Priming Oregon's Talent Pipeline: May 2008

Oregon Future Workforce Needs Analysis

Oregon Workforce Investment Board

This analysis was produced under the auspices of the Oregon Workforce Investment Board (OWIB). The OWIB would like to thank its Business and Economic Development Committee (BEDC) for developing and leading the project. The BEDC is a business-led committee, with members from business along with state and local public and private partners.

Contractor Team:

Key Links

Audrey Theis
President

Battelle
The Business of Innovation

Mitch Horowitz
Director of Strategy, TPP

Carl Califaro
Chair
Oregon Workforce
Investment Board

Peggy Miller
Past Chair
OWIB BEDC

Claire Berger,
Workforce Policy Advisor,
Office of Governor Ted Kulongoski,
Staff to the BEDC

Greg White,
Executive Staff
Oregon Workforce
Investment Board

We would also like to thank the Oregon Employment Department, Communications Section for the design and layout of this report.

This report was funded with US Department of Labor Workforce Investment Act funs through Oregon's Employer Workforce Training Fund, administered by the Oregon Department of Community Colleges and Workforce Development. An equal opportunity employer/program. Auxiliary aids and services are available upon request to individuals with disabilities.

Thank you...

WORKSOURCE OREGON

Table of Contents

Executive Summary

Increasingly, the ability of a state to excel in technology development and deployment in targeted industry sectors and simultaneously cultivate a resident talent pipeline of agile, skilled workers is emerging as THE critical and defining determinant of economic competitiveness.

Oregon is well positioned to be a winner in this global race. Its overall economy is increasingly diversified and impressively strong—well outpacing the nation on most fronts. Moreover, over the past six years, Oregon has been aggressively building a solid infrastructure to support talent, technology and innovation with the launch of significant new initiatives linking economic development, education and workforce investment.

The question: how long can Oregon maintain its current competitive position and stay "ahead of the curve" given the confluence of: the rapid advancement of technology, the increasing need to be recognized as world-class and the impending retirement of tens of thousands of skilled knowledge-workers? The answer: Not long. There is urgent need for immediate action across several fronts!

This report, *Priming the Talent Pipeline: Oregon's Future Workforce Needs Analysis*, was commissioned by the Business and Economic Development Committee of the Oregon Workforce Investment Board and is intended as a **strategic investment plan** to drive and focus that action. While this is fundamentally a research report, it is also a message of **opportunity** and **choice**. Lack of immediate attention to addressing critical gaps identified in this report could seriously compromise Oregon's strong economic position in the near future. Businesses interviewed in support of this study were very clear. If they can't find the workers over the next several years with the skills they need to maintain a competitive edge, they will have to downsize, close or leave the state. It is that simple.

This study answers five key questions, as highlighted. Because this research project focuses on future drivers of the economy, the focus of inquiry is on the traded sectors, those industry groups that trade their products and services outside the state and therefore serve as critical wealth generators for the state's revenue base. But the study builds on and broadens that perspective to an understanding of the technology competencies, or "critical mass of know-how" found within and across Oregon's industry base.

Bringing these two perspectives together allows for the critical linkage of workforce needs to the technology and market platforms that will likely define Oregon's competitive advantage in the future. It is from existing industry technology competencies that gaining a position in emerging technologies can best be realized. See Appendix 1 for detailed methodology.

Future Drivers? The recent period from 2001–2006 has been one of extraordinary economic performance for all Oregon traded sectors, outpacing national trends in employment growth across the board. Analysis of Oregon's current strengths resulted in a robust set of technology innovation

Key Research Questions

- What might be the economic drivers of Oregon's future economy?
- What workers with which skills will be needed?
- What capacity does Oregon have now?
- Where are the major gaps in the workforce system relative to technology and market opportunity areas?
- What should we do?

drivers across the traded sectors covering electronic components and devices, software development, and Internet-based services, along with niches in medical devices, shoe design and agriculture.

Results for technology deployment in more traditional industries such as wood products, food processing and metals manufacturing were mixed, with productivity levels at or below U.S. average levels, suggesting the value-added and complexity of products produced in Oregon is not a strength, but the *growth* of productivity has been positive and outpaces the nation.

The integration of traded sector analysis with the analysis of industry technology competencies resulted in the identification of **seven Oregon-specific technology and market platforms**, which emphasize critical interrelationships of technology and markets/suppliers across the traded sectors. These platforms represent areas of economic opportunity—**likely economic drivers of the future economy**—where Oregon industry has a presence in existing and emerging markets, as well as the competencies to innovate and to deploy technologies needed to be competitive in the global market. See Appendix 2 for platform profiles.

Oregon's Technology and Market Platforms

- Electronics Components & Devices
- Software, Computing & Internet Services
- Agriculture & Food Processing
- Forestry & Wood Products
- Metals & Transportation Equipment
- Biomedical Technologies
- Clean Technologies

Which Workers? Which Skills?

Globalization of work and advances in technology are reshaping the workplace at breakneck speed, setting an ever escalating bar for skill requirements. Numerous national studies reach similar conclusions: the workforce of the future must be: able to learn quickly, creative and innovative, comfortable with ideas and abstractions, self-disciplined and well organized, able to work as a member of a diversified team and have critical thinking skills, as well as fundamental personal management skills.

A review of national market studies, complemented by interviews with key leaders of major Oregon trade associations and cluster organizations, identified key factors driving industry development and the workforce implications of those changes for each platform area. Common workforce implications emerged across all platforms: (1) rapid process and product innovations are driving a strong need for continued skill enhancements among current workers; (2) the more complex, technical environment is demanding a more versatile and multi-skilled technician and production workforce; (3) an aging workforce is impacting skill shortages at all occupational levels; (4) offshore outsourcing is raising skill requirements for innovation, new product design and project management; and; (5) newly emerging industries of biomedical and clean technologies require a broad and diverse set of skilled occupations.

Oregon-specific workforce challenges were also identified for each platform, and recurring themes identified as follows: (1) many graduates from Oregon's public K-12 system do not have the skills employers need; (2) the manufacturing-related platforms (including clean tech) share remarkably similar skill requirements: high performance/lean, control systems, industrial electricity, safety, documentation, etc.; (3) there is continued reliance on out-of-state recruitments for high end electronics and software workforce; and (4) the urgency of finding replacement workers for retiring skilled/knowledge workers at all levels is real and compelling—identified in numerous surveys as already impacting bottom line outputs.

Current Capacity? Four broad "mega-occupational groups" emerged that cut across all seven technology and market platforms: production, technician, engineering, and computer-related. In terms of specialized occupations, those more concentrated in Oregon than in the nation, the majority currently require only relatively lower-end skills and limited education, i.e., high school plus on-the-job training. That is, Oregon tends to have relatively higher concentrations of generally lower-skills workers than the rest of the country.

At the same time, Oregon's student pipeline of enrollments in critical programs at higher-education institutions and registered apprenticeships is generally down. While there are a few bright spots in engineering (+15 percent) and production (+38 percent), enrollment levels in both computer (-23 percent) and engineering-technician (-54 percent) are down substantially. Apprenticeships in the industrial trades are far below need.

