically among establishments in the same industry; the way KSAs and TTRs are deployed horizontally for workers under the same occupational title across different industries;<sup>27</sup> and the substantive knowledge possess by training program completers in directly or closely related major fields of study.

Deductive matching by imputed occupation-level descriptors can work well in identifying employment opportunities if technology shocks (i.e. enabling technology-for-labor substitutions) have not directly changed the occupation's required KSAs, the TTRs used, productivity rates, skill-to-technology or skill-to-skill complementarities since the last data refresh.

Occupation-based projections work well if:

- 1) the uptake rate for product innovations (e.g., product substitutions or displacements) has been relatively slow in
  - a. directly impacting final demand for an industry's output and industry, and
  - b. establishment staffing patterns (i.e., organizations charts, division of labor, workflows) do not change fundamentally as staffing levels fluctuate with final demand for their products or services;

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<sup>27</sup> The NAICS-to-SOC micro-matrix can be used to examine how various occupations are employed vertically in any given industry's staffing pattern. The matrix can be inverted to examine how workers under the same occupational title may be deployed horizontally across multiple industries. The micro-matrix, however, does not provide insights into heterogeneity in the detailed work activities of an occupation as it is deployed in different industries or in the heterogeneity of occupational work activities as deployed in the staffing patterns of different establishments within the same industry.

- 2) the uptake rate for process innovations (i.e., production technology, regulations, new business models) has been relatively slow in impacting the way work is organized, job content and demands for skills at the establishment-level; and
- 3) the rate of knowledge diffusion has been slow in
  - a. broadening the talent pool and
  - b. shifting comparative advantage to persons in other locations who are willing to do the work at lower wages.

These conditions are more likely to prevail when industry clusters are securely anchored geographically; economic growth is generally robust; unemployment is primarily frictional or seasonal; recent innovations have been incremental rather than disruptive; and demand shocks have been widely dispersed<sup>28</sup> rather than concentrated in a particular sector.<sup>29</sup> If such conditions prevail, decision support tools for operations (e.g., the electronic labor exchange, the WPRS UI-claimant profiling, case management information systems) built around occupational employment information work well to help job-seekers and employers with job openings find one another and consummate the employment transaction.

In the absence of structural changes in the way work is arranged and in the skills needed to perform them, well-defined career ladders and associated competency models signal to workers what abilities they should have, what knowledge they should accumulate and what skills they should hone in achieve stable employment and career advancement. In other words, occupation-centric, survey based LMI supports operational and individual decision making if:

- 1) there is little variance in the implementation of innovations either because:

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<sup>28</sup> e.g., a general tightening of capital availability reduces the consumption of all goods and services.

<sup>29</sup> e.g., a bursting of the housing bubble directly impacting construction and real estate.

- a. managers at the establishment-level made the same choices in adapting to the disruption, or
  - b. a level of maturity has been reached in the life cycle of an innovation where the early adopters are imitating the practices of the first entrepreneurs and the late adopters are making only incremental modifications; and
- 2) discontinuities between personal skill endowments and market demands for skills are small because:
- a. the innovation was relatively compatible with what they already knew and could do,
  - b. the newly required KSAs were not complex and difficult to absorb and master,
  - c. there was little latency in progression from tacit knowledge to explicit knowledge to formal knowledge, and
  - d. there was ample access to low opportunity cost options for acquiring the knowledge.

### **Questions Arising from the Changing Nature of Work**

As early as 1966, notable business analysts saw signs that changes were occurring in the way work is organized and how that affected job content and skill requirements – and the need for micro data to address them. In the aggregate data they interpreted the simultaneous existence of unfilled jobs and unemployed workers — coupled with increased duration of job vacancies and employer reports of key newly created positions being “*hard-to-fill*” — as indicators of structural change and signs of a very real “*maladjustment*” in the labor market (Meyers, 1966; Rees, Weisberg, Goldstein and Johnson, 1966). Human resource management and operations needed “more sensitive instruments” to understand and address those change when manifest as discontinuities at the individual level (Meyer, 1966). Rees, Weisberg, Goldstein and Johnson

suggested at a conference on job openings and labor turnover that operational decision support for human resource management asserted that job orders were more reliable sources of information for placement purposes than sample surveys that classifying jobs by occupation. Job orders themselves provide the “fine and accurate detail” needed on such matters as determining job content, projecting trends in employment and employer’s future needs, and serving “the training purpose.” They did note, however, that providing useful data for operational purposes “would involve more a great deal more staff time and effort than any of the current employment statistics programs now being handled” (Rees, Weisberg, Goldstein, & Johnson, 1966; also from the same conference notes see Slotkin, 1966 and Meyer, 1966).

Three decades later the changing nature of work was still driving discussions about what kinds of data are needed for operations. At their 17<sup>th</sup> annual conference in Toronto (April, 2002), members of the Society of Industrial and Organizational Psychologists (SIOP) questioned the suitability of occupation-centric LMI as they responded to the key question put to them by the panel’s chair, Allen Wilson; he asked, “Is the notion of the job antiquated?” Kenneth Pearlman asserted that the concept of the job was dying, if not dead. Ann Howard shared Pearlman’s view; she opined that “the job” was created in an industrial age “to package work in factories and bureaucratic organizations.” Susan Mohrman added, “Work for pay will continue, but the concept of a job as a defined set of tasks or duties performed in a continuous employment situation is eroding in today's world” (Church, 1995).

Pearlman, Howard, and Morhman cited several factors. In an increasingly competitive and integrated global economy, the boundaries between the organization and its environment as well as between jobs within the organization become less impervious. As the economy shifts from manufacturing to a service economy, technology is being infused into all jobs at all levels

which make work activities more knowledge-based. As organizations become flatter and more decentralization, they make greater use of flexible, dynamic and independent work teams, and a contingent workforce (contract and temporary labor as well as outsourcing) which eliminates hierarchical, multi-rung corporate ladders. All these factors taken together place increasing value on "intellectual capital" as a competitive advantage for increasingly knowledge- and technology-intensive industries and businesses (Church, 1995).

Some notable commentators since then have presented similar views in more sensational fashion. Jeremy Rifkin predicted that the demise of jobs as we know them would ultimately result in a nearly workless society (Rifkin, 1994). Daniel Pink summarized nineteen developments he believed would turn us into a nation of free-agents — bundles of skills working episodically for others and honing our skills between project-length contracts in order to remain marketable (Pink, 2001).

Now *Businessweek* is selling a CEO's guide to the micro-workforce which describes how pioneering firms like LiveOps and ODesk use "crowd sourcing" and the "human cloud" – getting skilled workers anywhere in the world to complete very short assignments on a piecework basis. Amazon.com has entered the micro-workforce arena with its Mechanical Turk in which its business customers can parse and pay for work in short segments – often less than an hour long. And the *Economist* magazine will prominently feature workshops on the "global micro workforce" and the "worldwide freelance economy" at its 2011 conference in New York City on "The Ideas Economy: Human Potential and the Next Level of Competition".

If the nature of work is changing then the tools for describing job content and required worker characteristics need to work inductively in order to be sensitive their fluidity, dynamic reconfiguration and heterogeneity.

## **The Quest for Alternatives to Occupation-Centric LMI**

Human resource management consultants, in responding to the reported demise of “*the job*,” opted for greater specificity in skills-based approaches to meet their business clients’ operational needs such — e.g., for firm-wide or establishment-level succession planning, recruitment and applicant screening, business-site selection, employee performance evaluation and compensation. Those needs tend to be addressed *ad hoc* on a for-fee basis at small scale wherever specific clients determined it was affordable and doable. And forensic analysis (e.g., for individual disability and workman’s compensation determination) is done on a case-by-case basis at a higher level of specificity than can be obtained from sample survey data. But to date no public LMI system has been built to provide micro-data essential to operations.

### **Meta-Analysis of Data Needs in Operations.**

At the close of the 20<sup>th</sup> Century, a distinguished panel of subject matter experts (SMEs) in various operational domains convened to assess how the changing nature of work would impact their information needs for decision-support. (Appendix A lists panel members, their affiliations and their areas of expertise in operations and human resources.) The panel, convened by the National Research Council, was called the “Committee on Techniques for Enhancing Human Performance (CTEHP)”. They examined various approaches to, and tools for, managing human capital to identify best practices and to make recommendations regarding the development of an LMI system to address their specific needs. They offered the following conclusions (CTEHP, 1999, pp. 207-209).

- 1) Given variance in uptake, implementation and adaptation of new technologies and human resource management practices, the level of aggregation used should account for the organizational context in which work is performed.

- 2) To provide the rich detail necessary for operations, the content model would have make room for data provided by incumbent workers, supervisors and job analysts.
- 3) Because the accelerated pace of change likely would disrupt the organization of work and the “currency” of job content frequently, research to refresh work descriptors would have to be done on less than a five year cycle with a process in place to expedite “out-of-sequence” data refreshes.

The panel was prescient in seeing that new technical capabilities would increase what could be accomplished at a reasonable cost. They expressed hope, for example, that useful demand data gleaned from job postings in America’s Job Bank (AJB) could be integrated into the labor market information system.<sup>30</sup> The panel was particularly optimistic that “extremely important” data collection would be done at the “level of work descriptors” to “build up inductively” a rich and useful body of information about occupational employment rather than creating a system that deductively imputed details about job content and worker characteristics from overly broad occupational constructs (CTEHP, 1999, p. 209).

Economists outside the United States also are looking for alternatives to their respective nation’s occupation-centric LMI in order to address structural changes in the way work is organized, job content and skill requirements. Central and Eastern European Countries (CEECs), for example, are coping with the changes wrought by global competitions while also dealing with the transition from centrally planned to free market economies. Olga Strietska-Ilina, of the

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<sup>30</sup> The DOL’s ETA developed an electronic labor exchange called America’s Job Bank (AJB) to facilitate placement of UI claimants. ETA also developed America’s Talent Bank (ATB) as a repository of resumes by UI claimants and One-Stop Career Center walk-in and online customers. DOL elected to give the source codes for AJB and ATB to private firms for for-profit service development. The CTEHP’s suggestion predated DOL’s decision to turn over the AJB and ATB as well as current efforts by HelpWanted Technologies, Burning Glass, and the Conference Board’s HelpWantedOnline to provide analysis of job bank scrapings.

Czech Republic's National Observatory of Employment and Training, observed that "rough definitions of occupations and qualifications" do not represent the "actual picture of skills required" particularly in "newly emerging hybrid occupational profiles" as "conventional forecasts" lag behind the process of innovation" (Strietska-Ilina, 2003, p. 5).

### **What Alternatives Are Being Explored?**

The DOL itself advised responsible parties to keep in mind that occupation-centric, survey based LMI is a good place to start since "O\*NET occupations are broad categories and should not be assumed to represent a particular job in a particular setting" (Fine, Harvey & Cronshaw, 2004). Despite that caveat, a suite of free occupation-based tools from the DOL and for-fee tools (such as TORQ®) populate the landscape of the nationwide workforce development network for use in operations management and individual decision-making.<sup>31</sup> Some within the workforce development network, however, are casting about for alternatives for operational decision support. In describing the situation in the field, Maine's state LMI director told discussants at a Brookings Institution-hosted roundtable on *Putting America to Work*, "In large part right now, we are relying on private data sets to capture emergent/demand skill requirements" (Dorrer, 2010a).

Outside the workforce development arena, alternative models of the way work is organized have been developed and used, or are contemplated, for specific operational purposes in different contexts. The Office of Personnel Management (OPM), for example, adopted its own competency-based job and worker analysis system for classification and compensation in the federal civil service, Multipurpose Occupational Systems Analysis Inventory - Close-Ended

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<sup>31</sup> For a comprehensive overview of how the O\*NET is used in a variety of domains, see the presentations made to the National Academies of Science O\*NET Review Panel at <http://www7.nationalacademies.org/cfe/ONET%20Workshop%20Agenda%20March%202026.html>.

(MOSAIC) Competencies (O’Leary). The Social Security Administration (SSA) is seriously exploring the possibility of resurrecting and updating of the DOT for forensic job analysis in disability determinations (OIDAP, 2011). Industrial and organizational psychologists (Fleishman; Harvey, undated), assessment center operators and human resource specialists (Swanson, 2000) who serve as consultants to business clients and the disability/rehabilitation community rely on their own job analytics and skills-based matching tools that operate on a level of greater specificity regarding job content and worker characteristics than the O\*NET-SOC.<sup>32</sup>

The military, in particular, has special operational needs in manpower analysis, development and deployment to cope with rapid changes in the nature of warfare, logistics and weapons technology. In a study conducted for the U.S. Department of Defense (DOD), researchers from RAND Corporation concluded, “existing systems ... provide information that is too general and abstract” for their use across the uniformed services and for coordination with the civilian workforce” (Hanser et. al., 2008). Accordingly, the DOD uses a forward-thinking, skill-centric Human System Integration (HIS) model to do work breakdowns across all branches (Directorate of Human Performance Integration, undated; Narkevicius, Stark & Owen, undated; Narkevicius, undated; CTEHP, 1999).

### **Effort and Data Costs Relative to Purpose.**

The various purposes for using LMI are not mutually exclusive. Rather they overlap on a continuum – arrayed from concrete and operational (e.g., job-person matching, training referral that require micro data) to abstract and statistical (e.g., requiring macro data as economic indicators and for broad supply-demand comparisons). Rees and his colleagues (1966) were

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<sup>32</sup> For-profit assessment centers also do job analysis, applicant matching and assessments using legally defensible, psychometrically sound methods. See [www.assessmentcenters.org](http://www.assessmentcenters.org).

correct in noting that, in the mid-1960s gathering the high resolution, very granular and detailed micro data necessary for operational purposes would have been a daunting undertaking compared to gathering macro data for inferential statistical purposes. The need for reliable summative statistical data can be met by using sample surveys at regular intervals. Case management, on the other hand, requires analysis of actual job orders and the human capital endowments of individual job seekers. Summative statistical data typically are collected through closed-ended, forced choice items that can be coded and organized in tightly structured data bases. Findings can be generalized by making inferences from small but scientifically selected samples. Obtaining formative data for operational purposes would require continuous, real-time effort. The data essential for operational purposes are scattered across a variety of sources, most often in unstructured “natural language text.”

The emphasis in using inferential statistics is on methodological consistency for comparability across; finding broad patterns in, time-series data; and establishing confidence intervals around generalizations made from them. The emphasis in operations is on making sense of the fluid and dynamic – seemingly chaotic – nature of labor market transactions.

Given the state of art for computational power and software sophistication at the beginning of the millennium, it would have been cost-prohibitive to build a national scale LMI system with microeconomic data with high enough resolution and granularity for operational purposes. Public resources continue to be put into building a LMI system based on easier to collect, low-cost occupation-centric surveys coupled with relatively low-cost, minimum-touch self-service application. The U.S. BLS, for example, continues to improve its collection and dissemination of information at the occupational level (Sommers, 2010b; Sommers, 2101c).

Special surveys were funded by BLS<sup>33</sup>, ETA<sup>34</sup>, and the Economics and Statistic Administration of the U.S. Department of Commerce<sup>35</sup> to define “*green occupations*” and count the number of workers in them.

### **A Task Framework for Increasing Explanatory Power**

Several economists took steps in the last decade to move for occupational employment analysis towards skill supply and demand analysis in trying to explain wage differentials and polarization of earnings. They blended occupational descriptors from the O\*NET with other constructs to describe structural changes in the labor market statistically. In 2003, David Autor, Frank Levy, and Richard Murnane (ALM) introduced a “*task-based conceptual framework*” to examine one aspect of structural change; viz., how skill-biased changes in information and communications technology enable shifts in employment demand for groups of occupations to offshore locations – and what effect that has on employment and earnings (Autor, Levy, Mernane, 2003; Levy & Mernane, 2004). For the balance of the decade, variations of the ALM task framework were used in looking for generalized explanations for broad shifts in occupational employment demand (e.g., job polarization and growing wage inequalities) and related non-monotonic returns to education and training (Blinder, 2006; Mankiw & Swagel, 2006; Blinder, 2007; Blinder & Kruger, 2008; Autor & Handel, 2009; Autor & Acemoglu, 2010).

In the ALM framework, units of work are organized by tasks. Individuals are endowed with a stock of innate abilities plus knowledge and skills acquired through schooling and

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<sup>33</sup> <http://www.bls.gov/green/>.

<sup>34</sup> <http://www.dol.gov/ocia/notifications/20091118-Green.htm>.