Oregon has managed to maintain its strong economic position with this current skill profile. However, the emergence of biomedical and clean technologies, aggressive efforts to spur innovation, advocacy for the adoption of high-performance practices, implementation of lean manufacturing strategies, commitment to reduce the carbon footprint, and other factors are sure to drive up skill requirements in Oregon's traded sector workforce across the board. Given Oregon's current relatively weak position in terms of specialized occupations that feed the technology and market platforms, this will require an aggressive, multi-faceted strategy designed to strengthen this critical specialized workforce across all skill levels.

Gaps? The table below summarizes the major gaps identified relative to the talent development needs of employers in technology/market platforms.

While Oregon has developed an impressive infrastructure for building and delivering the next generation of workforce development, the hard truth is that over the past decade Oregon has not invested in the education and training of its human capital resources as aggressively as have many other states and industrialized nations, which puts Oregon in a "catch up" posture.

Major Identified Gaps/Needs	Overview
Lack of 21st Century Foundation Skills among new and current workers	Foundation skills include applied academic and technology; workplace skills including: creativity/innovation, ability to learn, critical thinking, teamwork, and continuous improvement.
Significant need to increase supply of production workers (3,500 per year for ten years)	The gap between supply and demand for skilled production-level workforce is significant, and will increase over time, with clean tech employers "stealing" skilled workers from other sectors.
Increasing need to increase technician level certificate, AA and apprenticeship program enrollments	As more companies adopt continuous improvement practices, skill requirements will increase and more structured training will be required. Current output in community college and industrial apprenticeship programs lags well behind demand.
Need to address skills mismatch in computer-related program areas	Given the fast pace of changes in computer technologies, applications and software, a persistent concern is whether graduates in computer related fields have the right skills to meet the needs of industry.
Need to strengthen employer linkages in engineering programs	Engineering is a key skill set for both process and product innovation. Oregon's traditional manufacturing industries all face significant challenges in advancing process and product innovation, yet the connection between these industries and the growing base of engineering talent needs to be strengthened.
Eliminate stovepipe approach to talent development; use "systems" approach	While coordination has increased in recent years, the public K-12, post-secondary education and federal workforce systems still function relatively independently
Move beyond pilot mentality/ Increase funding levels	The decade long history of underinvestment in human capital development has left many systems compromised; effective pilot programs rarely get to scale.
Broader funding sources	Policy leaders and decision makers must think outside the box and be willing to explore new, flexible sources of funding for talent development opportunities.
Improve messaging	Lack of information and misinformation abound regarding high wage career opportunities, value of career technical education, importance/ urgency of ongoing life-long education and training viewed by business as an investment, as opposed to a cost.

What Should We Do? Each of the seven Technology and Market Platforms emerged with a slightly unique profile in term of their industry technology competencies and industry market specializations. At the same time, however, all seven technology and market platforms, even those in emerging industries, share many of the same needs for talent across four mega-occupational groupings: production, technician, engineering and computer-related.

What this means is that Oregon does not have to pick "winners" from among the potential future drivers of the economy. **Investing in the common, shared workforce needs that cut across all technology and market platforms provides an integrated investment framework that can bolster all traded sectors while simultaneously maximizing opportunity for individual sectors to cultivate areas of expertise where they can differentiate themselves in the global market.**

Listed below are the twelve priority recommendations to address critical occupation and skill shortages, as well as identified systems gaps.

Priority Recommendations: *Critical Occupation and Skill Shortages*

- Set specific, quantifiable targets for high-demand occupations that cut across Technology and Market Platforms and provide incentive funding to community colleges, registered apprenticeship programs and universities to offer additional programs and increase recruitment efforts;
- Address the need to recruit more qualified instructors to teach technical courses in high-demand occupational areas at all levels; one strategy might be to create the nation's first "Retired Skilled Workers Corps" in partnership with business to serve as "Emeritus" instructors;
- Adopt a career readiness credential for use by all education and training providers that would signal a "readiness for work" based on specific, standardized criteria and align with documented 21st century workplace foundation skills; the career readiness certificate should be aligned with the Essential Skills of the high school graduation diploma for application with out-of-school youth, adult entrants to the labor market, etc.
- Aggressively expand and promote Career Pathways education and training opportunities as a systems-building strategy across all levels education; prioritize funding to high-demand, technology-reliant occupations across Technology and Market Platforms;
- Expand Career Technical Education at the secondary and community college levels and focus on the cross-cutting occupations linked to Technology/ Market Platforms and projected high demand/ specialty occupations;
- Double the Employer Workforce Training Fund using flexible dollars to serve as an incentive for more employers in traded sectors to upgrade the skills of their current workers to address advancing technology and changing business practices;
- Expand and prioritize training programs in clean technologies that have a documented, immediate need, such as wind turbine and solar that will support the state's sustainability agenda;
- Adopt a standardized certificate-level program offered by the community colleges and targeted towards "middle skill" production and technician occupations that emphasizes critical foundation academic, employability and cross-cutting technical skills;
- Support expansion of proven effective models of work-based learning - internships and coop; require greater linkages to on-the-job experiences at all levels of the educational system;

Priority Recommendations: *Systems Approach*

- Adopt and promote the concept/terminology of a Talent Pipeline or Knowledge Supply Chain (systems approach) to integrate the discrete parts of the supply side in support of the seven critical Technology and Market Platforms;
- Provide sustainable support to regional cluster- and consortia-based entities that aggregate employer need and function as intermediaries in creating demand-driven, agile "pull" oriented talent development systems in critical areas of skill shortage;
- Launch a multi-faceted messaging campaign to advertise the availability of good "middle-skill" jobs; promote the value of career technical education and post-secondary alternatives such as apprenticeships; and stress the importance of continued life-long education.

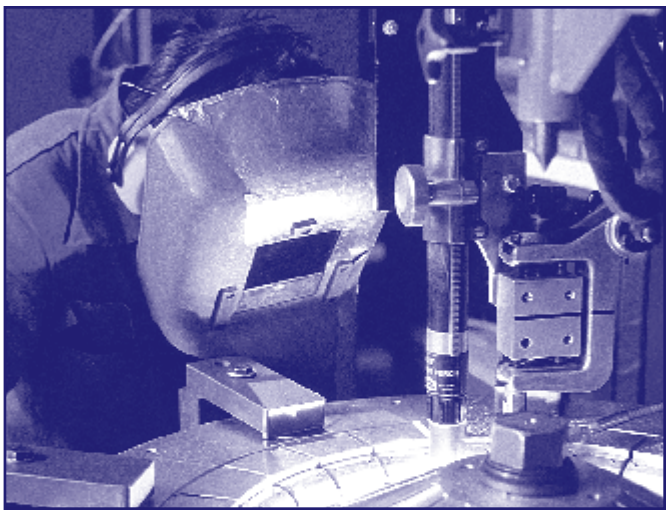
Conclusion

This study points to three possible scenarios that could play out in Oregon over the next decade, which, in reality, constitute choices to be made by both the private and public sectors.

- Scenario #1: Loss of traded sector business base. Both the demand side (business) and supply side (government/education) maintain a fairly passive posture in the adoption of innovation, with generally incremental change and typically underfunded approaches to human capital investment.
- Scenario #2: Global competitive businesses needing to shift jobs outside of Oregon. Traded sector businesses aggressively implement strategies to increase innovation and improve productivity, while education/training providers and the state government continue with current trends and fail to respond to the rapidly changing requirements of the high performance workplace.
- Scenario #3: Increased shared prosperity. Both the demand side and the supply side, in partnership, aggressively address the workforce challenges the state faces, adopting a bold and unified systems perspective.

The purpose of this research study was to provide a focused, future oriented investment strategy for Oregon that will ultimately drive shared prosperity. As the recommended investments are realized, Oregon's workforce education and training system will be strengthened and better positioned to produce the workers critical to the future economic drivers of the state's economy. Those workers will be equipped to fuel the innovation and productivity gains that result in competitive advantage in the global market. The resulting prosperity for Oregon's economy, companies and workers allows continued reinvestment in building the talent pipeline.

While implementation of the strategic investment plan will result in shared prosperity, it will also require shared responsibility. Key partners—business, labor, education, government and elected officials—must all aggressively embrace the call to urgent action. The three-five year window outlined in the recommendations is likely an outside window of opportunity and choice.



Priming Oregon's Talent Pipeline:

Oregon Future Workforce Needs Analysis

States shouldn't be lemmings, following the crowd of an uncertain future. They must strategically choose areas most likely to pay off in new or expanding businesses, a well-educated and agile workforce and high-paying jobs. It's not enough to find opportunities for marginal gains. The goal is to overwhelm the competition by being the pioneer, the champion or the only player.

Innovation America,
Pew Center of the States

The Opportunity

In today's fast-paced, knowledge-based economy, a state must differentiate itself by cultivating and sustaining specialized areas of expertise where it can be recognized as a world leader. The idea of driving economic growth through strategic areas of focus is not new, but what is different today, given the staggering rate of change and the critical link between economic and workforce development, is:

- The emphasis placed on technology-based innovation, and
- The absolute requirement to have a resident talent pipeline of agile, skilled workers.

Increasingly, the ability of a state to excel in technology development and deployment in targeted industry sectors and simultaneously cultivate a workforce able to drive that innovation is emerging as THE critical and defining determinant of economic competitiveness.

Oregon is well positioned to take advantage of this tremendous opportunity to win in the global market. As discussed in this report, twelve of the fourteen recognized traded industry sectors in Oregon outperformed the nation in growth of employment in the economic expansion years of 2002–2006. Several industries grew in Oregon while declining nationally. Oregon's overall economy is strong.

Additionally, over the past six years under the leadership of Governor Ted Kulongoski, Oregon has been aggressively building an infrastructure to support talent, technology and innovation. Major milestones include, but are not limited to:

- Adoption of a traded-sectors focus and cluster-based framework for economic and workforce development policies and practices;
- Creation of Oregon Inc. to cultivate new economic ecosystems that leverage Oregon's inherent strengths and help expand technology-based markets for Oregon companies;
- Development of a strategic workforce plan by the Oregon Workforce Investment Board (OWIB) to create a talent pool with the skill needed to fuel the current and future economy;
- Establishment of the Employer Workforce Training Fund focused on capacity-building through strategic investments in high-growth industry sectors and workforce training; and
- Increased funding to stabilize and enhance the public education system pre-K-16.

The Challenge

While these accomplishments bode well for positioning the state to compete in the global market, the real question is: **How long can Oregon "ride the wave" before advancing technology, the need to cultivate specialized areas of expertise, and the impending retirement of masses of skilled workers challenge Oregon's currently strong economic position?** What is Oregon's comprehensive strategic investment plan to ensure future economic drivers have access to the talent pool needed to drive the innovation and process improvements needed to win in the global market?

Absent an integrated investment plan that links the strategic planning efforts of education, workforce and economic development, Oregon might risk losing the ability to sustain and maximize its current competitive position. The challenge is urgent. The time to act is now!

Key Questions

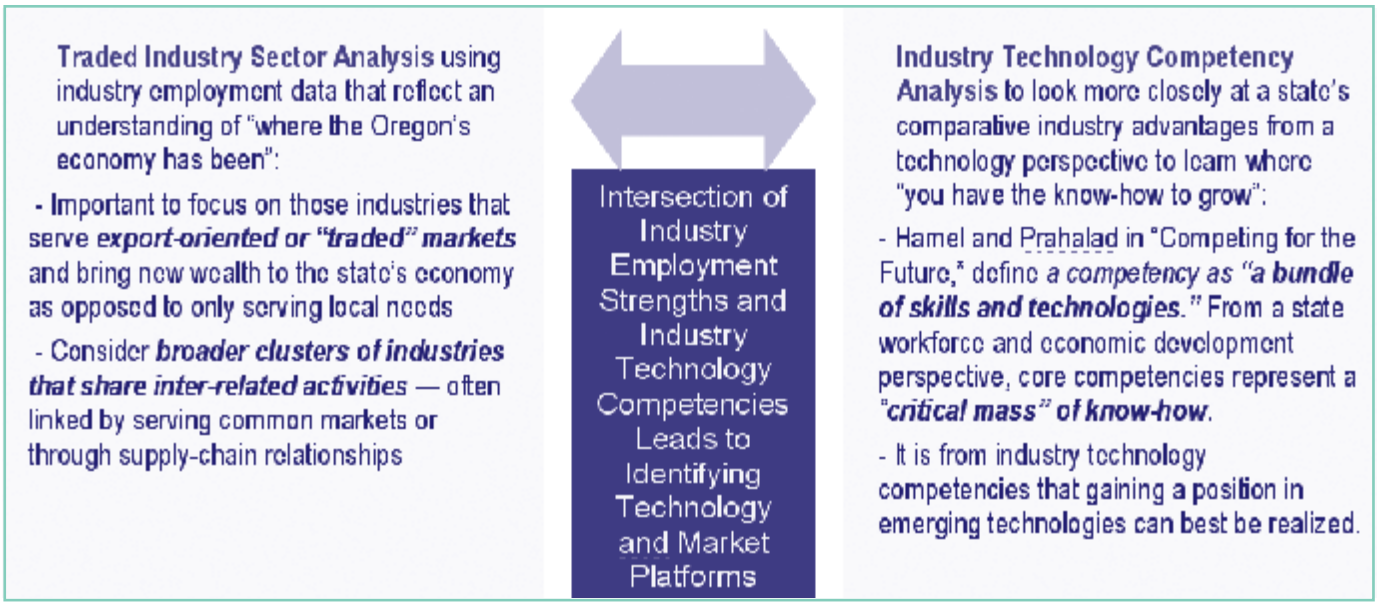
- What might be the economic drivers of Oregon's future economy?
- What workers with which skills will be needed?
- What capacity does Oregon have now?
- Where are the major gaps in the workforce system relative to technology and market opportunity areas?
- What should we do?