<sup>35</sup> <http://www.esa.doc.gov/Reports/measuring-green-economy>.

experience. Individuals are assigned to work-units according to their capacity to perform tasks based on their stock of KSA (referred to collectively as “*skills*”). Tasks requiring comparable skills are clustered together conceptually along a hierarchical continuum that reflects the difficulty or complexity of skills involved (e.g., “high skill,” “middle skill,” “low skill”). Earnings are attached to the performance of tasks rather than to a worker’s entire stock of skills since the individual’s endowment may include the capacity to perform tasks that are not required by or related to the outputs desired by the employer.

The supply of skills changes as individuals seek higher wages by being assigned to perform tasks which more fully utilize all their skill endowment or increasing their stock of skills through additional training and work experience. Meanwhile, technology change alters the demand for skills. But there are inherent skill-biases in various kinds of technology changes. Some changes are skill-complementary in that they enable workers to use their endowments more productively. Others imbed skills technology in ways that allow it to be substituted for human effort in performing tasks; i.e., capital for labor substitution (Solow, 1956 and Solow et. al., 1966).

Economists, using various constructs, have characterized and grouped tasks together according to the kinds of skills required in performing them. In trying to determine which skills are most amenable to offloading (i.e., substitution of technology for workers’ endowments), for example, tasks have been categorized along two dimensions, including repetitive vs. non-routine and manual vs. cognitive. In trying to determine which skills are amenable to off-shoring, task objects have been categorized as anchored,<sup>36</sup> footloose<sup>37</sup> or interpersonal.<sup>38</sup>

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<sup>36</sup> Requiring localized/site-specific activities (e.g., plumbing to be installed or repaired).

<sup>37</sup> For example, digital objects what can be manipulated from any location – as in electronic data processing.

Task Dimension	Repetitive	Non-routine
Manual	Highly susceptible to technology substitution	Moderate susceptibility
Cognitive	Moderate susceptibility	Low susceptibility

### Utility of the Task Framework

By and large, the task framework has been used for statistical purposes – looking at historical patterns of variance in employment demand and earnings across constellations or clusters of occupations, e.g., managerial, professional and technical occupations; sales, clerical and administrative support occupations; production, craft, repair, and operative occupations; and service occupations. Occupations in this framework are construed as bundles of tasks. Occupational employment opportunities and wage premiums presumably vary over time as labor markets move with more or less efficiency toward equilibrium as exogenous factors change the demand for and supply of skill groupings associated with task components.

By moving to a task framework, Autor and others have been able to identify and document underlying trends in, or symptoms of, structural changes in the organization of work and differentiate between skill-complementary and skill-substitution technologies. In their meta-analysis of the task framework, Autor and Acemoglu (2010) concluded that it is an improvement over coarser industrial and occupational models in explaining employment, earnings and returns to human capital acquisition. In examining employment and earnings, they found that occupation and education have more explanatory power than industry. Starting in the 1990s as employment and earnings started to polarize (the “hollowing out of the middle”), occupations

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<sup>38</sup> Requiring hands-on or face-to-face activities, such as hairdressing. Recently, however, services like GoToMeeting have substituted multimedia digital interaction for many of the work functions heretofore done face-to-face. Today, the “*interpersonal*” element of work is being erode – leaving the hand-on and geographically-anchored immune from off-shoring.

gained more importance and overtook education by 2007. “But the rise in the explanatory power of the task measures is steeper than either the education or occupation measures after 1989, and it surpasses both by 2007” (Autor & Acemoglu, 2010, pp. 31-32). The research design behind the task framework changes the dependent variable from employment per se towards returns to skills. That sets an agenda for finding ways to do job content and worker trait analyses that can be helpful in skill demand projections, career exploration and informed choice in selecting training options.

### **Limitations of the Task Framework.**

While improving economists’ ability to describe and predict occupational employment, earning differentials and returns to educational attainment and years of work experience for statistical purposes, the task framework still lacks sufficient specificity to guide operational management of workforce development programs and individual decision-making by employers and job-seekers caught up in the discontinuities resulting from changes in job content and way work is organized. In a critique of their own use of the task framework, Autor and Acemoglu list its limitations. First, it is still difficult to characterize the “task content” of jobs. Of the numerous potential loosely defined and weakly differentiated task scales in the O\*NET, “it is rarely obvious which measure (if any) best represents a given task construct” (Autor & Acemoglu, 2010, pp. 23-25).

Since tasks are rather coarsely defined, they can be mapped only to broad clusters of occupations and crude proxies of individual skill endowments (e.g., level of educational attainment, years of work experience). Imputation of tasks to broad occupational titles and crude proxies of the skills required in performing them masks significant heterogeneity of the work to

being done within occupations and skill endowments among workers sharing the same occupational title.

They conclude that future research should be based on a “flexible and tractable task-based model for analyzing the interactions among skill supplies, technologies, and trade in shaping the earnings distribution” (Autor & Acemoglu, 2010, p. 46). The model would have to explicitly distinguish skills from tasks, and “allow for general technologies in which tasks can be performed by different types of skills, by machines, or by workers in other countries.” The objective is to understand “how different technologies may affect skill demands, earnings, and the assignment (or reassignment) of skills to tasks, it should allow for comparative advantage among workers in performing different tasks” (Autor & Acemoglu, p. 83).

While providing an explanation of the “hollowing out of the middle” of the wage distribution that is occurring as a result of structural change, the task framework provides little specific guidance to individuals on the cusp of change on how to respond. The prescription seems to be a general exhortation to, “Get more high skills that can’t be offloaded to computers or assigned to lower wage workers offshore!” The model assumes that wage signals are understood symmetrically by employers and job-seekers, and skills are highly elastic. It is presumed that individual workers can improve their earnings by searching for and moving to different jobs which more fully utilize and compensate them for their full endowments or responding in an unfettered and rational fashion to wage signals to acquire more or different skills to meet emerging market demands.

Treating the task framework as part of a larger human capital model, Autor and Handel (2009) offer additional insights into its limitations. While the human capital model has been successful in explaining returns by level of education and in providing individuals with

incentives for investing in general skill acquisition, “it is silent on what factors determine the skills that are demanded. Concretely, empirical analysis of the return to education is not directly informative about what skills workers use on the job, why these skills are required, and how these skill requirements have changed over time.” While the task approach lays a foundation for linking aggregate demand for skills to specific skill demands of specific job activities, to answer the basic questions “requires a conceptual framework that links the tasks and activities that workers perform on the job to the skills needed to carry out these activities” (pp. 2-4).

For operational purposes, more specific LMI is needed for determining the market price of skills in real-time as a key to helping workers interpret market signals, identify their comparative advantage and guide their individual choices regarding how to value and manage their human capital. But, Autor and Handel note that, unfortunately, the primary data sets used for research on employment and earnings are too coarse. They provide “rough measures of workers’ human capital... but essentially no information on their job tasks.” Typically task requirements are imputed to person-level observations using information on job characteristics at the occupation level. “This makes analysis of within-occupation heterogeneity in task demands and its relationship to earnings infeasible.” The second limitation is that it is difficult to track changes in tasks because “the job content measures in these databases are updated too infrequently” (Autor & Handel, 2009, p. 5).

#### **A Refinement of the Task Framework.**

To address their self-concerns, Autor and Handel explored the potential of task measurement at the person level for explaining patterns in employment and earnings. They merged self-reported job tasks obtained through the Princeton Data Improvement Initiative (PDII) survey with O\*NET data for the SOC title of each respondent. The power of their

earning models significantly improved when they used measures of tasks that workers actually perform (Autor & Handel, 2009, p. 6).

At this point in the evolution of LMI analysis, then, there is evidence for the following. A task framework is more powerful than previous industry- or occupation-centric approaches to explaining changes in employment and earnings statistically. Adding person-level measures of actual work performed increases explanatory power within the task framework. But in order to improve operational management and to guide individual decision-making, additional research needs to be done to determine the market price of specific skills in the context of within-occupation heterogeneity in job content and the way work is performed.

### **Imputation of Skills from Overly Broad Training and Work Experience Categories**

The task framework moves us toward making returns to skills an important dependent variable in research to describe and explain employment transactions. In trying to determine the returns to skills, parallel research in the education and training domain has looked at how the skills have been acquired and at proxies for their accumulation rather than at the specific skills themselves (e.g., years of education/formal credentials and/or length of work experience).<sup>39</sup> Since forecasting models use these as proxies for skill levels, BLS is refining the way it classifies education and training requirements (Sommers, 2010a). The chief focus of educational researchers using the occupations-centric labor market information system seems to be forecasting demand for workers with various levels of education and training (Strohl, 2011). But DOL did take the initiative to make projections of skill requirements (Dias, 2010a). And the mySkills/myFuture<sup>40</sup> utility provided by the DOL endeavors to help students and job-seekers

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<sup>39</sup> In general, see the works of Jacob Mincer on hedonic analysis of returns to human capital.

<sup>40</sup> <http://www.myskillsmyfuture.org/>

self-assess their skill deficiencies relative to their career aspirations —based on occupational imputations — and where to find related training — based on inventories of programs by field of study by institution by location (Dias, 2010b). In both initiatives, however, skills are imputed to O\*NET-SOC occupations deductively rather than deriving skills requirements inductively from patterns detected in archived job postings. And the skills that are supposed to be imparted are deduced from educational program titles by major field of study.

### **An Alternative Model**

Accepting the demise of “*the job*”<sup>41</sup> does not logically compel a decision to move to the more abstract, highly aggregated occupation construct as the primary unit of analysis. “*Working*” (as a verb) still involves human effort to accomplish tasks and perform duties in exchange for pay. Demise of “*the job*” does not mean that work is going away as Rifkin suggested. It simply means that there is far more heterogeneity in job content and the way units of “*work*” (as a noun) are orchestrated. Two individuals from different establishments may share the same occupational title based on producing the same the work object, but their work units may be mixed, managed and performed differently. Job content and attendant KSA requirements may change over time even though the occupational title does not. Actionable information is lost when more specific and nuanced job descriptors are rolled into a broad, abstract occupation and when a priori assumptions are made about the elasticity of skills. That rich detail is needed for operational purposes such as job-person matching.

Economists who developed the task framework recognized the need to address heterogeneity within occupations and among workers employed in them. However, just as useful

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<sup>41</sup> i.e., whose definition is consistent across workers, under the same title, and relatively stable over several years.

detail is lost when data are aggregated into overly broad and abstract occupations, so too does grouping skills in a canonical model on a small number of dimensions; imputing or ascribing a broad legacy lists of skills, *a priori*, to all workers in the same classification; and using coarse measures — like educational attainment and years of work experience — as proxies for an individual worker’s skill endowment. And, while the task framework has been used to shed light on the way technical change impacts the demand for skills, it has not been used to illuminate how knowledge supply factors impact the market price of skills.

### **Theoretic Basis for a DWA Model**

Development of a DWA-based model is based on the observations of Drucker (1959, 1969, 1993, and 1999) and Bourlieu (1986) on how the way knowledge assets are converted and worker’s time is appropriated for productive use through detailed work assignments. It also is rooted in the human factor analysis done by the military in support of its human system integration system used to tailor technology specifications to context-specific manpower roles and assignments. As assignments vary across establishments (or context-specific roles) and over time, work content and required worker characteristics imputed to occupations are not sensitive to the discontinuities at the job and person level. In looking at detailed work activities as the unit of analysis, one can get direct subject matter expert descriptions from incumbent front line workers and first line supervisors on the job content, the KSAs required and the TTRs used. They become the central object of study when trying to identify and explain discontinuities between job skill requirements and worker skill endowments at the person-job level.

One can think of DWAs as the connective tissue between cross-occupational competencies (which are too overly broad for using to differentiate work content and worker characteristics at the job level) and tasks (which are not likely to be detailed in the source

documents – like job postings, resumes, training rubrics – used for person-job and person-training matches. To use an analogy from biotechnology, one can look at occupations as gross anatomy of the workplace whereas DWAs at the job-person level are its recombinant DNA.

### **Developing A DWA Model**

As a companion to a survey-based occupation-centric LMI, supplemental data collection and research based on DWAs as the appropriate unit for describing the organization of work of analysis might serve the unmet needs of operations managers, workforce intermediaries and individual decision-makers. AI can be used to distill DWA configurations at the person-job level from unstructured natural language text in real-time job postings and job seeker profiles.

DWAs already are described at the occupation level in the O\*NET content model. But DWA statements in O\*NET can reference multiple activities which may be decoupled as new technology and new work arrangements evolve. Some do not provide the basis for useful KSA assessment metrics because they are framed using amorphous verbs (like understand) which cannot be observed directly. To serve well as the primary unit of analysis, the syntax for describing DWAs has to be more precise.

A process for doing gathering and precisely formatting information about DWAs was initially developed to support manpower planning and analysis in the military (Narkevicius, undated; Narkevicius, Owen and Stark, undated). Akin to structural changes in the way civilian work is done, the changing nature of modern warfare and innovative weapons technology necessitated changing the DoD's approach to role assignments, training and deployment. In particular, the military needed to integrate human factor research into weapons and equipment research and development, engineering, acquisition and training as a "force multiplier" (the military equivalent of competitive advantage in the civilian economy).

As a foundation for a comprehensive human system integration model, the Navy commissioned the development of an automated data collection process around syntax for expressing DWA descriptors in a rigorous and precise format in order to map individual KSAs to their manpower needs by role and context. The tool was first used to facilitate matching Navy reservists' capabilities to vacancies in the Navy's active duty roster (Brown, 2006). A brief explanation of the automated job analysis tool developed for the Navy is provided in Appendix B.

### **Military Roots.**

In addition to identifying potential reservists' talent endowments to fill active duty rosters vacancies, the process provided a foundation for developing e-learning skill-upgrade training modules to address any detected skills gaps more efficiently (*Defense Industry Daily*, 2006). The precise syntax aligns with the Sharable Content Object Reference Model (SCORM) for specifying expected learning objects for content management in the DOD's Advanced Distributed Learning (ADL) model.<sup>42</sup> The process also is used in forward thinking "human system integration" planning as it is now done by all branches of the United States military and allies of the North Atlantic Treaty Organization (NATO), such as Australia.<sup>43</sup> (U.S. Department

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<sup>42</sup> The syntax provides a consist format for sharing and feeding learning objects into the ADL. By an executive order, President Clinton identified the ADL as the model other federal agencies should use in developing and distributing online learning. The DOL's implementation of SCORM-compliant advanced distributed learning is exemplified by the LearningLink Programming Standards (January 6, 2011) at <http://www.dol.gov/oasam/learninglink/2011implementing.pdf>. The syntax also conforms to the learning object metadata standard of the Institute of Electrical and Electronics Engineers (IEEE1484.12 -2002) recognized internationally. It also aligns with the S1000D data standards being developed under the lead of the Aerospace and Defense Industries Association of Europe as the potential equivalent of an international Dewey Decimal system for cataloging and documenting human knowledge.

<sup>43</sup> Because the nature of warfare is changing rapidly, the DOD recognizes the need for nimble and effective force deployment drives the matching personnel (faces) to positions (slots) and rapid, efficient training to address skill gaps. Indeed, to anticipating and avoiding skills gaps in the first place becomes a "*force multiplier*," the functional

of the Army, 2001; Garamone, 1998; Directorate of Human Performance Integration, undated; Narkevicius, Stark & Owen, undated; Narkevicius, undated; CTEHP, 1999). The DOD subsequently has used the forward-thinking, technology-driven job skill requirement analysis process to promote interoperability of personnel across various branches of the Armed Services<sup>44</sup> and in joint multinational force operations.<sup>45</sup>

### **Civilian Context.**

Decisions are made at the establishment-level on which combination of DWAs is to be performed by any worker, how frequently each is performed (frequency) and how critical each is to overall work output (criticality). A stack of DWAs can be used to describe what a particular worker does for a particular firm at a particular establishment in a particular context. This is the civilian counterpart to the approach used by the Navy and other branches in “work breakdowns” to determine how skill-technology interactions will differ from one context to another and the implications for manpower recruitment, training and deployment.<sup>46</sup> In the civilian workplace,

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equivalent in the military for comparative advantage of civilian firms in capturing and holding market share in a globally competitive economy. Therefore, it mandates that each branch factor human capabilities and limitations into the design of new technologies, procurement decisions and investments in context-specific training to prepare personnel to operate them. The military’s human system integration model goes beyond life cycle engineering which focuses primarily on technology capabilities from conceptualization to de-commissioning. It also goes beyond ergonomics which looks primarily at the interaction between human physical abilities (e.g., anatomy and kinesiology) and physical requirements for efficiently operating equipment. See, for example, the Navy’s System Engineering, Acquisition and Personnel Integration model (SEAPRINT), parallel planning initiatives by the Army under the Manpower and Personnel Integration (MANPRINT), and the Air Force’s Improved Manpower Personnel and Training System (IMPACTS).