The Purpose

This Report, *Priming the Talent Pipeline: Oregon's Future Workforce Needs Analysis*, is intended to provide key decision makers in Oregon with information and a framework for linking the vast array of related but separate initiatives currently operational within education, workforce and economic development into an **integrated workforce investment strategy**. Commissioned by the Business and Economic Development Committee (BEDC) of the Oregon Workforce Investment Board (OWIB), it offers a powerful lens through which to evaluate public investment decisions that impact the broad-based education and training workforce system across the state and to link them to the state's future economic engines.

This research study answers five critical questions, highlighted in the box below. Because the inquiry begins with the question of possible future **drivers** of the economy, this study does not explore the total breadth of the future economy. Rather, it focuses on the **traded sectors**, those industries that sell their goods and services outside the state and country and, therefore, are critical to the state's economy as a wealth generator. The roughly 32,000 business establishments create jobs through robust supplier networks, provide average wages more than $10,000 greater than their counterparts in the rest of the private sector, and represent the state's competitive advantages in terms of both goods and services. Also included in the inquiry are emerging industries, primarily in the biosciences and clean technologies that have tremendous potential to become future drivers of the economy.

This study builds on and broadens Oregon's perspective on **traded-sectors** and cluster-based frameworks, which is rooted in the current industry employment base of the state, to an understanding of the **technology competencies**, or 'critical mass of know-how" found within and across Oregon's industry base.



Bringing these two perspectives together—industry analysis and technology competency identification—allows for the critical linkage of workforce needs to the technology and market platforms that will likely define Oregon's competitive advantage in the future.

This study breaks new ground in integrating these two perspectives, as illustrated above.

The Methodology

The project methodology was designed to answer the five research questions. It is outlined briefly below, with a fully developed statement of methodology included in Appendix 1. A visual that represents the research flow is included at the conclusion of the narrative

Future Drivers? In order to identify possible future drivers of the state's economy, a thorough analysis of industry employment data was completed on Oregon's twelve statewide traded sectors. An in-depth analysis was then conducted of the core technology development and deployment competencies (or strengths) inherent in the traded sector industries, as well as seven additional industries emerging in the economy, in order to assess Oregon's existing areas of "know-how" upon which to build future opportunity. Finally, key leaders from trade associations and cluster organizations affiliated with both existing and emerging industries were interviewed to gather "ground truth" about factors influencing change in their industry, future trends and existing areas of market specialization. These steps correspond to the three figures on the left hand side of the visual below. The synthesis of all this data and information resulted in the identification of seven "technology and market" platforms that reflect the interrelationships among the various traded and emerging industries in terms of shared technologies, common markets or supply-chain relationships. These seven technology and market platforms, as likely drivers of Oregon's future economy, became the lens through which the balance of the analysis was conducted.

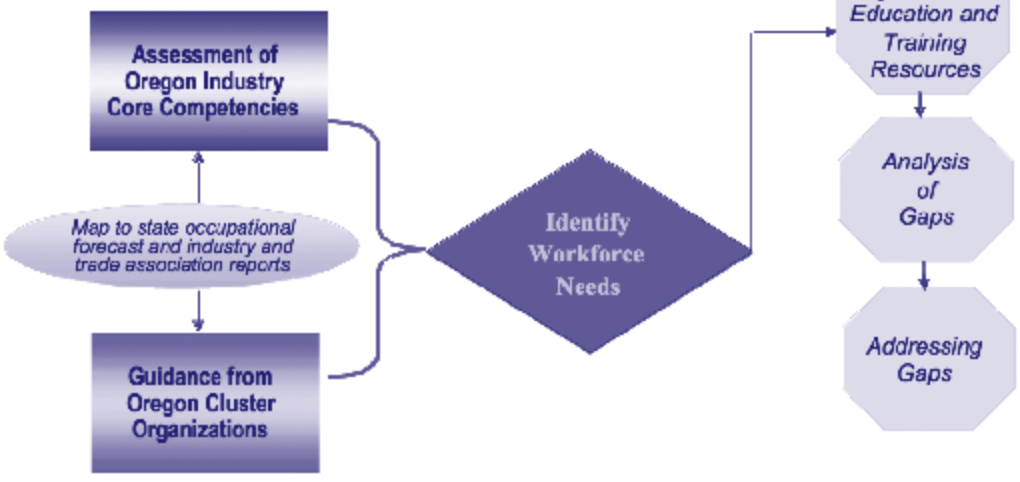
What Workers? What Skills? Investigation of the answers to these questions began with a general review of studies reporting on the changing nature of work and skill requirements driven by globalization and rapid advances in technology. Then, using the Technology and Market platforms as a framework, factors driving change were linked to implications for the workforce within each platform area, based on a synthesis of findings from various trade association reports and interviews with key leaders of trade associations and cluster organizations within Oregon. Finally, the Oregon-specific workforce needs identified by industry leaders were reported. While individual Technology and Market Platform profiles reflected specific sets of workforce challenges and needs, common issues that cut across all seven platforms were identified and reported as critical to informing the integrated investment strategy.

Capacity? This area of research, designed to assess Oregon's current capacity to address identified workforce needs, began with development of a framework within which to consider occupational data and identify areas of strength. That resulted in the formation of four broad "mega" occupational groupings that span all seven Technology and Market Platforms and represent potential high-impact areas of investment for driving future economic growth: production, technician, engineering and computer-related. The next step was to conduct a detailed analysis of Oregon's position across the major occupational groupings to identify relative concentrations of specialized strength compared to national averages, as well as trends in employment levels over the recent past. To further investigate capacity, the output of graduates from the state's community colleges, university and apprenticeship system was considered. Finally, the major infrastructure and initiatives that shape Oregon's education and training delivery system were identified and compared to a set of criteria established by the National Governors Association for an effective and integrated economic, workforce and education delivery system.

Gaps? The identification of gaps focused on three areas. The first was the quantitative gaps between supply and demand. While an inexact science at best, comparing projected employment demand to the output of the primary education and training systems provides keen insight into pure numbers gaps that must be addressed for building a talent pipeline. A second area concerned content and service delivery gaps identified through qualitative input from Oregon business leaders. The third area of gap focus was on overarching systems issues.

What Should We Do? The final step of the methodology was to synthesize all of the findings into a set of actionable recommendations. The intent was to offer a prioritized set of recommenda-

Visual Representation of Project Methodology



tions, linked directly to gaps that could serve as the framework of an integrated investment strategy for future talent development in Oregon. In addition to focusing on specific programmatic and service delivery recommendations, the methodology also included recommendations for addressing broader systems gaps.

This Project Report is organized into five sections that directly correspond to the five research questions.

What Might be the Drivers of Oregon's Future Economy?

In today's global, knowledge-based economy, states are increasingly competing on their ability to educate, train, and recruit a qualified workforce that meets the needs of industry. But states differ in their mix of industry and specific drivers of economic growth, and consequently can vary significantly in the specific workforce needs they confront to stay competitive.

A study of future workforce needs critical to a state's economic growth must be grounded in the specific industry-related drivers of a state's global competitiveness. In particular, states must identify those areas of opportunity where its industry has existing and emerging strengths to serve growing markets and the industry technology competencies to innovate and deploy technologies needed to maintain a competitive advantage.

Approach to Identifying Likely Future Economic Drivers

To consider the likely future drivers of Oregon's economic growth and workforce demand, this study breaks new ground in integrating two perspectives to provide a comprehensive understanding of "*where the Oregon economy competitive industry strengths have been recently*" with a more futuristic assessment of "*where the Oregon economy has the know-how to grow*."

The first perspective of industry performance involves an analysis of traded industry sectors – what is commonly referred to as the "wealth" generating part of the economy because it serves more than local needs and generates sales and revenues from outside the state. The Oregon Economic and Community Development Department (OECDD) has identified twelve such traded industry sectors, which are broad industry groupings of related industries that in effect represent a "supply-chain" of inputs, final goods & services and distribution. In addition, the 2007 Oregon Innovation Plan from Oregon Inc. identified seven emerging industries of potential development opportunity for Oregon, and three signature research centers to support research and development and technology transfer.

Surrounding these traded sectors and emerging industries are significant activities of trade associations and cluster organizations working at the state and regional levels. Many are actively engaged in the Oregon Cluster Network as part of the work related to the Oregon Business Plan. The table below reflects Oregon's traded sectors and emerging industries, along with the various organizations that support their development and growth.

- The Oregon Economic and Community Development Department (OECDD) has identified 12 statewide traded industry sectors.
- The 2007 Oregon Innovation Plan from Oregon Inc. identified 7 emerging industries.
- Surrounding these traded industry sectors and emerging industries are significant activities of trade associations and cluster organizations working at state and regional levels in Oregon and participating in the Oregon Cluster Network.

Oregon's Traded Industry Sectors and Examples of Associated Cluster Activities	Emerging Industries from Oregon Inc.'s 2007 Innovation Plan and Examples of Associated Industry Cluster Activities	Signature Research Areas from Oregon Inc.'s 2007 Innovation Plan and Examples of Associated Industry Cluster Activities
• **Agriculture Products** *Agri-Business Council of OR, OR Assoc of Nurseries, Community Seafood Initiative, Artisan Cheese Cluster, Columbia Gorge Winegrowers Assoc.* • **Apparel & Sporting Goods** • **Business Services** • **Communications Equipment** *AEA* • **Electronics & Advanced Materials** *AEA, Semiconductor Workforce Consortium, Gorge Technology Cluster, Display Technology, ONAMI* • **Information Technology** *Software Assoc of OR, Open Source Technology Cluster, Cybersecurity, NW Education Cluster, Gorge Technology Alliance* • **Logistics and Distribution** • **Medical Products** *Oregon Bioscience Assoc, Biomedical Devices/Biosciences Industry Alliance* • **Metals** *Metals Industry Consortium, Metals Industry Council, Manufacturing 21, Pacific NW Steel Fabricators Assoc, OR Precision Metal Fabricators Assoc, Mid-Willamette Valley Metals Consortium; Pacific NW Defense Coalition* • **Processed Food & Beverage** *NW Food Processors & Innovation Productivity Center* • **Transportation Equipment & Parts** *Transportation Equipment, Recreational Vehicle RV Consortium* • **Wood & Forest Products** *OR Forest Industries Council, OR Wood Innovation Center, OR Small Woodlands Assoc, OR Tree Farm System*	• **Bio-Fuels** *NW Bio-Fuels Assoc, Business Alliance for Sustainable Energy (BASE), Oregon Geo-Heat Center, Oregon Renewable Energy Center* • **Green Building** *OR Forest Industries Council, OR Wood Innovation Center, OR Small Woodlands Assoc, OR Tree Farm System, NW Energy Efficiency Council, Business Alliance for Sustainable Energy (BASE), Oregon Geo-Heat Center, Oregon Renewable Energy Center* • **Wave Energy** *OR Wave Energy Trust* • **Open Source Technology** *Software Assoc of OR, Open Source Technology Cluster* • **Network and Homeland Security** *Cyber Security, Pacific NW Defense Coalition* • **Bioscience** *Oregon Bioscience Assoc., Biomedical Devices/Biosciences Industry Alliance*	• **Oregon Nanotechnology and Microelectronics Institute** *AEA* • **Translational Research & Drug Discovery** *Oregon Bioscience Assoc., Biomedical Devices/Biosciences Industry Alliance* • **Bio-Economy and Sustainable Technologies** *NW Bio-Fuels Assoc, NW Environmental Business Council, OR Solar Energy Industry Association, OR Wood Innovation Center, OR Forest Industries Council, ONAMI, Business Alliance for Sustainable Energy (BASE), Oregon Geo-Heat Center, Oregon Renewable Energy Center*

The second perspective informing where a state has the know-how to grow involves an assessment of industry technology competencies found across Oregon's industry base. The concept of core competencies is now widely heralded by industry to promote competitive advantage. Gary Hamel and C.K. Prahalad in their landmark study, *Competing for the Future*, explain how a focus on core competencies can improve competitiveness:

> *"To successfully compete for the future a company must be capable of enlarging its opportunity horizon. This requires top management to conceive of the company as a portfolio of core competencies rather than a portfolio of individual business units…Core competencies are the gateways to future opportunities. Leadership in a core competence represents a potentiality that is released when imaginative new ways of exploiting that core competence are envisioned."* [1]

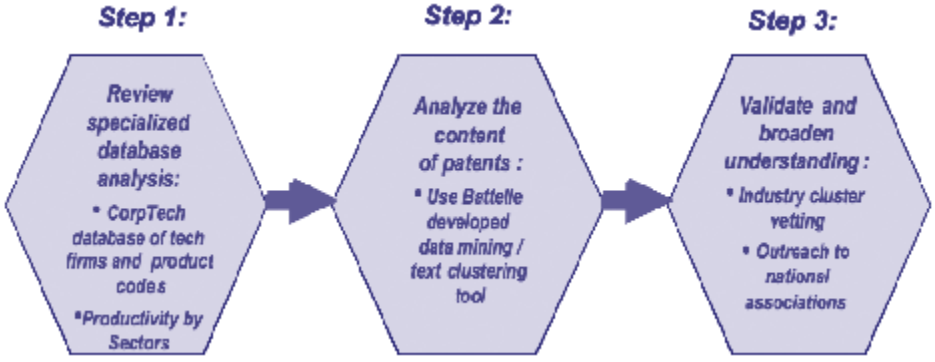
From a regional economic development perspective, core competencies represent a "critical mass" of know-how. It is from core competencies that gaining a position in emerging technologies can best be realized. Otherwise, emerging technology fields that are untied to core competencies require starting from scratch with major investments, rather than leveraging existing strengths.

Technology competencies reflect not only areas of innovation in processes and products taking place across industry in a state, but also the capabilities of industry in deploying advanced technologies for competitive advantage. How modernized and sophisticated a food processor or metals manufacturer is in the deployment of technology places a significant demand on the skill level of its workforce.