<sup>44</sup> With particular regard to maritime operations (Navy-to-Coast Guard) and aviation operations (Navy-to-Air Force). Specific DOD applications are referenced online at the Defense Technical Information Center’s Web site at [www.dtic.mil](http://www.dtic.mil).

<sup>45</sup> Such as in those conducted with NATO allies in Kosovo.

<sup>46</sup> Different skill sets, tools and technology likely will be used for “*battlefield target acquisition*” — a common task shared by a reconnaissance officer on the ground in an urban close-combat situation and a reconnaissance officer stationed on a ship in the Indian Ocean interpreting digital images from an Airborne Warning and Control System

workers who share the same payroll classification may perform a different combination of DWAs depending on the firm's innovation take-up rate and operational management decisions about how to deploy (mix) staff and technology at the establishment-level. DWA combinations can be fluid and dynamic even while nominal job/ payroll titles are unchanged. If a firm adopts new technology, produces a newer vintage product or modifies its business model, the frequency and criticality of the DWAs performed by any given worker may change. Indeed, some may be eliminated and replaced by other DWAs. Just as programmers “mash up” then borrow lines of code from several old applications, remix them, and add new lines of code when developing software, operations managers mash up the content of several legacy jobs, remix them, and add new assignments in order to adapt to market conditions.

It is critically important then to track how DWAs are being mashed up and reconfigured in order to determine job skill requirements. Required worker traits — i.e., KSAs — can be mapped more efficiently to DWAs than to abstract and overly broad, composite occupational titles or coarse task descriptions. The TTRs used can be mapped to DWAs more precisely than to occupational titles which are generalized across industries, firms, establishments and contexts.<sup>47</sup>

More precise KSA and TTR mapping at the DWA level facilitates operational management through less ambiguous job postings; skill profiling of incumbent workers and external applicants; algorithms for high fidelity transferable skills-based job-person matching;

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(AWACS) plane flying several miles above Taliban-held territory in the mountains of Afghanistan. In a civilian analogy, the broad task of “*reading patients' vital signs*” will be performed very differently with different instruments at different time intervals for trauma victims in an emergency room, premature infants in a neonatal ward, geriatric patients in a nursing home and high performance athletes at a sports medicine and training center — although the persons assigned the task would share the same occupational title, Registered Nurse.

<sup>47</sup> DWA-KSA and DWA-TTR mappings are more likely to be one-to-one or one-to-few whereas SOC-to-KSA, SOC-to-TTR, task-to-KSA and task-to-TTR mappings are more likely to be one-to-many given the abstract and composite nature of each SOC title and the opaqueness of task descriptors.

and actionable gap analysis for case management (i.e., individual employability plans; training eligibility and referral, on-the-job-training (OJT) development). Better mapping strengthens employers' input signals for demand-driven curriculum development, skill assessment metrics, job-seeker qualification vetting, Eligible Training Provider determinations; and informed choice in career guidance. Expressing DWAs at the job-person level in a more precise syntax achieves the degree of specificity and precision necessary for psychometrically sound, behaviorally anchored and legally defensible metrics for operational uses such as vetting job applicants' qualifications; assessing worker performance; and evaluating human capital assets.

DWAs can be flagged to denote the job titles of the SMEs who participated in the data collection process. For more generalized reporting and search purposes, algorithms can be built on the basis of correlations for rolling up common combinations of DWAs into job titles, job families and occupational titles for integration with survey-based data in the current labor market information system. This process builds inductively from job content descriptors to occupations (as the CTEHP recommended in 1999) rather than deductively imputing work conditions and worker traits from occupational titles (as Autor and Acemoglu warned against doing in 2010).

### **TWC's Common Language Project — Phase One**

The Texas Workforce Commission's (TWC)<sup>48</sup> LMI Division (TWC/LMI)<sup>49</sup> has undertaken a multi-year "*Common Language Project*" to develop and field test the utility of DWA-based data collection to supplement to the current survey-based occupation-centric system. In phase one (already completed), 830 SOC occupations were identified as comprising

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<sup>48</sup> <http://www.twc.state.tx.us/>

<sup>49</sup> <http://www.lmci.state.tx.us/>

90% or more of employment in the state. The DWA statements associated with each of those SOC titles were downloaded from the O\*NET. Using the SOC-to-NAICS crosswalk, TWC/LMI obtained employer contact information from the NAICS-based database from InfoGroup licensed to the state through the DOL. SMEs (incumbent workers and front-line supervisors) from the employer sample validated the DWAs statements from the O\*NET to current employment practices at establishments in each of the state's regional labor markets. SME-provided descriptors were formatted in the precise syntax that previously had been developed for the Navy to use in its work breakdowns for human system integration.

Web-based tools were developed to automate and streamline the data collection process (details are provided in Appendix C). An individualized electronic workbook was tailored to each incumbent worker/SME's lay job title. Each workbook was pre-populated by deducing DWA statements from the legacy O\*NET library based on the closest fitting SOC title. SMEs were instructed to mark for deletion those which do not apply to their role or context and modify those which did not quite fit what they do. SMEs also could add DWA statements to reflect things they do on the job but which were not expressed in any of the pre-populated items. Once a set of refined DWAs was established for a job title, additional information was gathered from first-line supervisors, operations managers, human resource specialists, and cognitive scientists on the TTRs used in performing each DWA; the required KSAs; preferred modality of training; and average estimated training time to achieve entry level, intermediate and advanced proficiency. Additionally, front-line supervisors and human resource personnel were asked to

identify which workplace basics/soft skills (e.g., critical thinking and problem solving, among others) were most important to performing each DWA.<sup>50</sup>

### **Operational Applications**

Data were developed in phase one of the Common Language Project initially to populate decision support tools for case management and other One-Stop Career Center operations, e.g., person-job matching, training referral, and customer-informed choice.

#### **Decision Support for Person-Job Matching.**

In the public workforce development system, vacancies are posted on a state-operated electronic labor exchange (e.g., [www.WorkInTexas.com](http://www.WorkInTexas.com)). For the purpose of cross-referencing data and descriptors in the current labor market information system, openings are listed by their SOC title — either through forced choice from dropdown lists of SOC titles or auto-coding of lay payroll titles into the SOC taxonomy. Notices also list minimum qualifications in terms of formal education and prior work experiences. They can contain information on applicable licensure requirements and employer preferences for specific industry- or professional association-recognized skill certifications. Notices vary in degree of additional detail about the work to be performed — described in unstructured natural language text. The physical worksite location may be given or inferred from the Federal Employer Identification Number (FEIN) supplied by the business when logging into the system.<sup>51</sup>

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<sup>50</sup> Obviously, employers would like workers in all positions to be proficient in every workplace basics skills. However, SMEs were asked to rank order the top five picked from a list of thirty-six workplace basics skills compiled through a literature review by Texas's LMI Director (Froeschle and Theis, 2009).

<sup>51</sup> Geo-coded location information as well as primary and secondary industry focus by NAICs code is contained in the FEIN database for each firm.

Similarly, job-seekers registered with the state-operated electronic labor exchange supply (self-reported but not vetted) information in structured format about their prior work experience, formal education, licenses, and certifications. They are asked to fill open-ended text boxes to provide descriptions of the work they have performed. Each has the option of attaching a resume. The work descriptions and resumes typically are in unstructured natural language text. To remain eligible for UI benefits, claimants must register with the state-operated electronic labor exchange. Other job seekers may register with the service online or as walk-in customers of local One-Stop Career Centers funded with Workforce Investment Act (WIA) dollars.

**Job matching with occupation-centric data.**

Person-job matching in the present system can be done in an iterative process. Legal requirements (e.g., licenses or gateway credentials for regulated occupations) must have a one-to-one match between job order stipulations and seeker self-reported qualifications. Employer-specified skill certifications also can be matched one-to-one with seeker-reported skills-based credentials. There is sufficient specificity in licensure requirements and in many skill certification stipulations to yield matches that are valid. Seekers, subject to the vetting of their self-claimed credentials, can be referred to potential employers who then use additional criteria to see if the candidate is a good fit with the specific corporate culture and has greater productivity potential to surpass otherwise well-matched candidates.

In the absence of licensure requirements and employer-specified skill certifications, matching is done on the basis of correspondence of seeker-provided qualifications to employer-identified occupational titles and length of work experience and formal academic credentials in a specified field of study. Seekers identified in this iteration are presumed to be 100% matches worthy of referral to the prospective employer. But these variables are only proxy indicators of

the seekers' KSAs, the TTRs they used, and their productivity potential. Time elapsed since the seeker last worked in the target occupation may be used to reduce the estimated goodness-of-fit.

If no 100% fit is found, the parameters typically are broadened in the next iteration through "transferable skills matching." With respect to formal academic credentials, a SOC-to-CIP crosswalk is used to infer training-relatedness. In the case of regulated occupations, one CIP will be an exact match to a SOC (e.g., JD-attorney, BSN-RN) insofar as completion of the program of study is a necessary and sufficient prerequisite for taking the licensure or certification exam. In other cases, SOC-to-CIP mapping may be one-to-few. For example, the fields of study mapped to Financial Analyst as "*directly related*" can include Accounting, Business Administration and Economics, and "*closely related*" fields might include Mathematics or Statistics. Thus, additional purported matches can be found for the seeker on the basis of the substitution of credentials in directly or closely related fields of study for those stipulated in the job orders — with the estimated goodness-of-fit reduced to reflect crude determinations of training-relatedness per the ratings in the SOC-to-CIP matrix developed by the National Crosswalk Center.<sup>52</sup>

Similarly, KSAs and TTRs are not put to use exclusively in a single occupation (e.g., key-boarding). While not identical, the KSA requirements of separate occupations will overlap as do the TTRs used. A seeker can be matched on the bases of prior employment in an occupation other than the one specified in the job order according to the extent to which the

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<sup>52</sup> The latest revision (October 9, 2008) of this crosswalk may be downloaded (socxcip.doc) from <http://webdata.xwalkcenter.org/ftp/download/xwalks/>.

comprehensive KSA and TTR lists of the two occupations coincide — despite significant heterogeneity in their deployment within both of the occupations being compared.<sup>53</sup>

Seekers can go to the DOL's online CareerOneStop Web portal for assistance in self-directed searches using the mySkills/myFuture matching utility that operates at the occupational level<sup>54</sup> (Dias, 2011b). Various transferable skills matching utilities (e.g., TORQ®<sup>55</sup>), available on a license fee basis to workforce development entities, are based on proprietary (most often undisclosed) algorithms for weighting the importance of overlapping KSA and TTR requirements between occupational titles. Transferable skills ratings are used to guide the decisions of both employers and job-seekers. Employers can see candidate referrals stack ranked according to the goodness-of-fit with specifications in their job orders. Case management can prioritize seekers' job search activities based on a stack ranking of job orders according to goodness-of-fit with their respective self-reported qualifications. Gap analysis can be used to guide training referrals to providers with offerings in the field of study related to a seeker's unfilled career aspirations.

The problem with a transferable skills approach lies in the deductive imputation of skill requirements to the occupational title appearing in the job posting and worker skill endowments from their prior occupational employment and major field of study in their formal training. The

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<sup>53</sup> TTRs are classified by their United Nations Standard Products and Service Codes (UNSPSC). Examples can be found online at <http://webdata.xwalkcenter.org/ftp/download/onet.sup/TT09ReadMe.pdf>. In the latest release announcement (January 4, 2011), the National O\*NET Crosswalk Center reported that 43,000 TTRs have been mapped to 629 of the SOC occupations. The TTRs are not mapped to tasks or DWAs by the National Crosswalk Center. The O\*NET Supplemental File containing the TTR-to-SOC crosswalk can be downloaded from [http://www.xwalkcenter.org/index.php?option=com\\_content&view=article&id=96:onet-supplemental-files&catid=31](http://www.xwalkcenter.org/index.php?option=com_content&view=article&id=96:onet-supplemental-files&catid=31).

<sup>54</sup> <http://www.myskillsmyfuture.org/>

<sup>55</sup> [www.torqworks.com](http://www.torqworks.com).

matches generated are overly broad unless the job order involves a licensed occupation or the employer specifically requires an industry- or professional association-recognized skill certification. The number of KSAs and TTRs associated with the SOC title attached to a job order likely will exceed those required to fill it because auto-coding shoehorns heterogeneous job titles and all their accompanying KSAs and TTRs into a single SOC code. The number of KSAs and TTRs that a seeker actually used to perform work functions likely will be smaller than the number associated with the SOC label attached to his employment history.

In assessing the utility of current transferable skills programs (TORQ, JobSTAT, and mySkills/myFuture), Alstadt concluded that their validity is limited by the lack of up-to-date information about the KSAs needed for a particular occupation – especially for emerging occupations altogether. Secondly, “the tools assume that job seekers have the knowledge, skills, and abilities for their specified occupation—nothing more and nothing less.” Users are not allowed to self-identify the KSAs they have acquired through or along other pathways or “remove competencies that they do not possess but are supposed to have for their current occupation.” In failing to portray existing skills accurately, such transferable skills utilities are “miss[ing] potential skills gaps that need to be addressed through additional education and training” (Alstadt, 2010, p. 34).

Alstadt did express hope that the shortcomings he identified would be remedied through arrangements in the Northeast Consortium LMI Improvement Grant States partnership with Burning Glass to apply AI tools to real-time job bank scrapings and in Minnesota’s efforts to do the same as it embellishes its JobSTAT utility.

Similarly, derivation of skill endowments from education and training achievements suffer the same shortcomings as derivations from prior occupational employment experience.

The training-relatedness ratings of CIP and SOC pairs are based on the overlap between overly broad CIP-coded fields of study and overly broad SOC. Each field of study in the CIP taxonomy encompasses a wide variety of course offerings within a major. That masks heterogeneity of within-major course-taking behavior and within-course content or expected student learning outcomes. It also overlooks electives taken. For example, a postsecondary institution awarding undergraduate degrees in Economics might not offer any courses on labor supply and demand, or where such a course is offered, a student can complete the major degree plan without taking Labor Market Economics. Moreover, the learning objects and performance assessments for courses with the same title can vary widely from one institution to another or from one instructor to another at the same institution.<sup>56</sup>

When a skills match is based on imputations deduced from a crude ranking of training-relatedness of CIPs to SOCs, then KSAs may be ascribed to credential holders that are imparted in courses they never took and KSAs actually acquired in the courses taken (in closely but not directly related CIPS) may be of marginal or no use in the SOC in general or the narrower job order in particular.

On both accounts, well-intentioned, but overly broad, transferable skills ratings make job matching less reliable. In the long run, that damages the credibility of the public workforce development system's electronic labor exchange, case management practices, and job candidate referrals. If flooded by referrals from One-Stop Career Center job placement specialists for registered job-seekers who clearly were not qualified, employers will be reluctant to post job notices with the public labor exchange. Poorly matched referrals increase the employer's costs of

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<sup>56</sup> This issue is taken up again later in the paper in relation to research and development currently underway in the study of returns to education.

recruitment rather than providing a value-added service. And if seekers are frustrated by chasing referrals to jobs for which they are not genuinely suited, they may become discouraged and exit the workforce.

### **Job matching with DWA-based semantic processing.**

DWA-based skill profiling of actual job requirements and seeker characteristics provides more reliable matching. AI using a semantic processing engine built around a lexicon of DWA statements in a precise syntax can distill the specific and unique KSAs and TTRs combinations in a job order and translate seeker information into concrete skill profiles. In a first pass, the processing engine translates job orders into a large list of KSAs and TTRs based on what can be imputed from the O\*NET to the posting's SOC label and deductively derived from the CIP-to-SOC crosswalk about the training-relatedness of fields of study identified in the minimum educational qualifications. Up to this point, the system flow is virtually identical to other transferable skill matching tools that are anchored in occupation-centric LMI. But rather than looking immediately for a match, AI is used in a second pass to refine the profiles. In the second step, semantic analysis of the unstructured natural language text portions of the job order ranks the ascribed KSA and TTR requirements in order of importance, deleting those of zero order or marginal importance. This semantic analysis is based on word/phrase frequency, word order, distance between key words, word valence (i.e., positive/negative) and intensity indicators (i.e., "required" vs. "preferred" and "must" vs. "may"). The DWA lexicon and thesaurus are used to parse natural language text descriptions of essential and occasional job functions into the precise syntax developed for the Navy's use.