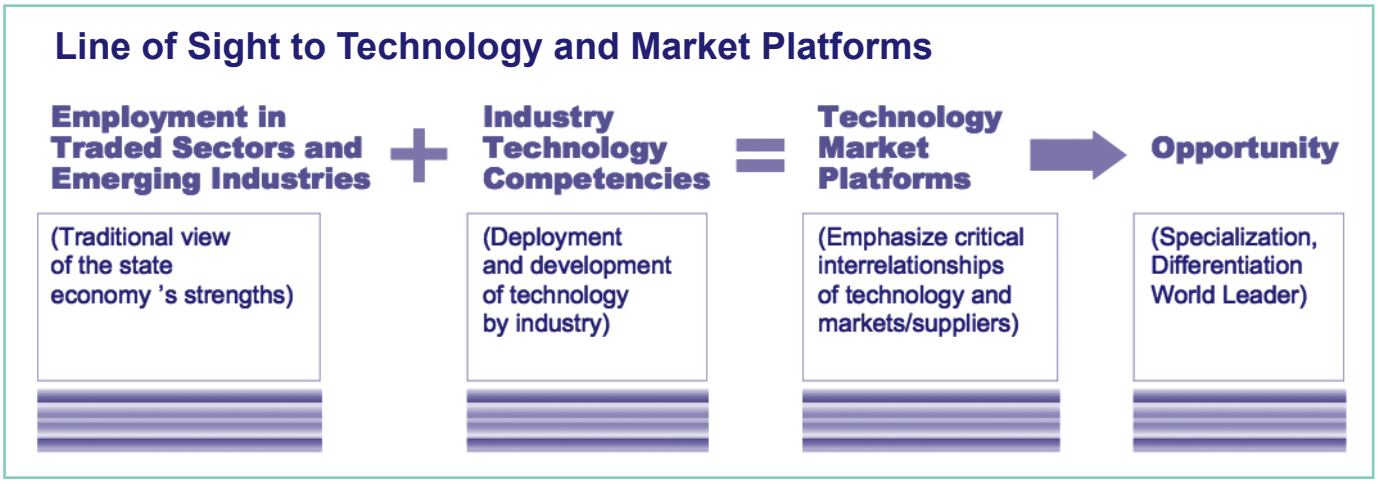
To assess industry technology competencies the Key Links/Battelle team undertook a review of both technology development/innovation and technology deployment across Oregon's industry base. This multi-step process included: a unique cluster analysis of industry patents to identify innovation themes, assessing productivity data and specialized proprietary corporate databases and conducting in-depth interviews with leading industry trade associations and cluster organizations to collect first-hand qualitative information on critical technology innovation and deployment strategies.

Merging these two perspectives relates established and emerging markets served by industry together with industry technology competency strengths that can serve as broad platforms for advancing future economic growth and inform likely future drivers of workforce demand in Oregon. **To be a technology and market platform requires drawing upon multiple core competencies and having multiple development opportunities in significant market niches.**

Methodology for Assessing Industry Technology Competencies in Oregon



[1] *Hamel and Prahalad, Competing for the Future, Harvard Business Press, 1994, pg 90 and 217.*



Assessment of Traded Industry Sectors

To assess traded industry sectors in Oregon, the period of 2001 to 2006, reflecting the recent growth period since the end of the last recession, is examined. Two specific measures of economic performance using industry employment data are considered:

- Economic Specialization – Does Oregon have a larger or smaller employment concentration in its traded industry sectors compared with the overall U.S. economy at a specific point in time? If Oregon has a substantially larger concentration than the U.S. (i.e., 20 percent greater relative concentration), then Oregon is considered specialized in that traded industry sector.
- Economic Competitiveness – What is the employment growth rate in Oregon for a traded industry cluster compared to the U.S. over the course of the current growth period of the business cycle?
- What stands out for Oregon is that the recent period from 2001–2006 has been one of robust economic performance compared to the U.S. across all traded industry sectors
- Oregon is specialized in four traded industry sectors: Wood & Other Forestry Products; Electronics & Advanced Materials; Agricultural Products; and Processed Food and Beverage Products.
- Oregon particularly stands out in the economic competitiveness of ALL traded industry sectors, where the state is outpacing national trends in employment growth from 2001 to 2006.

The bubble chart below graphically presents both the economic specialization and the competitive performance of Oregon's large traded sector clusters and its emerging signature areas.

- Stars (upper right quadrant) are those industry clusters that are both specialized and outperforming the nation in growth. Agriculture Products and Electronics strongly fall into that category, while Wood Products is on the borderline (having slightly outperformed the nation, though still declined in employment).

Oregon Growing Faster than U.S.	Business Services Medical Products
Oregon Growing, while U.S. Declining	Agricultural Products Apparel & Sporting Goods Logistics & Distribution Processed Food & Beverage Products Transportation Equip. & Parts
Oregon Declining, but Less than U.S.	Communications Equip. Electronics & Adv. Materials Information Technology Metals Wood & Other Forest Products