Similarly, seeker profiles are built by first translating information in fixed fields about prior occupational work experiences and formal credentials by imputing KSAs and TTRs based

on SOC labels and CIP fields of study. Then semantic analysis is done on information in the unstructured natural language text of open-ended fields and attachments (e.g., resumes) that describe prior work actually performed and self-reported learning experiences. Verb-object combinations again are used to parse that information into a precise syntax to better assess what KSA and TTR imputed to prior occupational employment and formal education were actually used in previous jobs. Algorithms are used to reduce the relevance rating of prior work activities based on elapsed time since last performed. Educational credentials can be weighted on the basis of lapsed time since date of issue. The semantic analysis yields a stack ranked list of the seeker's KSAs and TTR with zero order and marginal ones deleted.

In other words, both job orders and seeker profiles are translated into a common language. Deductive imputations are made in the first passes respectively through the job orders and seeker files for the sake of building a transaction-specific lexicon that the semantic engine can use to mark and tag residual information in the job orders and seeker files, Then the second AI pass outputs profiles built inductively from semantic evidence of actual job requirements and actual seeker endowments.

The first round's imputed translation coupled with the second round's parsing (or "culling") yields higher fidelity job skill requirements and seeker skill profiles. With greater specificity on both sides of the equation, estimates of the goodness-of-fit are more accurate. Fewer, but more suitably qualified, seekers are referred for placement with employers who use the public labor exchange. That helps employers contain the costs of recruitment and applicant screening — thereby increasing the value added by the local workforce investment board's employment services contractor. Seekers, chasing fewer fruitless leads, can use their time and

job search assistance services in vetting and documenting the KSAs and TTRs of critical importance to their genuinely viable job opportunities.

***Proof of concept in a closed system.***

Capital Area Workforce Solutions (CAWS) funded a project to avert mass layoffs at a hospital in its service area (Travis County, Texas) which served as a proof of concept for a DWA-based approach to job-person matching. (Additional details are provided in Appendix D.) The hospital's reorganization plan included deactivating some departments and creating new ones. The hospital hoped to avert a mass layoff by reassigning personnel from departments that were closing either to new positions in departments they planned to open or to vacancies created by natural attrition in departments unaffected by the reorganization. Aversion project researchers worked in parallel with HR to match candidates from the closing departments to new jobs and vacancies opening through attrition. Researchers downloaded a lexicon from the Texas employer-validated DWA library (from Phase One of the TWC's Common Language Project) into a semantic engine for applying AI to create job skill requirement profiles from HR-supplied postings. The semantic engine using the same DWA-based lexicon for applying AI produced skill profiles of the seekers from their *pro forma* application information and resumes. Two sets of AI-generated goodness-of-fit matches were produced in near real-time. Department heads and Human Resources (HR) received a stack ranking of available in-house candidates for each new position. Reorganization-affected workers were given a stack ranking of job openings for which they were best qualified. The ordinal rankings of in-house candidates for all jobs generated by AI in near real-time corresponded nearly perfectly to the ordinal rankings produced by HR after it had spent three months on its own in labor-intensive reviews of more detailed off-line resources that had not been made available to the aversion project team for semantic analysis.

Nearly instantaneous turnaround provided sound, just-in-time decision support for hiring choices and preparing reassigned personnel for their new jobs. Where necessary, HR was able to anticipate the learning curve (based on very specific gaps identified in the goodness-of-fit) and provide pinpoint skill-upgrade training. Lead times and instructional delivery schedules could be set according to SME-identified preferred training for each skill gap to be addressed. Because training was tightly targeted, costs were reduced and productivity losses were minimized as reassigned personnel were brought up to speed in a timely fashion to meet performance expectations so that they “hit the ground running” in their new jobs.

The proof of concept effort demonstrated that a semantic processing engine built around a precise DWA lexicon could use AI on a small scale in a closed system to generate valid job-person matches. The closed context (single employer and internal-only applicant pool) in which the proof of concept was achieved is analogous to succession planning and internal recruitment by private sector firms or public agencies and to military work breakdowns (e. g., for internal promotions, duty roster reassignments, and reservist call ups).

Indeed, when asked to evaluate decision support tools for succession planning across all agencies, the LMI Director of the TWC recommended the DWA-based semantic engine as the tool that best fit with the guidelines for the job analysis components (i.e., §VII – Conduct Workforce Analysis and §XIII - Workforce Analysis Activities Matrix) of the State Auditor’s Employee Classification System<sup>57</sup> (Texas State Auditor, undated). Applications in other closed

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<sup>57</sup> The Texas state employee succession planning guidelines served as the model for the processes adopted by other states including New Hampshire, California, Wisconsin, Washington, and Kentucky, and other governmental agencies such as Fairfax County, Virginia. The model has been commended for use by small businesses in the private sector by the Small Business Chronicle (Mathew, undated).

systems would simply be a matter of scale; the theory behind and technology for DWA-based, job-person matching for larger closed systems would not change.

***Open context application.***

In theory, the tools and techniques which worked successfully in a closed system can be used for person-job matching in a context open to all employers and an unbounded applicant pool. State-sponsored electronic labor exchanges are a case in point. WorkInTexas, for example, accepts job postings from any employer. UI claimants are required to register with WorkInTexas and actively search for jobs through it in order to remain eligible for benefits. Other job-seekers may register with WorkInTexas (e.g., walk-in customers of the One-Stop Career Centers' online users). Job postings and job-seeker records both contain combinations of structured data (e.g., answers to mandatory items in fixed format fields) and unstructured natural language text (e.g., extended job descriptions and attached resumes). The chief difference in applying the technique for job-person matching in an operation open to an unbounded applicant pool would be the need to add a step for verifying the worker characteristics claimed by the job-seeker.

The main challenge in applying the technique in an open system to find best fitting job-person matches is not a technical one. Rather it is a matter of coverage. Aside from UI claimants, for example, job-seeker registration with WorkInTexas is voluntary. Other job-seekers may not be aware of that electronic labor exchange and they have other options to choose (e.g., Monster.com). Aside from state and local government agencies in Texas, no employers are required to post job openings with WorkInTexas.

But state workforce agencies are now turning to “consolidators” (e.g., HelpWanted Online from the Conference Board and Burning Glass) for solutions to the coverage issue (Alstadt, 2010; Vollman, 2010; Dorrer, 2010a; Dorrer, 2011). Consolidators scrape postings

from public and private job banks using web-based spidering technology. If a firm posts the same notice on multiple job banks — even if with slightly different wording — AI is used to purge duplicate entries from the scrapings. Consolidators then forward the unduplicated scrapings for a particular state/region or industry to its customers (e.g., state workforce agencies and private subscribers) based on customer-selected filters (e.g., geo-codes and NAICS). The same process could be used to scrape, consolidate and forward seeker application information and resumes.

Consolidation increases the likelihood of finding hits by expanding both the pool of job notices and the talent pools to be matched at a single site or portal. It does nothing, however, to increase the reliability or “sensitivity” of any match so long as job skill requirements and worker traits are imputed to occupational titles and deduced from major field of study. Some of the consolidators who provide services to state workforce agencies and One-Stop Career Centers currently are pilot-testing the development of AI utilities to translate job postings and seeker information into skill profiles to facilitate higher fidelity job-person matching. If demonstrated to be effective, the tools and techniques under development would address the shortcomings of current practices by combining:

- 1) real-time LMI for supply and demand analysis envisioned by Froeschle and Anderberg (1997) and touted by Jim Vollman at the Brookings Institution’s roundtable on an emerging role for the federal government in human capital development (Vollman, 2010);
- 2) AI/semantic processing to distill and digest information from unstructured natural language text as described by Michael Brown (2006) and John Dorrer (2010b); and

- 3) a common skills-based language/lexicon for less ambiguous communications among stakeholder groups which, heretofore, talked past one another using separate jargons and disparate taxonomies (Anderberg and Bristow, 1996; Brown, 2006; Froeschle, 2011).

### **Gap Analysis to Drive Case Management.**

When done at a high degree of specificity, person-job matching yields substantive information beyond a numerical indexing of goodness-of-fit. One gets feedback in the form of gap analysis. For example, when seekers comes up short (e.g., less than an 80% match with an opening), a detailed graphic can be generated to compare the stack ranking of employer-identified job skill requirements against the stack ranking of the KSAs and TTRs each possesses. After attempts to match the seeker to several openings fail to yield any good fits, a better picture of the seeker's overall skill gaps emerges relative to current local labor market demands.

Gap analysis is especially useful for UI claimant case management. It provides more nuanced guidance information than occupation-centric case management tools and procedures, specifically, the Worker Profiling and Reemployment System (WPRS) and technical guidelines for the authorization of training services.

### ***Comparison to the Worker Profiling and Reemployment System.***

WPRS looks primarily at relatively gross variables, such as the extent of a claimant's work history by industry and occupation and prior bouts of unemployment and their duration, as well as broad indicators, such as occupational employment within a service region's industries. The purpose of WPRS is to predict the likelihood that a claimant will exhaust benefits before becoming reemployed (Sullivan, et. al., 2007). As the result of WPRS, likely exhaustees are referred for more intensive services.

Given the gross inputs of the WPRS model, the likelihood of exhausting UI benefits without gaining reemployment is assumed explicitly to be a function of the interaction effects of the claimant's weak labor market attachment and weak overall local occupational employment demand in the industries where the claimant previously worked. Case management interventions for those who score high on the WPRS index will involve providing incentives or sanctions to motivate potential exhaustees to search more intensely and assistance in broadening their searches beyond the industry/industries of prior employment. The coarse industrial and occupational employment orientation of the WPRS model renders it relatively insensitive to alternative skill-mismatches and discontinuities as explanations of benefit exhaustion like demand deficiencies in the local labor market for the skills in the claimants' legacy endowments and the claimants' lack of endowed skill "currency" to meet new and evolving requirements even in the job family or industry where they were previously employed. WPRS may indicate a general need for training, but, in the absence of specific skill gap analysis, it can only direct case managers and claimants to look at locally available training options to determine which are related to employment in high demand target occupations.

In this sense, WPRS is a form of what Jim Vollman calls "case management triage" (Vollman, 2010). However, it does not identify the specific skills gaps which affect the individual's employability. Thus, WPRS is relatively ineffective in identifying and rapidly diverting those most in need to training. A DWA-based approach to describing claimants' legacy skill endowments would provide a refined profile that can be compared to current demands of the local market. Gaps identified through that comparison can pinpoint more precisely what training each claimant will need in order to become marketable. In the triage

model, those claimants would be referred more promptly to training rather than to other intensive services.

### **Justifying training referrals in the absence of suitable employment.**

While prompt training referrals are integral to case management triage, they are the most costly service option. Technical guidelines for implementing WIA specify a case management sequence designed to conserve scarce resources. Low-cost core services (e.g., providing access to LMI and the public labor exchange) are to precede intensive services (e.g., aptitude and interest assessment and job search assistance) which must precede the most costly (e.g., training referrals and relocation assistance). Determination of eligibility for a WIA-funded Individual Training Account (ITA) is a critical gateway in case management. Like the WPRS, stringent guidelines for approving training referrals implicitly make an *a priori* assumption that suitable jobs do exist. The assumption is a *prima facie* one, but rebutting it is difficult because case management guidelines provide a low threshold for empirical evidence regarding the sufficient availability of suitable jobs to warrant waiving the training requirement.

Trade-affected and North American Free Trade Agreement-affected workers, for example, are nominally entitled to training, but only under certain conditions. Training can be approved for trade affected workers under 20 CFR 617.22(a)(1) only if there is no suitable employment available. Suitable employment is defined for this criterion as "work of a substantially equal or higher skill level than the worker's past adversely affected employment, and wages for such work at not less than 80 percent of the worker's average weekly wage" (DeRocco, 2005, emphasis added). In Texas, former Assistant Secretary DeRocco's Employment and Training Guidance Letter is interpreted to mean that the training element can be waived if a trade-affected worker has "marketable skills." That is, in waiving the training element, case

managers need only determine that the claimant has a “reasonable expectation of suitable employment” (not that an actual opening with at least an 80% replacement wage exists).

Case managers are directed to base their determinations on an initial battery of assessments of claimants’ skill levels, identification of transferable skills, and an analysis of employment trends in the local labor market (TWC, 2005). In doing the analysis, case managers are to examine LMI covering the widest range of demand and targeted occupations as appropriate based on the individual assessment of KSAs to identify specific occupations (which will “reasonably be available” but not necessarily have openings/vacancies) which will meet the 80% replacement wage target (TWC, 2005, §D-200.4). At the close of §D-200.4, case managers are reminded to document their findings. “In order to approve training,” they must ensure that “no suitable employment is available.”

For documentation purposes, TWC guidelines direct case managers to use TRACER (Texas Rapid Access to Career and Economic Resources).<sup>58</sup> TRACER is a portal to standard data series for state and federal LMI consisting of the Covered Employment and Wages Program; the Current Employment Statistics Program; the Local Area Unemployment Statistics Program; the Occupational Employment Statistics Program; and the Mass Layoff Statistics Program. Note that all of the recommended resources are occupation-centric and based on data derived from sample surveys or administrative records.

By directing case managers to rely on imputed characteristics from coarse and time-lagged occupational employment data, the guidelines are likely to produce false positive findings that suitable jobs do exist. Finding false positives can result in denying eligibility for genuinely needed training. First, as previously discussed, based on highly aggregated occupational titles

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<sup>58</sup> <http://www.tracer2.com>.

and heterogeneity of work activities therein, occupation-to-occupation matching exaggerates the availability of suitable employment opportunities. And when skills are imputed to both the claimant's prior occupation and potential closely related target occupations, the transferable skills approach further compounds the likelihood of finding false positive evidence of suitable employment opportunities.

In particular, the transferable skills approach to identifying alternate occupational employment opportunities will score corresponding demands for general human capital under each title as a positive hit. In the human capital theory, the labor market will demand both general and specific human capital. General human capital refers to workplace basics valued by employers across virtually all work activities and cross-cutting KSAs valued by all employers in a particular industry. Specific human capital refers to more specialized skills which are of value to a unique firm or establishment. General and specific human capital are not dichotomous but rather are arrayed on a continuum. Demand for general human capital is considered relatively constant across individuals with different specific capital. On the other hand, variability in market demand for human capital will increase with the degree of specificity and specialization. Employers signal their demand for specific human capital by offering wage premiums. (Mincer, 1958; Schultz 1961; Schultz 1963; Becker, 1964; Schultz, 1971; Schultz, 1972; Becker, 1992; Becker, 2002; Becker & Cheswick; Tiexeria, 2007)

When accelerated implementation of innovations creates more frequent discontinuities, market wage signals are obscured in two ways by an occupation-centric LMI system that relies primarily on data collected through periodic sample surveys. Time involved in conducting surveys, compiling the results and releasing them publicly creates "*signal lag*." Moreover, the wages tend to be "*sticky*." Wage offers do increase promptly when positions requiring new and

scarcely held KSAs go unfilled. But wages provided to incumbent occupational workers may have been set in long standing contracts which are not renegotiated whenever a demand shock occurs in the middle of the contract period.