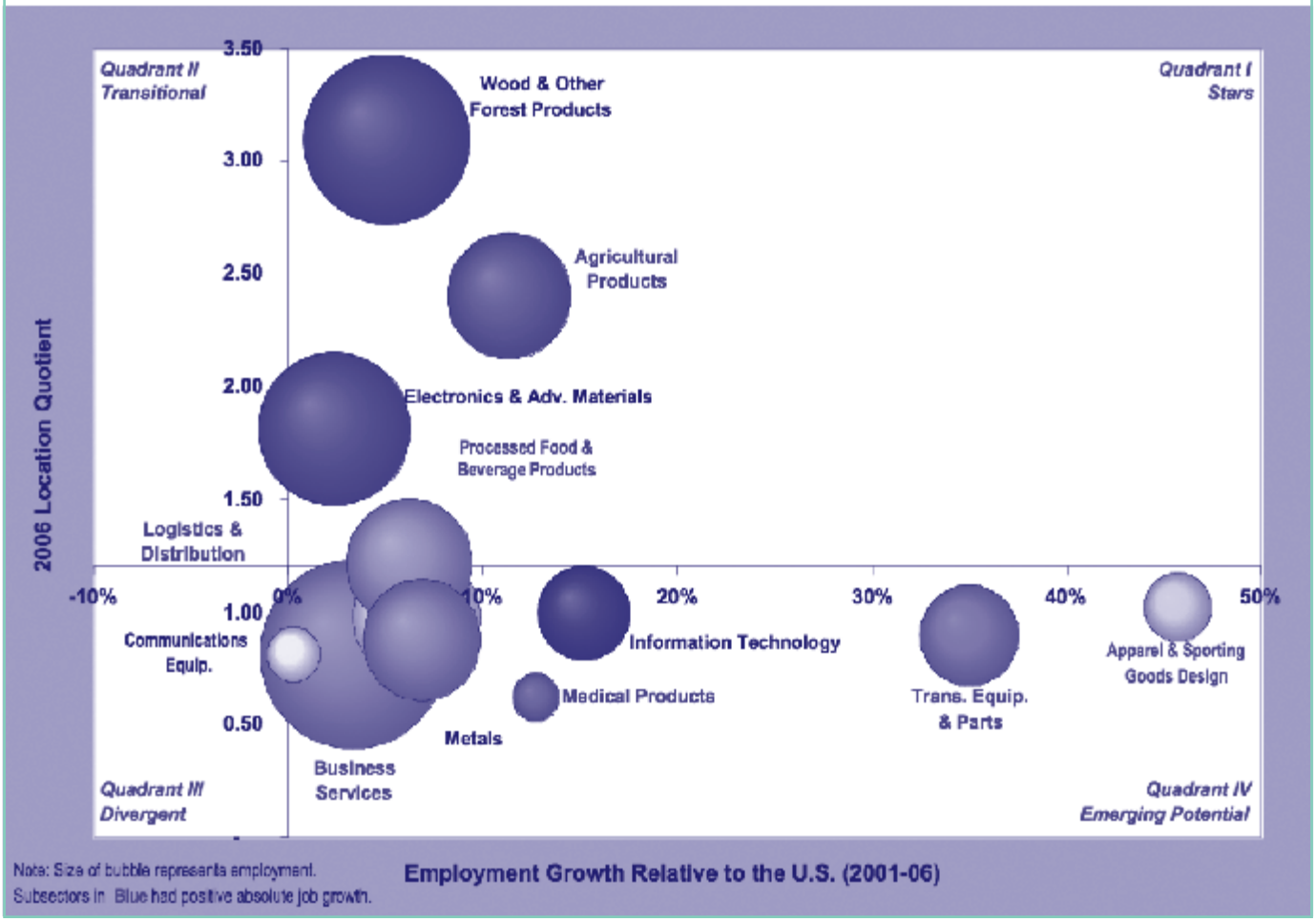
- Emerging Potential (bottom right quadrant) reflects those industry clusters that have not yet become specialized in Oregon, but are outperforming the nation in employment growth. Nearly all of the remaining clusters in Oregon fall into this category.
- Divergent (lower left quadrant) includes those industry clusters that are neither specialized nor outperforming the nation, and therefore not well positioned for development. In Oregon, none of the traded sectors lie in this quadrant.

Oregon's remarkable job situation is evident in the bubble chart. **It is extraordinary that none of Oregon's specialized industry sectors have lagged national performance**, though Wood Products comes close and did decline during the 2001 to 2006 period. Typical regional profiles show numerous industries and clusters with bubbles in the left quadrants where the national sector has outpaced them in recent years making Oregon's growth performance even more remarkable.

Assessing Oregon Industry Technology Competencies

There is no one single source of information that serves to identify industry technology competencies. Rather, a variety of integrated and complementary analyses are required to help provide a perspective of industry technology competencies.

Oregon Traded Idustry Sectors: Employment Specialization and Recent Growth



Technology Development: What often comes to mind when one thinks of industry technology competencies are those areas in which Oregon's industry is actively engaged in technology innovation and advancing new technology development. This is the "gee-whiz" part of industry technology competencies…the ability to shape new discoveries and ideas into product and process ideas, such as inventing the computer or the cell phone.

To assess Oregon's focus in technology innovation, a unique assessment of patents was undertaken along with an examination of areas of technology product focus of Oregon's technology-based industry using a specialized proprietary corporate database.

- Patent Cluster Analysis – Patents represent the intellectual property generated by companies. Battelle used a propriety software tool to examine the relationships and key innovation themes found in patents issued or applied for by Oregon organizations and individuals over the period January 2002 to August 2007. The cluster analysis grouped over 13,000 Oregon generated patents based on the connections of words in sentences from patent abstracts and not a pre-determined classification system.
- Corp-Tech Directory – a specialized database of technology companies—provides a non-traditional way to view industry innovation activities from standard industry employment analysis. Corp-Tech Directory maintains a detailed focus on technology firm activities in more than 270 detailed technology product fields based on surveys and interviews with firms. Nearly 90,000 firms are maintained within the Corp-Tech Directory, of which 1,166 or 1.3 percent are headquartered in Oregon.

The results were a robust set of technology innovation drivers across industry in Oregon covering electronic components and devices, software development, Internet-based services, and metals & manufacturing, along with niches in medical devices, shoe design and agriculture.

- Broad Technology Competency Areas: Seven of the patent cluster groupings are considered to be broad technology competencies since they comprise 5 percent or more of the patents encompassed in the analysis. These competencies reflect the state's broad presence in electronics, computers/communication equipment, and information technology.

    - Computing systems and devices with 16.3 percent of the patents clustered
    - Semiconductor fabrication and wafer manufacturing with 13.1 percent of the patents clustered
    - Chips, circuits and electronic components with 10.1 percent of the patents clustered
    - Communications & networking technologies with 9.3 percent of the patents clustered
    - Digital imaging with 7.5 percent of the patents clustered
    - Printing & color technologies with 6.5 percent of the patents clustered
    - Optics with 6.1 percent of the patents clustered

- **Niche Technology Competency Ares:** Eight of the patent cluster groupings are considered to be niche technology competencies comprising less than 5 percent of patents encompassed in the analysis. These niches are more narrow in nature—in some instances relating to the broader competencies—but also reflecting unique aspects of the diverse mix within Oregon's economy, including competencies in areas related to apparel and sporting goods, metals, and medical products.

    - Processor power management technologies with 4.4 percent of the patents clustered
    - Shoe design with 4.2 percent of the patents clustered
    - Digital/media technologies with 2.1 percent of the patents clustered
    - Sensors with 1.6 percent of the patents clustered

- Plants with 1.4 percent of the patents clustered
- Laser technologies with less than 1 percent of the patents clustered
- Polymers with less than 1 percent of the patents clustered
- Aircraft and navigation instruments with less than 1 percent of the patents clustered

Note: More detailed information on illustrative application/focus of these patent cluster groupings and key companies found in that grouping are presented in Appendix 1.

- **Detailed Product Focus Areas:** Nineteen (19) detailed technology product focus areas (out of more than 270) were identified for Oregon in the CorpTech database, where Oregon had 10 or more firms that represent more than 2 percent of all firms in that detailed product code in the CorpTech Directory:

Technology Deployment: Industry technology competencies are more than just advancing new products and processes. Just as critical—if not as widely heralded—is the ability of industry to "put technology to work." Many of the most successful companies are not those who invent new products, but deploy state-of-the-art technology in making the best products most efficiently. Industry competencies in deploying technology are particularly important in more mature industries, such as food processing, metals and wood products, in which technology is critical in improving how products are produced.

To assess Oregon's position in technology deployment, a focused analysis was conducted of the more mature and manufacturing focused traded industry sectors—food processing, wood products, metals manufacturing and electronics—involving two specific steps:

- Reviewing industry surveys and interviews to identify key manufacturing technologies and processes being deployed in Oregon.
- Analyzing industry productivity data—output per employee—to see how well Oregon industry compares to the U.S. overall. Higher productivity suggests more effective deployment of technologies as well as ability to produce more complex, higher value products.