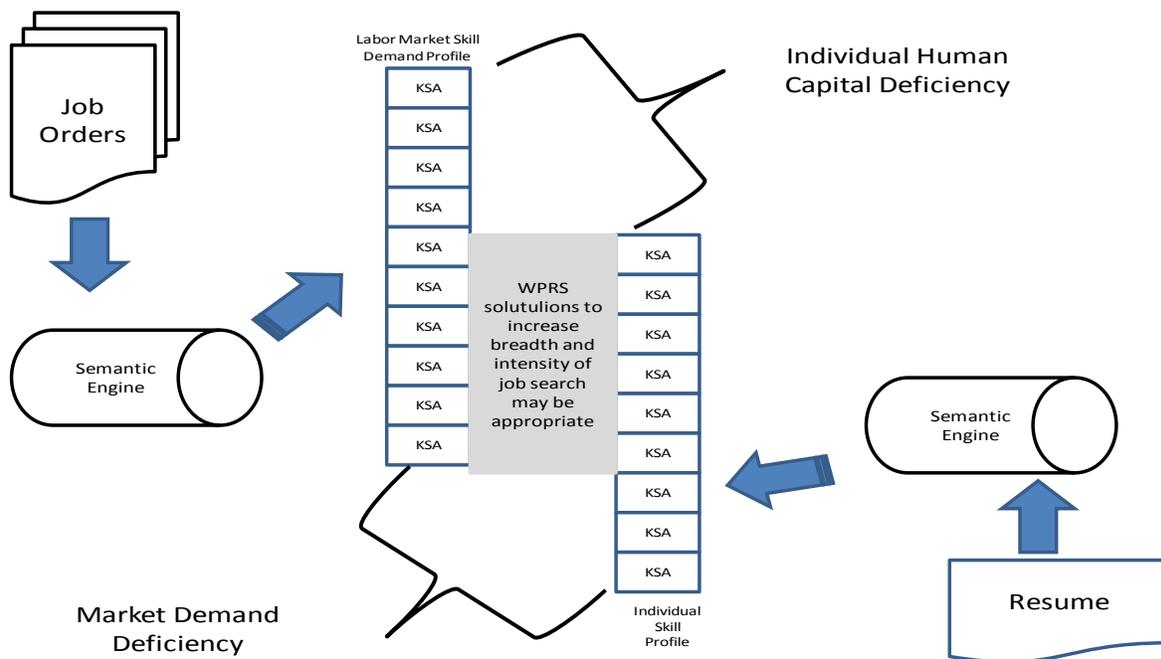
In a recession, some occupational workers are laid off. Their wages drop to zero but that is not factored in the average occupational wage calculation since those who were laid off are dropped from the denominator and their “post-layoff” earnings are not part of the numerator. Meanwhile, those who are retained continue earning wages that have not yet been adjusted to reflect currency of reduced demand for their KSAs. Moreover, some workers still employed under a legacy occupational title may see their wages increase if they are redeployed in innovative processes where they apply new, scarce in-demand skills to be more productive and/or they are provided skill-complimentary technology in a new job level DWA configuration. Workers with firms or at establishments that gain comparative advantage as early adopters of incremental innovations may earn more while those at laggard establishments remain at the same old sticky wage rate. Thus, the average occupational wage may go up although the market value of the dislocated workers’ outdated skill endowment does down.

It may appear, then, that jobs are available at or even well above the 80% replacement wage even though they are not suitable for dislocated workers because their legacy endowments of specific skills were integral to DWAs that are no longer in the assigned mix, have been depreciated or rendered obsolete by the destructive side of innovations impacting the occupation, and wage premiums which sustain or even boost the prevailing occupational wage currently are offered only for specific human capital they do not possess.

DWA-based skills gap analysis makes no low threshold assumptions about the local availability of suitable jobs based on gross indicators of regional occupational employment

demand; deductively imputed skills; assumptions about skill elasticity; or individual applicability of time-lagged and possibly misleading prevailing occupational wage statistics. It sees the likelihood of benefit exhaustion not as an inference about motivation or ineffective search strategy but rather as an empirical question regarding the market value of claimants' human capital (i.e., their unique endowments of KSAs and prior experiences in using specific TTRs). The graphic below depicts how gaps can occur on either end of a comparison of what the local labor market demands and the human capital that the potential exhaustee can supply. The gap may be a result of the individual's human capital deficiency, market demand deficiency, or both.

Picking an appropriate intervention depends on specifying which gaps best explain why the claimant might exhaust UI benefits before being reemployed. Prompt referral to an eligible training provider program on an ITA would be the most logical triage intervention if the claimant lacks the right human capital to be marketable (i.e., to find a new job that pays an 80% replacement wage).



**Reality check on the UI claimant’s reservation wage.**

Counseling to motivate the seekers to invest in their own human capital development would be a logical intervention if there is insufficient market demand for the KSAs that the potential exhaustee does possess. Despite educators’ exhortations about lifelong learning, adults — particularly older workers — may be reluctant to bear the opportunity costs of, and overcome the psychological barriers to, pursuing additional education and training. The reluctance is likely to be acute if lengthy training is needed to make a midlife career change. A reality check on the marketability of their skill endowments can be an important motivational tool.

Effective case management involves helping UI claimants interpret employer signaling under conditions of market demand deficiency. Take the case of dislocated or trade-affected workers with long work histories, steady career progressions, and commensurate wage growth. Such workers may exhaust benefits before being reemployed despite evidence of strong labor

force attachment. The critical factor may be the claimants' reservation wages — the minimally acceptable wage at which they are willing to return to work. A misunderstanding of market signals may lead UI claimants to set their reservation wages too high under demand deficiency conditions.

Several factors influence claimants' reservation wage. Dislocated and trade-affected workers with histories of strong labor market attachment likely will be accustomed to monotonic wage growth comprised of a linear component reflecting seniority and stepwise increases for career progressions. Experience and formal training typically are taken as proxy measures of productivity and the value of the workers' human capital. The wage earned just prior to losing a job creates an expectation that is hard to shake. It likely is reinforced by the financial obligations claimants have accumulated, consumption habits, and lifestyle choices made in anticipation of continuing to earn the last wage. That last wage may be perceived by claimants as the cumulative value of the KSAs comprising their individual stock (or legacy endowment) of human capital. From the claimants' perspective, there is no reason to alter (and especially to decrease) self-valuations of their human capital if their abilities have not noticeably deteriorated since last employed; skill proficiencies have not “rusted” and declined while out of work; and they retain the knowledge they previously acquired.

But on the demand side, the value that the employer places on the KSAs comprising the claimants' human capital endowments may have changed dramatically since the claimant's last wage rate was set. To remain competitive in a dynamic global market, employers mash up and reconfigure DWAs as they produce new products and vintages, take up new technologies, and adopt new business models that recombine human capital, financial capital and technology for greater efficiency, productivity, and cost containment.

Relevant and reliable hard data are needed to show claimants the discontinuity or disconnect between the shelf life of their KSAs and diminishing returns to them. As noted above, the publicly-released prevailing occupational wage is time-lagged. It reflects stickiness and fails to capture heterogeneity of within-occupation DWA configurations and the fluidity of returns to skills as DWAs are reconfigured at the job level. Given occupation-level wage information by the case manager, dislocated or trade-affected workers may fail to reset their reservation wages because that coarse market signal is misleading. Believing that their skill endowments retain, or monotonically increase, their value over the entire shelf-life and that suitable employment opportunities do exist, claimants — encouraged by their case managers — futilely engage in broader and more intense searches for jobs that pay more than their reservation wage. Their failure to become reemployed quickly may be taken by observers at a distance as evidence of weak labor force attachments. Instead, those failures may be indicative of the claimants' hard-to-shake psychological attachment to unrealistic self-appraisals of the currency of their human capital and reservation wages derived from there.

Translating data scraped from real-time job orders into skill demand profiles will better inform claimants about the fluidity and dynamics of “recombinant DWAs” in their respective fields of work. Case managers can use DWA-based, real-time data about returns to skills to help claimants determine if they can no longer expect a premium wage offer for (or “rents” on) the KSAs associated with the DWAs they used to perform — much less for all of the KSAs in their legacy endowments.

## **Training Services.**

### ***Maximizing returns of on scarce training dollars.***

Using a more sensitive model for determining the availability of suitable jobs would result in raising the threshold for withholding approval of training referrals. Insofar as training is one of the most costly options among services available under the WIA and the Trade Adjustment Act, funding at current levels likely would not be sufficient to cover all requests for ITA vouchers. That leaves three options, namely specifically earmark a larger portion of current funds for training services; increase appropriations; or use scarce training dollars more effectively.

Option one would entail cutting back on other uses of federal workforce dollars held dear by state and local officials (e.g., for employment-generating activities). Ironically, option one would likely pit funding of training services against funding the data development necessary to make realistic training eligibility determinations.

Option two is unlikely given calls for curbing expenditures to address the budget shortfall. Education and training programs, in particular, seem to be on the chopping block. Note, for example, that Congress has defunded vocational and technical education programs under the Carl D. Perkins Act as of July 1, 2011<sup>59</sup>, with more cuts to Perkins-funded career and technical education programs likely in the next federal budget.

Option three would entail more effective use of training referrals. Necessary efficiency gains and savings capture can be achieved through the use of the same skills-based modeling used to identify claimants' skills gaps. These three ways are described below.

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<sup>59</sup> <http://www2.ed.gov/offices/OVAE/CTE/perkins.html>

First, the DWA-based modeling can pinpoint claimants' human capital deficiencies more precisely. The mix of DWAs in locally available jobs openings may require that each claimant need only add one or two KSAs to their stock of human capital. Those KSAs might be obtained through short (less than semester length) classroom instruction, open-entry/open-exit/self-paced distance learning, or short-term on-the-job training (OJT). But case managers may be hamstrung by the crude decision support tools at their disposal for determining where to enroll training-eligible claimants.

### ***Developing OJTs.***

The Trade Act [at 20 CFR §617.22(a)(2)] does stipulate that the criteria for approval necessitates that the training program for a trade-affected worker should be complete enough to make the worker "job ready." The Trade Act [20 CFR §617.213(c)(1)] adds that state agencies give priority to the use of OJT programs but it provides no guidance to case managers for determine how claimants' skill gaps will be addressed, how long OJTs should last, and how progress will be measured. The DWA-based approach can be used to compare skills required for employment with firms offering OJTs to those that the claimants can and cannot yet perform given their legacy skill endowments. The comparisons can be used to identify precisely the skill requirements that need to be addressed for any DWA in a job order. That gap information can drive the stipulation of an OJT-providing firm's deliverables and how they will be monitored and measured. Research based on SME inputs can provide guidance on how long the skill acquisition should take. Indeed, that research can be used to determine if an OJT is the best modality for acquiring the required skills. That would enable a data-driven choice between OJTs and other training options, as opposed to a normative policy preference for OJTs. And it would set a

reasonable time limit on OJT contracts rather than issuing blanket contracts for the maximum allowable length.

***Vetting cost-effectiveness of services from Eligible Training Provider services.***

Under 20 CFR §617.22(a)(4), in the absence of an OJT option, approved training must be reasonably available from either government agencies, education providers, or private training providers. But neither the training nor administrative funds can be used to pay for the development of a training curriculum. In other words, approved training is, by and large, bought off-the-shelf with the units of instructional delivery and content (learning objects) set by the provider. The training must be available locally and at a reasonable price (although there is no formal cap on training payments). In meeting the stipulation that referrals be made to entities on the Eligible Training Provider (ETP) list, case managers have access to price information but they are not likely to have access to employment and earnings of program completer cohorts in order to determine the cost-effectiveness of each training options.

An ETP listing signifies only that the provider offers a program of study locally that is related to a target occupation. There is nothing in the ETP screening to assure that the instruction they can deliver will impart precisely the skills needed by a claimant to become marketable, only that direct or close CIP-to-SOC for target occupations was identified through a cursory desktop review. The provider determines how the instruction will be packaged and delivered, including billing for units which impart KSAs that claimants already possesses or do not need in order to be work-ready. The entity promises to provide the training to claimants at or below the lowest price it otherwise offers to the general public. While ETPs must attest that they are not debarred

from delivering training services, they are not required to provide evidence of cost-effectiveness.<sup>60</sup>

Typically, community colleges and multi-campus proprietary trade schools strive to get all of their programs of study included on the ETP list. The general good standing of the provider institution may drive approval for listing all of its programs, despite the possibility of uneven quality or market relevance from one program to another. Largely absent from the list are distance learning providers based outside the local workforce development region and private providers who offer short courses locally which could address some claimants' specific skill deficits (e.g., a hardware and software retailer that offers evening or weekend courses on MicroSoft Excel or MicroSoft Word).

### **Returns to skills.**

The model currently in use is to examine the connection between occupational employment and training that looks chiefly at the modality or type of preparation (e.g., classroom training versus work experience) and duration of preparation (e.g., length of work experience and level of award as a proxy for length of formal training). But decision support tools based on a more refined concept of returns to skills could be used to enhance the efficiency and cost-effectiveness of training referrals. The research agenda on returns to education in the workforce arena and relation to default aversion in the Direct Federal (Student) Loan program are both inching closer to looking at, perhaps even projecting, returns to skills. The TWC's Common Language Project is already developing the data for drilling deeper from returns to education to returns to skills. Vocational education development officials in member nations of

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<sup>60</sup> Debarment typically occurs if a training entity engages in fraud (e.g., billing for instruction that it did not deliver) or loss of accreditation to issue particular educational or occupation-related credentials.

the European Union have been developing a skills-based approach to quality assurance that might be useful to adapt to workforce development in the United States.

*Variance within level of award and across training providers.*

A research team directed by Anthony Carnevale at Georgetown University's Center on the Workforce and Education found that earnings at the bachelor's level vary by major field of study. (Carnevale, Strohl, & Melton, 2011). The study also looked at the dispersion and concentration of industry employment by major. That research moves past previous studies which reported on variance in earnings by level of educational attainment (e.g., high school diploma versus baccalaureate degree.) Nonetheless, there appears to be wide variance in earnings within each major.

When operating the Consumer Report System (CRS),<sup>61</sup> the Automated Student and Adult Learner Follow-Up System at the TWC found that placement rates and earnings for students exiting the states' public two-year institutions with associate degrees varied by field of study. The data also showed that post-exit employment and earnings also varied within major by the institution awarding the degree. They also varied by the degree of training-relatedness of occupational employment based on the CIP-SOC crosswalk.<sup>62</sup>

Other possible sources of variance have been hypothesized but the data were not developed for testing those hypotheses before the CRS was deactivated. The hypothesized

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<sup>61</sup> The Texas Consumer Report System was developed under a grant from the ETA and was operated by the Automated Student and Adult Learner unit of the TWC for five years. Operations were suspended when the state's Higher Education Coordinating Board determined that the Family Education and Right to Privacy Act prevented them from sharing student unit records for matching by the TWC to wage records in the employer's quarterly reports to the UI system. Data files have since been destroyed under provisions of the data exchange agreements at the expiration of the authorized retention period.

<sup>62</sup> Occupational titles were not part of the UI wage records. They were obtained by contacting the employer of record in the UI system through a follow-up survey.

explanatory variables included differences in major field of study instructional content (learning objects/expected student learning outcomes) by institution and differences in course-taking among students in the same major. Course completion data (e.g. from transcripts) and course level information on expected student learning outcomes were not available. The former were not covered in the data exchange agreement between the TWC and training providers per the Family Education and Right to Privacy Act. Course level data on expected student learning outcomes were never developed because programs did not require rubrics for class development;<sup>63</sup> the cost for computational capacity would have been prohibitive; and fully developed AI tools were not available then.

To estimate returns on skills actually imparted, one needs both course-level expected student learning outcomes on the front end and student-level course completion information on the back end. Those kinds of data are just now being developed – voluntarily by some education and training providers or in response to new reporting requirements aimed at promoting accountability and transparency.

- 1) Some postsecondary institutions (particularly those which make heavy use of non-tenured, short contract adjunct faculty) now require detailed rubrics for course approval. They also provide rubrics to prospective students in the pre-enrollment stage to facilitate informed choice in course selection.<sup>64</sup>

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<sup>63</sup> A rubric is a formal statement outlining expected student learning outcomes, how student achievement on each expected outcome will be assessed, empirical metrics for each assessment, and the relative weight of each expected outcome to the overall grade awarded to the student.

<sup>64</sup> Park University, Park, Missouri, operates multiple campuses and provides distance learning. Students may configure their graduation plans by taking courses from more than one campus and online. Park University requires faculty submit rubrics to obtain approval for any course offering.

- 2) Other postsecondary programs (e.g., Registered Nursing at Midwestern State University, Wichita Dallas, Texas) are issuing competency transcripts upon course completion to specify course content and student proficiencies rather than opaque grades (Green, 2006; Roberts, Lockhart and Sportsman, 2009; Sportsman, 2010).
- 3) Guidelines for education and training programs funded with federal dollars under the Carl D. Perkins Vocational and Technical Education Act require reporting of student attainment of industry skill standards where applicable. A study done in Pennsylvania by MPR Associates indicates that schools are not consistent in the way they comply with that requirement (Staklis & Klien, 2010).

Breaking down instructional content to skills-based learning objects and mapping them to job-level DWAs is essential to modeling returns to skill acquisition. While some steps have been taken by education and training providers in the United States to develop taxonomies and rubrics for breaking down course offerings into skills-based learning objects, the TWC's Common Language Project is the first effort to link them to employer-identified skill requirements to perform the DWAs comprising jobs in the current market.

***The Gainful Employment rule for federal direct student loans.***

The issue of returns to training is also being raised as the U.S. Department of Education is now issuing direct student loans. To avert student loan defaults, the rules regarding institutional eligibility to participate in the program have been rewritten. Under the predecessor guaranteed student loan program institutions could lose their eligibility if, in several consecutive years, their cohort default rate exceeded the threshold. Two considerations led to changes in the rule. First, students on federally guaranteed loans were still being enrolled at poorly performing institutions as unacceptable percentages of prior cohorts were defaulting. Rule changes aim at

forecasting likely defaults in order to suspend institutional eligibility before more potentially bad loans were made. Secondly, the previous measure was insensitive to within-institution variance among the programs of study it offered. So long as the overall institutional cohort default rate was below the trigger point, programs within the institution with unacceptably high defaults continued to enroll students on federally guaranteed/tax-payer backed loans.

A gainful employment rule, adopted in June 2011, will use debt-to-income ratios to forecast likely defaults. The rule will be applied separately to each program within an institution. Some programs may remain eligible while others at the same institution are denied eligibility to enroll students on federal direct loans. The central question is whether or not, based on comparisons of post-exit earnings relative to pre-exit debts incurred, students from a particular program are likely to default at an excessive rate. The gainful employment rule will speed up the denial of eligibility but it is still an *ex post* measure. The trigger for denying eligibility is predictions based on the program cohort's first and second year post-exit earnings.

Skills-based modeling based on comparison of expected student learning outcomes and labor market demand could, theoretically, provide default forecasting before loan origination. If not grounds for terminating program eligibility, results of the skills-based modeling could at least be provided to prospective borrowers to help them make informed choices before enrolling in a program likely to perform poorly with respect to placement and earning for their exit cohorts. The idea of pre-loan informed choice based on skills modeling might well be added to the Career Manager services that Mr. Vollman has recommended beginning at date of loan origin (Vollman, 2010a; Vollman, 2010b).

To date nothing has been mandated on a system wide basis to do the data development necessary to begin research into returns on delivered skills. However, two initiatives by non-

governmental organizations are developing standards for data elements that would be integral to refining skill gap-based person-to-training matching. The Institute of Electrical and Electronics Engineers' (IEEE) Learning Object Metadata (IEEE1484.12 -2002)<sup>65</sup> has been established as a more precise and highly specified classification of instructional content. Similarly an international effort is underway to develop a more precise classification of human knowledge called the S1000D.<sup>66</sup>

### **TWC's Common Language Project – Phase Two**

Efforts are underway in Texas to refine the data necessary for assessing returns to skills being delivered by the education and training partners in workforce development. The Texas Education Agency (TEA), Texas Higher Education Coordinating Board (THECB) and the TWC jointly funded phase two of the Common Language Project. (Additional details are provided in Appendix E.) In phase two, researchers used AI to translate public secondary<sup>67</sup> and postsecondary education<sup>68</sup> rubrics into skills-based expected student learning outcomes for core course requirements.<sup>69</sup> The lexicon used in the semantic processing engine was built using the

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<sup>65</sup> <http://ltsc.ieee.org/wg12/> and [http://www.imsproject.org/metadata/mdv1p3/imsmd\\_bestv1p3.html](http://www.imsproject.org/metadata/mdv1p3/imsmd_bestv1p3.html)

<sup>66</sup> Think of the S1000D as the functional equivalent of the United Nations Standard Product and Service Code currently used in the O\*NET to standardized descriptions of tools and technology.

<sup>67</sup> The TEA issued Texas Essential Knowledge and Skills (TEKS) as the core expectations for instruction delivered through K-12 courses that lead to a high school diploma.

<sup>68</sup> The THECB issued the Workforce Education Course Manual (WECM) as the core expectations for instruction delivered through public postsecondary technical and workforce preparation courses whose credits apply to one year certificates, two year associates' degrees, and for-credit continuing education.

<sup>69</sup> The THECB uses the hierarchical CIP taxonomy to classify instructional delivery. The WECMS are developed at the course level (six-digit CIP). In that hierarchical structure, courses can be rolled up (aggregated) or packaged for dissemination by four digit CIPs (major field of study — i.e., department or discipline) or by two digit CIPS representing broad fields of study. The Texas Education Agency uses its own Public Education Information Management System (PEIMS) taxonomy for classifying and cataloging instructional delivery. Like the CIP, the PEIMS codes are hierarchical. Both the TEKS and WECMS were developed at the course level then are cross-

library of DWA statements that had been validated by employers in phase one of the Common Language Project.

Staff used the semantic engine to translate the expected student learning outcomes from the rubrics into a precise syntax for describing learning objects. Translation of core expected student learning outcomes at the course-level provides higher fidelity skills-based information about an individual's education and training achievements than do imputations deduced *a priori* from degrees awarded by major field of study at the four digit CIP level or by career cluster designation in the PEIMS taxonomy.

Next, researchers mapped the SME-identified job skill requirements for all Texas employer-validated statements in the DWA library to the unduplicated and measurable expected student learning outcomes catalogued in the TEKS and WECM. The mapping identified multiple learning pathways to acquire many of the skills required to perform the DWAs comprising the work Texans do. Researchers built campus-specific DWA-to-expected learning outcomes of courses offered locally by independent school districts (ISDs) and community colleges that volunteered to participate in the mapping project.

The campus-level mapping produced local, skills-based training inventories. Campus level maps were shared with the operations managers of One-Stop Career Centers in the areas where ISD and community or technical colleges had volunteered to participate in the Common Language Project. Arming One-Stop Career Center case managers with skills-based inventories of locally available programs provided them with more detailed information about service

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referenced to higher orders of aggregation. Whereas the six digit postsecondary CIP course codes are cross-referenced to their respective major fields of study, PEIMS courses are cross-referenced to a higher level of aggregation for the OVAE's Career Clusters ([http://ritter.tea.state.tx.us/textbooks/materials/Cluster\\_Courses\\_CTE\\_MLC\\_PEIMS\\_2010.pdf](http://ritter.tea.state.tx.us/textbooks/materials/Cluster_Courses_CTE_MLC_PEIMS_2010.pdf)).

offered by vendors on their respective ETP lists. The skills-based information provided more detailed information on what each eligible provider actually had to offer. That would facilitate training referrals down to the course level (if permitted) for greater efficiency in addressing an individual's marketable skills deficits relative to their employment aspirations.

If the research designs for Carnevale's (2011) study of returns to training or gainful employment analysis of federal direct student loans were expanded to explain returns to skills, those data could be cross-linked to skill-delivery profiles of courses offered by ETPs. Given course-level pricing of ETP offerings, case managers and eligible claimants could better estimate the cost-effectiveness of their training options.

In the pilot campus-level mapping project, only volunteer school districts and community colleges participated. To serve as a case management tool for training referrals, campus-level mapping would have to be done for all ISDs and public two year postsecondary institutions in a local workforce investment board's service area. Other training options available in the region would also have to be mapped at the course level (e.g., private/proprietary trade schools, apprenticeship programs, etc.) Insofar as Carnevale's research examined only returns to baccalaureate degree programs, comparable research on returns to skills certifications would be a good place to start in order to determine if issuing entities should also be considered as prospective training providers. More specific research into the skills they deliver and returns to those skills would provide better decision support for referrals to programs on the ETP list and case management and comparisons of cost-effectiveness of available options to drive informed choice among training-eligible claimants.

## **Inter-Agency Collaboration.**

### **Facilitating employer input into education and training partners' skill delivery.**

Person-to-job and person-to-local market demand matching done in the course of case management both yielded concrete, actionable information to guide individual investments in human capital development. Namely, in the absence of suitable jobs, the resultant skills-based gap analysis provides the evidence of claimants' needs as is required for approving a training referral. Mapping employer-identified job skill requirements to the expected student learning outcomes at the core of course offerings provides useful information for determining what training to include in claimants' Individual Employability Plans (IEP). If, or when, the research agenda moves from returns-to-training to more detailed studies of returns-to-skills, case managers will have information for judging the cost-effectiveness of offerings from rival vendors on the ETP list and claimants will be able to make informed choices about their human capital development options.

Issuing an actual training referral assumes that suitable options are available from vendors on the ETP list. What if no local vendors offer suitable options for meeting the training needs of claimants that are not currently employable or work ready? Do the DWA-based skills modeling tools for decision support in case management also offer useful information that the workforce development system can share with partners from education and training who share an interest in human capital development?

In phase two of the Common Language Project, the TWC shared its findings with the education agencies (TEA and THECB) that had joined in funding the research. Just as person-to-local labor market demand comparisons yielded useful gap analysis for job-seekers and case managers, the DWA-to-TEKS and DWA-to-WECM mapping identified gaps where employer-

identified skill demands were not being met by education and training providers. In some cases, the statewide core course requirements in the TEKS and WECM did not address employer-identified skill requirements. The TEA and THECB were provided lists of DWA-based skill requirements that were missing as core learning objects at the course level in their respective curriculum guides. Additional information was provided on SME-identified preferred training modalities and expected average training time to impart the employer-demanded skills. The state agencies could use the information in determining their priorities for their subsequent curriculum guideline revisions.

If coupled with analyses of trends in skill demands based on the envisioned semantic processing of job postings archived by the consolidator services (e.g., HWOL and Burning Glass), skill gap analysis would help the state education agencies prioritize funding for efforts to make the curriculum relevant and responsive to unmet employer needs.

In addition to voids in the statewide K-12 and public postsecondary curriculum, gaps also occur because local education institutions in Texas are not required to offer every course covered respectively in the TEKS and WECM. Entities that voluntarily participated in the pilot campus-level mapping were provided gap analysis to use for strategic planning of their instructional delivery. Each gap in local offerings was listed as either a void in the statewide curriculum (as noted above) or as a local decision not to offer courses that would theoretically have imparted skills that employers demand. Coupled with evidence from the envisioned analysis of trends in regional job postings (provided by a consolidator service), education institutions could determine if there was sufficient demand to:

- 1) add the relevant skill-delivery course(s) to their local offerings, or

- 2) draft a cross-district exchange agreement to enroll its students in training programs offered by another educational institution in the region.

Obviously, curriculum development is not a function of the state workforce agency or of local workforce investment boards. However, they do have an interest in the transparency of, and returns on, training services they procure on behalf of their customers with workforce development dollars. The translation of course offerings into skills-based learning objects and mappings to campus level offerings would be legitimate decision support for education and training partners in the comprehensive workforce development system.<sup>70</sup> The local workforce investment board could serve as a “trusted broker” in handing off the gap analyses to local education and training providers by providing the “data handshake” to help align the curriculum with employer-identified skill-demands.

**A role in workforce quality control: Vetting and signaling job seekers’ skills.**

To this point, this paper has covered applications of DWA-based skills modeling in job-person matching, training referral approvals, informed choice in the selection of cost-effective training options, and partnering with education and training providers to make the curriculum relevant and responsive to employer-identified needs. Those operations are all antecedent to executing an actual job placement/employment transaction. Assuming that a good person-to-job match has been found (or developed through appropriate training), employers must still vet and verify the job-seekers characteristics and qualifications assertions. Employers see risks in each hiring decision; namely, will the marginal productivity of the candidate allow the employer to make a reasonable return after paying a “rent on labor” out of gross revenues. There also are

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<sup>70</sup> Stipulations regarding education and training representative on local workforce investment boards are provided in the US Code, Title 29, Chapter 30, Subchapter II, Part B §2832(b)92)(A)(ii).

opportunity costs involved in prolonged recruiting and screening. Production lags when key positions remain vacant for long periods. But rushing to fill those vacancies can result in bad hires that are even more costly. Risk-adverse employers endeavor to screen candidates quickly but carefully.<sup>71</sup>

Employers want to determine what job-seekers know and can do. One signal is academic credentials – degrees earned, credit hours/seat time accumulated, grades. For reasons given above, academic credentials – whether by level of award, institution or major field of study – do not suffice to provide a skills-based profile of what the job-seeker learned as a student. Given the weak signal strength of formal academic credentials from their perspective, more employers are looking for credible skill certifications.

Employer interest in skill certifications also is increasing because, as they dynamically reconfigure DWAs to remain competitive, they want education and training to be equally nimble in responding to their skill demands. Because of their large size and bureaucratic structure, public education and training face hurdles when trying to make the curriculum relevant and responsive. Maldonado (2008) describes this as “informational latency”. Namely, it takes time to develop new curriculum, get approval at several signoff points to deliver it. Then administrators wait for funding (which is becoming an ever more protracted fight when budgets are tight). Once funded, they have to wait for the next window in the academic calendar to offer a new program.

Other education and training options become more attractive if the wheels of public education and training turn too slowly. Indeed, nearly two thirds (65%) of the dollars for postsecondary education and training in the United States are spent outside formal postsecondary

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<sup>71</sup> For insightful analyses of HR strategies and performance metrics beyond the scope of this paper, see the works of John Sullivan, San Francisco State University, archived at <http://www.gatelyconsulting.com/PP15JS00.HTM>.

institutions. At the Brookings Institution Roundtable on *Putting American to Work*, Andrew Reamer broke down the estimated \$772 billion spent on postsecondary education and training annually as follows: \$16 billion on public job training; \$141 billion on employer-provided formal training; \$6 billion on apprenticeships, \$25 billion on industry certifications; and \$313 billion on informal employer-provided training (Reamer, 201b).

Having a process in place for speedier identification and validation of employers' skill demands and for translating employer inputs into expected learning projects would expedite rapid prototyping for curriculum development and, perhaps, expedited program approval and funding of instructional delivery. Some public postsecondary institutions already are responding by developing what Michael Bettersworth, a Vice President of Texas State Technical College System, calls "a DWA paradigm for instructional delivery" which entails the following:<sup>72</sup>

- 1) Rapid development of less-than-semester length instruction delivered on contract to an employer or group of employers for incumbent worker skill-upgrade training. Because the instruction is not for credit and is paid for by the employer, this approach bypasses the lengthy program approval, funding and calendaring hurdles. Admissions and enrollment hurdles are by-passed since the employer/sponsor determines who will be trained.
- 2) Joint development with business, industry and/or labor organizations of training modules that can stand alone or be dropped ("plug and play") into existing courses. So long as the existing courses meet core guidelines, no additional approval is needed for module insertion.

The institution covers development costs through:

- a. a grant from the co-developer/corporate sponsor; and/or

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<sup>72</sup> In private conversations with Michael Bettersworth, Vice Chancellor, representing the Texas State Technical College System on the technical advisory team for phase 2 of the TWC's Common Language Project.

- b. licensing the module to other education and training providers or non-education groups for use in their formal employee training programs.

At the same time, more persons are acquiring human capital in nontraditional ways. The training pipeline has become more like a sieve with multiple off-ramps and on-ramps. Through lifelong and life-wide learning, one can develop human capital by taking courses in a variety of disciplines from more than one institution without enough accumulated credits to earn a credential from any one of the providers or acquiring knowledge and skills through work experiences and self-directed learning without documentation to show for it. But with all those options outside the formal accredited learning channels it is difficult for today's lifelong/life-wide learners to signal their qualifications to employers as they moves from one job to the next. Some training providers are now doing Recognition of Prior Learning (RPL) to give academic credit to prospective students for what they already know and can do based on work experience,<sup>73</sup> self-directed learning<sup>74</sup> and military service records.<sup>75</sup>

Workforce agencies in the United States can refer claimants to appropriate training and monitor their persistence to program completion, but they are not in the business assessing students/training program completer or credentialing them. Workforce agencies can parse job-

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<sup>73</sup> This is the functional equivalent to what is know in the European Qualification Framework as work-derived experience validation. For details, go to [http://www.evta.net/evta\\_employment\\_html/new\\_skills\\_for\\_new\\_jobs.html](http://www.evta.net/evta_employment_html/new_skills_for_new_jobs.html).

<sup>74</sup> Expanding upon the notion of using the College-Level Examination Program (CLEP) tests (<http://www.collegeboard.com/student/testing/clep/about.html>) to obtain course credits.

<sup>75</sup> The semantic engine can be used to distill detailed military personnel records in unstructured natural language text into KSA profiles with the service record serving as verification. The process yields higher resolution data that does the occupationally-oriented crosswalk currently available for equating Military Occupational Specialties (MOS) into their civilian SOC occupations.

seekers' self-reported work experiences into skill profiles, but they are not in the business of developing skill-assessment instruments or certifying job-seekers' skills.

Legally defensible and psychometrically sound skill assessments and certifications have been developed in many domains which can be classified under the widely used International Standard Organization's (ISO) hierarchical International Classification of Standards (ICS).<sup>76</sup> In the United States, the Institute for Credentialing Excellence,<sup>77</sup> (formerly National Organization for Competency Assurance), and its affiliated National Commission for Certifying Agencies, tracks skill standards and skill assessment instruments. They attest to the validity and reliability of assessments and certifications which conform to the general process guidelines and pass muster under the meta-analysis criteria jointly announced by the American National Standards Institute and the Society for Human Resource Management (ANSI-SHRM).

The DOL provides a search engine in its CareerInfoNetwork<sup>78</sup> to look up certifications by occupation. Artificial intelligence using a DWA-based lexicon in the semantic engine can take this CareerInfoNetwork service a step further. A job analysis done on the basis of DWAs to be performed and direct input of employer SMEs on the skill requirements conforms to

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<sup>76</sup> For a glossary of acronyms, an explanation of the classifications system and meta analysis of standard setting processes and content, go to [www.standardsportal.com](http://www.standardsportal.com). Most of the standard setting is by private groups but the standards portal also provides a good explanation of how government agencies get involved directly in standards setting (e.g., National Institute for Standards and Technology (NIST) at the U.S. Department of Commerce <http://www.nist.gov/index.html>) or indirectly by ratifying the standards of non-governmental organizations (NGOs) through provisions in government procurement rules. An alphabet soup of NGOs - many with official sounding names – keep track of Standard Developing Organizations (SDOs) that abide by process guides, recognized Contributing Trade Associations (CTAs) capable of contributing subject matter expertise and promoting buy-in (adoption), and Conformity Assessment Bodies (CABs) that monitor compliance. In the United States, ANSI, using ISO meta-analysis and classifications keeps track of domestic SDOs, CTAs, and CABs. ANSI maintains a comprehensive library of standards. Use ANSI's engine located at [http://www.standardsportal.org/usa\\_en/resources/nssn.aspx](http://www.standardsportal.org/usa_en/resources/nssn.aspx) to search for standards by domain.

<sup>77</sup> [www.credentialingexcellence.org](http://www.credentialingexcellence.org).

<sup>78</sup> <http://acinet.org/>

guidelines used by ANSI-SHRM. Thus, they can be used for establishing the legally defensible nexus between KSAs to be assessed and actual job performance requirements.

In addition to mapping Texas employer validated DWAs to the K-12 TEKS and the post-secondary WECM, the TWC's Common Language Project used the AI semantic processing engine to translate available certifications into profiles of the skills they assess. That translation enables researchers to map available certifications in the ICE library by granular ISO/ICS classification and content (provided in unstructured natural language) to discrete DWAs. This more detailed mapping will help employers determine what certifications to specify in their job orders as a means of legally vetting seekers' self-reported skills. Detailed mapping will help case managers and career counselors advise job seekers about:

- 1) what assessments to take in order to certify what they already know and can do; or
- 2) what training to pursue in what sequence to acquire stackable certifications to:
  - a) improve their marketability of jobs in the near term, and
  - b) support their general employability and specific career aspirations in the long term.

By providing these services that enable employers to do legally defensible and sound skill-vetting and job-seekers to clearly signal skills in their endowments, a case manager can move both parties from making the job-person match to consummating the employment transaction.

### **The European Qualifications Framework: A skill-centric approach.**

In the United States, various efforts are underway to develop useful labor market information and decision support tools for operation, case management and individual decision-making, including TWC's Common Language Projects; state and consortia partnering with consolidator firms to experiment with AI processing of real-time supply and demand data; and

research leading towards identifying returns to skills. Currently, such projects are not coordinated and articulated with each other. But if one looks back to 1994, the seeds were sewn for establishing a coordination framework in the National Skills Standards Act (which set up National Skills Standards Boards<sup>79</sup> (NSSBs), and provided their initial funding, and, through federal funding, the National Center for Research in Vocational Education (NCRVE). But after Public Law 103-27, Title V §5931 to §5939 were repealed,<sup>80</sup> the NSSBs voluntarily coalesced into the National Skills Standards Boards Institute. In 1999, the NCRVE lost its funding from the Office of Vocational and Adult Information and closed its doors.<sup>81</sup>

Similar coordination efforts initiated a decade ago in the European Union continue to operate. Under the Copenhagen Declaration, vendors eligible to deliver training through public-funded operations in European Union (EU) nations have agreed to a European Qualification Framework (EQF)<sup>82</sup> — common standards and practices to promote transparency and accountability in vocational education and training. The standards are more comprehensive, precise and rigorous than are the criteria used in the United States for putting vendors on the ETP list. The EQF includes a shared, skills-based taxonomy for clear and less ambiguous signaling across domains (e.g., education, businesses, workforce agencies, labor union) and between member nations.

As part of the arrangement, National Recognition Centers (NCRs) have been established to review and authenticate compliance with respect to instructional content quality, assessment

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<sup>79</sup> Information about authorization of, and appropriations for, the National Skills Standards Boards is archived at <http://www2.ed.gov/legislation/GOALS2000/TheAct/sec501.html>.

<sup>80</sup> [http://www.law.cornell.edu/uscode/uscode20/usc\\_sup\\_01\\_20\\_10\\_68\\_20\\_V.html](http://www.law.cornell.edu/uscode/uscode20/usc_sup_01_20_10_68_20_V.html)

<sup>81</sup> <http://vocserve.berkeley.edu/>.

<sup>82</sup> Details on the EQF are available online at [http://www.evta.net/html\\_mobility/index.html?tools.htm](http://www.evta.net/html_mobility/index.html?tools.htm)

methods and certifications.<sup>83</sup> Education and training providers submit their rubrics<sup>84</sup> and course materials in a common template called the Diploma and Certificate Supplements (translated into all the member countries' languages) for each course to their respective NCR (European Commission, 2002; Gazier, Paucard & Bruggerman, 2010). A semantic engine using AI distills the supplemental material into expected student learning outcomes and translates them into skill statements.

Employers and labor organizations from all EU nations collaborate with educators through the Leonardo da Vinci Project<sup>85</sup> via online “thematic networks” to validate the connections between learning outcomes and skills required in the workplace. Correspondence of expected student learning outcomes to employer-defined job skill requirements is a core element in the EFQ definition of instructional content quality. Through the thematic networks, businesses, organized labor, professional associations, industrial organization and educators collaborate on curriculum development in their respective areas of interest, share best practices, provide meta-analysis and endeavor to forecast the impact that innovations in their respective fields will have on both job skill requirements and training responses.

The EQF is modality neutral and venue neutral. That is, the same metrics are to be applied to instructional program whether delivered in the classroom, the workplace or online (modality neutral). The same metrics are to be applied to instructional programs offered by public educational institutions, private schools, labor unions, and business and industry groups

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<sup>83</sup> Details on the review and uses made of Diploma and Certificate Supplements by the National Academic Recognition Centers is available online at <http://www.enic-naric.net/>

<sup>84</sup> A rubric documents the expected learning outcomes, how instruction will be delivered, and how student learning relative to each expected outcome will be assessed

<sup>85</sup> Details at [http://ec.europa.eu/education/lifelong-learning-programme/doc82\\_en.htm](http://ec.europa.eu/education/lifelong-learning-programme/doc82_en.htm).

(venue neutral). The EQF establishes an empirical basis for comparing the relative contributions, including cost-effectiveness, of instructional programs of any length from providers at all levels in any member nation to the development of human capital to meet employer-defined needs and portable credentials to signal clearly what learners know and can do.

While the EQF aims principally at quality control and cross-border articulation of education and workforce programs, the framework could be used equally well at the regional level in the United States by workforce investment boards to make the ETP system under WIA more rational. Distilling training outcomes into skill statements in precise syntax is a step toward assessing returns to skills. That kind of very detailed micro LMI data updated through AI analysis of education and training providers' documentation — when combined with real-time DWA-modeling of skill requirements for posted jobs and claimant skill profiles — would help case managers refer claimants to programs which more precisely address their skill deficiencies and evaluate the cost-effectiveness of competing options.

The EQF also recognizes that human capital may be developed along multiple pathways. No single training provider or workforce agency in the lifelong sequence can track or authenticate all the learning an individual acquires through varied sources. Therefore, a Credentialing European Credit System for Vocational Education and Training was established under the EQF. The credentialing system inventories all of the possible certifications across all EU member countries — those which award them, how they conduct assessment, and what demonstrable skill acquisition credential signifies. The individual is responsible for obtaining diplomas, certificates and certifications, documenting them and filing them. Under the EQF, the workforce system provides a mechanism for tracking and managing one's own human capital

through an e-portfolio.<sup>86</sup> In the EUROPASS system, the skills-based credentials are portable across national boundaries and can be translated electronically into the language of the prospective employer.

Managing one's human capital becomes the primary consideration in the face of structural changes in employment and the increasing likelihood of discontinuities at the person-level. Job tenure is shorter and job content changes more rapidly. Managers at the establishment-level can mix human capital and technology in different proportions to compete with rivals. Returns to skills vary over their shelf life. Managing one's human capital includes periodically restocking the shelf.

In the face of structural changes that signal the shortening of job tenure and more frequent person-level discontinuities, the objective of human capital management in EU is on employability rather than employment. The e-portfolio is the key instrument. Workforce intermediaries in the EU do more than serve workers during bouts of unemployment. Knowing that episodes of unemployment are likely as structural change ripples through the labor market, case managers or career coaches provide continuous services. Their role is more than helping eligible workers obtain benefits and immediate reemployment just when they are out of work. Workforce intermediaries in the EU can help individuals plan how to market themselves for their next job even while currently working. That involves documenting skills being acquired in the current job and obtaining credentials to signal what they have learned to the next potential employer. It involves anticipating obsolescence of some skills in their endowment and

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<sup>86</sup> For a description of the EUROPASS system, go to [http://ec.europa.eu/education/lifelong-learning-policy/doc46\\_en.htm](http://ec.europa.eu/education/lifelong-learning-policy/doc46_en.htm)

diminishing returns to others. It involves using time between suitable job opportunities to make one's self more suitable for anticipated opportunities.

### **Policy Implications and Recommendations**

Nothing in this paper should be construed to imply that the occupation-centric, survey-based labor market information system should be abandoned. Rather, skill-centric, real-time information better serves operational and individual efforts to adjust to discontinuities stemming from the way work is being dynamically reconfigured at the establishment-level; fluidity and heterogeneity in content at the job level; commensurate changes in specific job skill requirements; and trends in returns to skills. But expanding and accelerating the development of the skills-based micro data to augment the current LMI system may entail making high level policy decisions and rethinking funding priorities.

#### **Who Benefits?**

Skills-based modeling requires continuous research to update descriptors of the DWAs employers use at the job level to organize work and the KSAs/TTRs associated with them. Compared to the scale and structure of data from periodic sample surveys, it requires processing massive loads of real-time data, most of which currently is contained in unstructured natural language text. That is not an insignificant undertaking. Pilot projects have demonstrated the feasibility of skills-based modeling — given the sophistication of semantic analysis and AI, increased computational power, and storage capacity of today's technology at decreasing prices.

(Vollman, 2010b) argued that improvements in the LMI to serve operational purposes would result in savings through greater efficiency in claims processing and case management, reduced UI benefits collections, and student loan default aversion. That suggests that several

programs across multiple agencies likely would benefit ETA, Wagner-Peyser, and the Federal Direct Loan Program (and, perhaps as part of a new mission for the loan servicing entities which once operated under the old Guaranteed Student Loan Program).

The U.S. Census Bureau and the Bureau of Economic Statistics<sup>87</sup> at the U.S. Department of Commerce likely would embrace innovative LMI development. The Rural Development Division of the U.S. Department of Agriculture needs real-time skills-based data to address the “brain drain” caused by the exodus of young college-educated talent. At the U.S. Department of Education, the Office of Adult and Vocational Education and the National Center for Educational Statistics would likely benefit and could anticipate capturing savings. The U.S. Social Security Administration<sup>88</sup> and the U.S. Department of Education’s Rehabilitation Services Administration<sup>89</sup> would have a DWA-focused skills analysis tool that would possibly be a better alternative to reviving and updating the DOT.

Economic development agencies and chambers of commerce could use real-time skill profiling of the available talent pool that would serve their information needs related to business recruitment and site selection. Associations representing industries or businesses with hard-to-fill, long duration openings and non-governmental organizations engaged in, or contributing to, skill standard setting, assessment, and certification would have a common process for providing input into workforce development planning, instructional delivery, and legally defensible skills vetting.

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<sup>87</sup> <http://www.bea.gov/>

<sup>88</sup> <http://www.ssa.gov/>

<sup>89</sup> <http://www2.ed.gov/about/offices/list/osers/rsa/index.html>

Education and training providers would have earlier notification of, and more specific detail on, changing employer expectations. That would help them reduce information latency in delivering a responsive and relevant curriculum.

### **Paradigm Shift and Performance Measures**

Skills-driven operational decision-making likely would entail adoption of case management practices emphasizing human capital investment and “*employability*” rather than search strategies aimed at immediate re-employment. That would signal a paradigm shift (Vollman, 2010a). Vollman’s expectation is borne out in the European Union’s experience after operating for ten years under the EQF. The EU’s workforce services delivery model is a paradigm shift from thinking about employment and job tenure to focusing on employability. That is, the capacity to get and hold jobs in sequence as well as organizing job transition in a secure and dynamic way. The emphasis is on renewal rather than reemployment as a measured response in adapting to macro-level labor demand and supply maladjustments and person-level skill-centric discontinuities.

The European Center for the Development of Vocational Training explains employability as the combination of factors which enables individuals to “progress towards or get into employment, to stay in employment, and to progress during career.” Individual employability depends on the adequacy and currency of one’s KSAs and the strength of the signals used to communicate one’s qualifications in the labor market. While individuals make choices in developing their own employability, the governments of EU nations play a role in providing information about employer-defined skill requirements to guide informed choice; incentives to update their human capital; and opportunities to validate and signal their qualifications (European Center for the Development of Vocational Training, 2008).

If adopted in the United States, the paradigm would shift from the *WorkFirst* approach integral to the Workforce Investment Act (WIA) and the Personal Responsibility and Work Opportunities Reconciliation Act (PRWORA) back toward a human capital investment approach previously used under the Job Training Partnership Act (JTPA). But current performance measures emphasize the former, not the latter.<sup>90</sup> If the paradigm shifts to one of employability rather than *WorkFirst*, then criteria likely would have to be developed for granting waivers to current performance measures and standards (or supplemental measures may have to be developed) to incentivize state workforce agencies, local workforce investment boards, One-Stop Career Center operators, case managers, and employment and business services' contractors to focus more on investing in human capital development.

#### **Concluding Remarks: Returns to Skills — The Common Denominator**

In responding to rapidly changing exogenous forces, employers are becoming more nimble in adjusting how human capital and technology are mixed at the establishment to remain competitive. The changes can be tracked most accurately at the DWA level as job contents are mashed up and reconfigured (even if titles and labels are unchanged). KSAs and TTRs required for performing DWAs in a particular mix may have value to employer and seeker in different measure over time. Their decisions to complete employment transactions boil down to their respective estimates of returns to skills. Returns on skills to employers come in the form of the

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<sup>90</sup> For example, while the federal training and employment guidance letters and state implementation guidelines express the goal of 80% replacement wage, the ETA's Common Measures Policy counts the entered employment of WIA-funded program participants (regardless of the wage). Earning increases are measured in terms of gains made between the first quarter after exit and both the second and third quarters after exit—even if neither the base earnings in the first post-exit quarter nor gains made in two subsequent quarters bring the program participant at least up to his 80% replacement wage target. Employment retention is subject to the Core Measures Policy but only from the first through third post-exit quarters. And the program efficiency measure provides a contrary incentive for providing the lowest cost services even if they result in recycling participants through the system periodically rather than promoting full employment and the most effective use of human capital.

value of each worker's marginal product. Returns on skills to the worker come in the form of wages.

While survey-based occupation-centric labor market information is useful to examining how aggregate supply and demand move from maladjustment toward equilibrium over time and operations deal with serving the immediate needs of the customer – of the employer to find and hire a good fit for each job and of the seeker to obtain suitable employment.

- 1) If lacking marketable skills relative to local demand, seekers have to decide what investments to make in their human capital development. The rational choice comes down to estimates of returns to the current endowment versus the marginal utility of acquiring additional skills.
- 2) Returns to skills, relative to the cost of acquiring them from rival eligible training providers, factors into case management and the efficient use of scarce training dollars.
- 3) Vetting and certification of job-seeker skills assures risk-adverse employers of their market value.
- 4) Decision support, alignment of the curriculum with employer-identified skill requirements, coordination and quality control in skill development, assessment and signaling of the sort being attempted under the EQF illustrate how what can be done with skill-centric, real-time labor market information.

The EQF lesson in coordination identifies stakeholders at the operational level who share a common need for more attention to skills in a labor market information system. The NSSBs did much the same in the United States in the mid-1980s as did the CTEHP in 1999. While the DOL gathers much of the data in the public LMI system and serves as its custodian, the others are both contributors and customers.

To date, the first ventures into the skills arena have been piecemeal. The Texas Common Language Project worked through industry and professional associations to engage employers in SME validation of a DWA library to be used as the lexicon for subsequent AI information discovery (as opposed to collection). As previously noted, Vollman, Dorrer, and Alstadt have identified partnerships between congregators, AI developers, and several state LMI divisions to glean actionable information out of job postings in real-time. Morman (2010) also provided the roundtable with information on virtual career management in the healthcare sector. In a presentation at the National Reemployment Summit in December 2010, Vollman (2010b) described partnerships developing real-time data for decision support in rapid reemployment and retraining; career management at point of origin of student loans; curriculum development at community colleges; and coordination of workforce preparation and economic development. Other potential applications and their articulation with or integration into the national LMI system are worth exploring.

Data development on the education and training side of the ledger is equally important when building decision support for triage case management. Some seekers need training to fill gaps in their skill endowments in order to become employable. Case management for them becomes person-to-training matching rather than person-to-job matching. It is just as critical to understand the skill-based learning objects of available options when doing person-to-training matching as it is to understand the skill requirements demanded by the employer when doing job-person matching. The data have to be specific enough to get past within level of award and within major field of study in order to guide informed choice. The TWC Common Language Project – Phase Two, in mapping DWAs to the learning objects of core course requirements in Texas public education and postsecondary workforce preparation provides one model for moving

to the appropriate level of specificity. Additional lessons can be learned from the IEEE efforts to establish a Learning Object Metadata (IEEE1484.12 -2002), the EQF's use of AI to distill rubrics for training programs into skills-based expected learning outcomes, and international efforts to develop the S1000D as a Dewey Decimal System for human knowledge.

Up to now, skills-based modeling and the use of real-time data in various combinations have been piloted as proof of concept. "Best practices" cannot be identified until some basis for meta-analysis is reached. One can likely calculate the cost of expanding and accelerating the development of skills-based elements in the LMI system and building decision-support tools around them, but we only have estimates of the savings that could be captured. For now, more pilot projects are needed to demonstrate the utility, cost-effectiveness of using skills-modeling of real-time labor market information on a larger scale to justify making changes in funding priorities and wrestling with the thorny issues of performance measurement and standards.

For now, the implications and issues likely will be debated by practitioners in forums on initiatives for workforce data quality improvement. David Stevens (2010) provided a cross-program/cross-agency information flow diagram at the Brookings Institute Roundtable on *Putting America to Work* which identified the patchwork of entities in the United States that engage in the development and deployment of human capital whose efforts might be better coordinated through shared research on returns to skills. That provides a good roadmap for inviting key stakeholders and likely beneficiaries into the discussion.

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Full Employment and Balanced Growth Act of 1978 (15 USC §3101 et. seq.) before passage was debated as the Humphrey-Hawkins Bill.

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Trade Act of 2002. Details available at [http://www.doleta.gov/tradeact/2002act\\_index.cfm](http://www.doleta.gov/tradeact/2002act_index.cfm)

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**Appendix A**  
**Committee on Techniques for Enhancing Human Performance**

Name	Affiliation	Expertise
Thomas Kohan, Chair	MIT, Sloan School of Business	management, organizational behavior
Stephen Barley, Co-chair	Stanford School of Engineering	organizing/managing technology work
Rosemary Batt	Cornell University	work design and technology use
Nicole Biggart	University of California – Davis	social organization of knowledge
Peter Cappelli	University of Pennsylvania Wharton School of Business	changes in work & effects on skill requirements
Mark Eitelberg	US Navy Postgraduate School	military manpower analysis
Ann Howard	Developmental Dimensions, Intl.	testing and assessment
Arne Kalleberg	University of North Carolina – Sociology Department	flexible staffing, higher performance work organizations
Ann Mavor	National Research Council	human factor analysis in military and disability work performance
James McGee	National Research Council	human factor analysis in military and disability work performance
David Neumark	Michigan State University – Economics	job stability
Paul Osterman	MIT, Sloan School of Business	Internal labor markets/broken ladders
Norman Peterson	American Institute for Research	measuring individual differences in predicting human performance
Lyman Porter	University of California – Irvine, School of Management	organizational psychology
Kenneth Spencer	Duke University – Sociology	work & personality, career dynamics
LTG Theo. Stroup, Jr.	Institute of Land Warfare; US Army	strategic manpower planning
Rovert J. Vance	Pennsylvania State University, Institute for Policy Research & Evaluation	personnel selection, job performance measurement

Source: CTEHP (1999) pages 341-349

## Appendix B

### An Automated DWA-Based Tool for Job Analysis

The automated job analysis tool developed for the Navy requires SMEs to express DWAs using a single action verb. O\*NET descriptors, on the other hand, sometimes couples two or more verbs together in a single DWA statement despite heterogeneity in the way the same work is performed across different contexts by different persons or by the same person over time as the job content evolves. The syntax used by the Navy provides an option for adding a verb modifier. However, verb modifiers that communicate gratuitous information or universal assumptions are eliminated.

Secondly, an object must be provided for each action verb. A context modifier can be added where it provides clarity or suggests nontrivial, concrete observables. A thesaurus of synonyms was built using AI to screen for, and eliminate, redundant statements. Greater precision in this syntax reduces the heterogeneity in job descriptors of DWAs level. It facilitates greater fidelity in mapping KSAs and TTRs to each DWA building block.

“Loose” DWA expressions	DWA(s) in a more precise syntax
<u>Two action verbs</u> : Direct and monitor the activities of retail salespersons.	1. Direct the activities of retail salespersons. 2. Monitor the activities of retail salespersons.
<u>Gratuitous modifier</u> : Measure thickness of industrial coating material <i>accurately</i> .	<u>Non-gratuitous modifier</u> : Measure thickness of industrial coating material <i>to nano-scale</i> .
<u>Redundant DWAs</u> : 1. Compute return on investment. 2. Calculate return on investment.	Calculate return on investment. (Calculate was selected over compute as the more generic term which allow alternatively for use of computer, handheld calculator or paper-and-pencil as tools for performing the DWA.)

## **Appendix C**

### **Automated Data Collection in the TWC Common Language Project – Phase One**

Web-based tools were developed to automate and streamline the data collection process. An individualized electronic workbook was tailored to each incumbent worker/SME's lay job title. Each workbook was pre-populated by deducing DWA statements from the legacy O\*NET library based on the closest fitting SOC title. But before pre-populating the workbooks, legacy O\*NET DWA statements were translated into the precise syntax developed for the Navy's use and for feeding learning objects into military and civilian ADL systems.

SMEs were given a unique account number and password to access their individually tailored electronic workbook. A workbook could be accessed at the SME's leisure, twenty four hours per day seven days per week. Simple online instructions and pop-up help screens were provided.

SMEs were asked to review the DWA descriptors imputed to their job titles as they appeared in their individualized, pre-populated workbooks. They were instructed to mark for deletion those which do not apply to their role or context and modify those which did not quite fit what they do. SMEs also could add DWA statements to reflect things they do on the job but which were not expressed in any of the pre-populated items. For both modifications and additions, the response structure called for SMEs to provide an action verb, an object and optional modifier as consistent with the precise syntax used in by the Navy. SME modifications and additions were filtered through a semantic processing engine (an AI application) for redundancy or gratuitous elements.

On average it took a front-line incumbent worker twenty minutes to access an individually tailored workbook, read the instructions and complete a DWA review. It took additional time for first-line supervisors to complete their reviews if they had multiple job titles under their direct supervision. For each set of closely related lay job titles, DWAs were reviewed by multiple SMEs from different firms cross different workforce regions in Texas. A majority of SMEs had to mark a DWA from the pre-population set for deletion before it was actually decoupled in the master library from their particular job title. An iterative process was used to submit modifications and additions "*nominated*" by one SME to the balance of SME peers for their concurrence or rejection by majority rule.

Once a set of refined DWAs was established for a job title, additional information was gathered from first-line supervisors, operations managers, human resource specialists, and cognitive scientists on the TTRs used in performing each DWA, the required KSAs, preferred modality of training and average estimated training time to achieve entry level, intermediate and advanced proficiency. Additionally, front-line supervisors and human resource personnel were asked to identify which workplace basics/soft skills (e.g., critical thinking and problem solving) were most important to performing of each DWA.

Automating the DWA review process through software-as-service on the "cloud" eliminated travel time to meetings for SMEs and workplace intrusions by trained job observers.

It significantly reduced the time and resource commitments of employers — thereby increasing the likelihood of their willingness to participate in the work breakdown process. Pre-populating workbooks with a non-redundant, non-gratuitous set of imputed DWAs in a precise syntax made the job analysis more coherent than a focus group approach. The latter typically uses open-ended/start-from-scratch group exercises and its free-form outputs typically require labor-intensive collation and qualitative analysis. “Group think” biases which occasionally infect face-to-face focus group studies were avoided through assurances of anonymity of SME’s online job descriptor validations.

Convergent validity could be obtained through onsite observations of workers doing their jobs. The precise syntax could be used as a standardized protocol for job analysts to record their on-site observations. Training job analysts to use the precise syntax (and built-in formatting error traps in the automated data collection tool) would provide greater inter-coder reliability. A semantic engine built around the revised DWA library as its lexicon could eliminate much of the tedious coding and completion by parsing the unstructured natural language field notes of job observers into the precise syntax.

## **Appendix D**

### **Proof of Concept Scenario**

Capital Area Workforce Solutions (CAWS) funded a project to avert mass layoffs at a hospital in its service area (Travis County, Texas) which served as a proof of concept for a DWA-based approach to job-person matching. The hospital's reorganization plan included deactivating some departments and creating new ones. Auxiliary personnel (i.e., those not engaged in patient care) in the departments to be deactivated faced termination. The hospital notified CAWS of the pending mass layoff as required under the Dislocated Worker provisions of WIA. The hospital hoped to avert a mass layoff by reassigning personnel from departments that were closing either to new positions in departments they planned to open or to vacancies created by natural attrition in departments unaffected by the reorganization. The reorganization timeframe gave the hospital approximately six months to avert a mass layoff.

The hospital's human resources unit (HR) resolved to use its own labor-intensive desktop reviews of extensive personnel records and its conventional applicant screening process to plan in-house reassignments. Aversion project researchers worked in parallel with HR to match candidates from the closing departments to new jobs and vacancies opening through attrition. HR provided job orders to the researchers with fixed fields and descriptions of job functions in unstructured natural language text; i.e., in the format they would have posted with the public labor exchange through the local One-Stop Career Center. HR also provided researchers with the resumes and information in the fixed fields of their general employment application form for each of workers affected by the reorganization.

Researchers downloaded a lexicon from the Texas employer-validated DWA library (from Phase One of the TWC's Common Language Project) into a semantic engine for applying AI to create job skill requirement profiles from HR-supplied postings. Downloads, edit checks and processing took less than twenty-four hours. Within another twenty-four hours, the semantic engine using the same DWA-based lexicon for applying AI produced skill profiles of the seekers from their *pro forma* application information and resumes. Using their direct access to their department heads and operations managers, HR validated the AI-generated job skill requirements. Using direct access to the in-house applicants and their immediate supervisors, HR validated the AI-generated seeker skill profiles. After careful desktop review, HR made no requests for changes in either set of AI-generated profiles.

Once job skill requirements and seeker skill profiles were validated and returned to the research team, two sets of AI-generated goodness-of-fit matches were produced in near real-time. Department heads and HR received a stack ranking of available in-house candidates for each new position. Reorganization-affected workers were given a stack ranking of job openings for which they were best qualified. As vacancies in other departments occurred and as reorganization plans changed in midstream (i.e., reconfiguring job requirements in soon-to-be-created departments), the aversion project team reran new sets of job matches with less than 24 hours' turnaround.

The ordinal rankings of in-house candidates for all jobs generated by AI in near real-time corresponded nearly perfectly to the ordinal rankings produced by HR after it had spent three months on its own in labor-intensive reviews of more detailed off-line resources that had not been made available to the aversion project team for semantic analysis. With the exception of a few who chose to retire or find work at some other establishment, in-house candidates agreed with the rank orderings of their reassignment prospects and actively applied for the best-fitting openings on their respective lists.

The nearly instantaneous turnaround provided sound, just-in-time decision support for hiring choices and preparing reassigned personnel for their new jobs. Where necessary, HR was able to anticipate the learning curve (based on very specific gaps identified in the goodness-of-fit) and provide pinpoint skill-upgrade training. Lead times and instructional delivery schedules could be set according to SME-identified preferred training for each skill gap to be addressed. Because training was tightly targeted, costs were reduced. And productivity losses were minimized as reassigned personnel were brought up to speed in a timely fashion to meet performance expectations as they “hit the ground running” in their new jobs.

## **Appendix E**

### **TWC Common Language Project – Phase Two: Mapping DWAs to Expected Learning Outcomes**

Efforts are underway in Texas to refine the data necessary for assessing returns to skills being delivered by the education and training partners in workforce development. The Texas Education Agency (TEA), Texas Higher Education Coordinating Board (THECB) and the TWC jointly funded phase two of the Common Language Project. In phase two, researchers used AI to translate public secondary and postsecondary education rubrics into skills-based expected student learning outcomes. The lexicon used in the semantic processing engine was built using the library of DWA statements that had been validated by employers in phase One of the Common Language Project.

The state's education agencies have established guidelines governing the core expected student learning outcomes for courses that award academic credits. The TEA issued Texas Essential Knowledge and Skills (TEKS) as the core expectations for instruction delivered through K-12 courses that lead to a high school diploma. The THECB issued the Workforce Education Course Manual (WECM) as the core expectations for instruction delivered through public postsecondary technical and workforce preparation courses whose credits apply to one year certificates, two year associates' degrees, and for-credit continuing education.

While the WECMS were in a standardized format, the TEKS were issued in unstructured natural language text (as MS Word documents). Common Language Project staff used the semantic engine to translate the expected student learning outcomes from the TEKS into a precise syntax. For both the WECMS and TEKS, redundant elements were merged into a single element. Elements that did not lend themselves to direct observation and empirical measurement were ignored. The processing resulted in a library of expected student learning outcomes in a precise syntax cross-referenced by course title for WECMS at the six-digit CIP level; for the TEKS by the PEIMS codes equivalent to the six-digit CIP at by grade level. Translation of core expected student learning outcomes at the course-level provides higher fidelity skills-based information about an individual's education and training achievements than do imputations deduced *a priori* from degrees awarded by major field of study at the four digit CIP level or by career cluster designation in the PEIMS taxonomy.

Next, researchers mapped the SME-identified job skill requirements for all Texas employer-validated statements in the DWA library to the unduplicated and measurable expected student learning outcomes catalogued in the TEKS and WECM. The mapping identified multiple learning pathways to acquire many of the skills required to perform the DWAs comprising the work Texans do. Multiple pathways to acquiring skills related to a DWA may exist because an expected student learning outcome can appear in the TEKS or WECM for more than one course.

Next researchers built campus-specific DWA-to-expected learning outcomes of courses offered locally by independent school districts (ISDs) and community colleges that volunteered to participate in the mapping project. Mapping had to be done at the campus level for several reasons.

- 1) ISDs are not required to offer all of the courses covered by the TEKS and public two year postsecondary institutions are not required to offer all of the courses covered in the WECM.
- 2) While courses offered for state-recognized credit must cover the core requirements, ISDs and public two year postsecondary institutions in Texas are at liberty to add other expected learning outcomes to the courses they do offer locally.
  - a. Some of the expected student learning outcomes added to courses by the local institution are “borrowed” respectively from the TEKS or WECMS for different courses.
  - b. Unique expected learning outcomes (i.e., not found in the TEKS or WECM) can be added to core course requirements by local educational institutions.

The campus-level mapping produced local, skills-based training inventories. Campus level maps were shared with the operations managers of One-Stop Career Centers in the areas where ISD and community or technical colleges had volunteered to participate in the Common Language Project. Arming One-Stop Career Center case managers with skills-based inventories of locally available programs provided them with more detailed information about service offered by vendors on their respective ETP lists. The skills-based information provided more detailed information on what each eligible provider actually had to offer. That would facilitate training referrals down to the course level (if permitted) for greater efficiency in addressing an individual’s marketable skills deficits relative to their employment aspirations.