The results for Oregon in technology deployment were mixed. Generally productivity was just at or below U.S. average levels, suggesting the value-added and complexity of products being produced in Oregon is not a strength. The good news is that the growth in productivity has been positive and outpacing the U.S. average across these mature industries, with the notable exception of electronics which may becoming more commodity-oriented in Oregon. Each of these mature traded industry sectors has identified deployment drivers relating to the use of advanced technologies, as summarized below.

What we learn from viewing the continuum of industry technology competencies from technology deployment to technology development is that different industries tend to focus in different areas of the continuum and so it is essential to have a broad

Electronics-related
- Graphic boards and processors (7.2% of all CorpTech firms in that field)
- PCB design/process/test (4.3%)
- Electronics mfg services (2.3%)

Metals & Manufacturing-related
- Metal processing services (3.6%)
- Materials molding & casting (2.8%)
- Machining services (2.4%)
- Fabrication services (2.3%)
- Conveyors & conveyor components (2.2%)
- Coating and plating services (2.2%)
- Automation manufacturing services (2.0%)
- Pipes & tubing (2.0%)

Business software-related
- Payroll and personnel accounting (5.4%)
- Accounts receivable software (3.1%)
- Accounts payable software (2.7%)
- Invoicing & billing software (2.2%)
- General ledger software (2.1%)

Internet related
- Frame relay Internet access services (2.8%)
- Web site administration services (2.3%)

Environmental services
- Water analysis services (2.2%)

Mature Traded Industry Sectors: Technology Deployment Characteristics

Traded Industry Sectors	DEPLOYMENT OF TECHNOLOGY			
	2005 Level of Productivity Compared to U.S. Overall	Oregon Productivity Growth (2001-2005)	Oregon Productivity Growth Compared to U.S.	Key Deployment Drivers Identified from Interviews (Product & Process)
Metals & Transportation Equipment	Metals: 104% Transp: 47%	Metals: 43% Transp: 34%	Metals: +19% Transp: +4%	Thermal processing; Welding and joining; Materials characterization and performance assessment; Surface engineering; Production prototyping; Large scale dynamic testing; Modeling and simulation
Wood Products	102%	24%	+2%	Timber processing; Computer controlled production; Engineered wood products
Ag & Food Processing	54%	27%	Same	Advanced process control systems (PLCs); Energy reduction technologies; Emerging nonthermal processes
Electronic Components & Devices	85%	-24%	-48%	Process control and integration; Use and maintenance of flow control systems, vacuum systems, furnaces, plasma generating systems; Cleanroom use and maintenance; Chemical and materials handling; Contamination control.

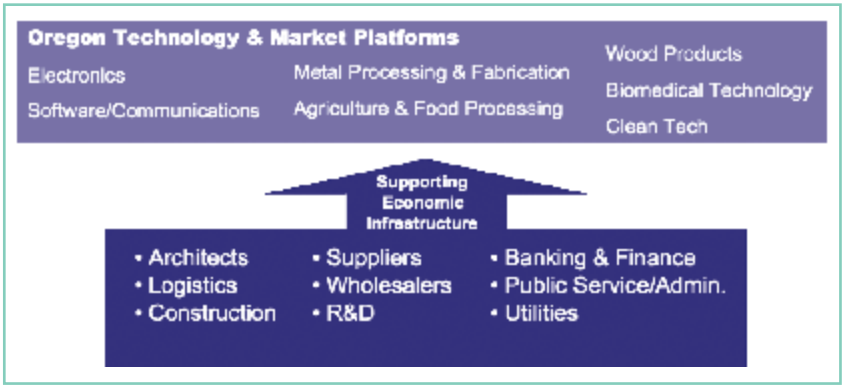
view of industry technology competencies. Oregon's key strengths in technology development are found in electronics and software development. Oregon's traditional industries of metals, wood products and food processing, meanwhile, are more focused on technology deployment and are having mixed success today as measured by productivity levels.

Drivers of the Future Economy: Technology and Market Platforms

Bringing together the analysis of Oregon's specific industry technology competencies and the existing and emerging market areas served by Oregon industry suggests seven "technology and market" platforms are critical in driving future workforce demand in those sectors critical to Oregon's economic competitiveness and growth. These technology and market platform offer a unique focus on Oregon's economic drivers integrating the perspectives of "where the Oregon economy competitive industry strengths have been recently" with a more futuristic assessment of "where the Oregon economy has the know-how to grow."

- Electronic Components and Devices with niches in semi-conductor design, testing & measurement, display, printing and digital media components. This platform combines electronics/advanced materials and communications equipment traded industry sectors given high degree of integration and focus of equipment on peripherals (display, printing). Also major linkage with nanotechnology and microelectronics.
- Software, Computing and Internet Services, which refines the broad terminology of the Information Technology traded industry sector to reflect Oregon's specific focus on business software, open source technology, data centers and Internet services, educational learning and network/homeland security.

- Metals and Transportation Equipment, combining the two sectors given their common focus on metals, with broad applications across aerospace, energy, mining, construction and military applications.
- Agriculture & Food Processing, given the common focus from growing to processing fruit and vegetables, with niches in fruits and vegetables, nurseries and greenhouses, organic foods and wineries.
- Forestry and Wood Products with niches in sawmills, softwood veneer/plywood and engineered wood products & green biomass.
- Biomedical Technologies, which augments the medical technology traded industry sector with new emphasis on biosciences diagnostics, drug discovery, and translational research.
- Clean Technologies, which brings together the emerging industries of biofuels and wind energy, along with the signature research area of bio-based products and sustainable development involving renewable energy, green materials and geo-thermal. Also strong connections with nanotechnology.



Oregon Technology and Market Platforms: Continuum of Technology Competencies & Market Specializations

Technology & Market Platform	Continuum of Industry Technology Competencies in Oregon		Market Specializations in Oregon	
	Industry Technology Deployment Presence	Industry Technology Development Presence	Existing	Emerging Areas Identified Via Reports and Interviews
Agriculture & Food Processing	Primary emphasis	Minimal	Yes	Organic Foods; Artisan/Boutique Foods
Electronic Components & Devices	Major emphasis	Extensive	Yes	Nano-enabled Components & Devices
Software, Computing and Internet Services	Major emphasis	Substantial	Yes	Web Services; Open Source; Network Security; E-learning
Metals & Transportation	Primary emphasis	Limited	Yes	Integrated Assembly Of Devices; Wave Energy
Wood & Forest Products	Primary emphasis	Minimal	Yes	Green Materials; Biomass
Biomedical Technology	Major emphasis	Limited	No	Implantable Devices; Biological Manufacturing; Vaccines/Treatments For Infectious Diseases
Clean Tech	Primary emphasis	Minimal	No	Solar Energy, Wave Energy, Bio-fuels, Green Materials, Geo-Thermal

The chart below summarizes each of these platforms across the continuum of technology competencies and market niches. What the chart reveals is that not all of the technology and market platforms have the same emphasis on technology deployment versus technology development. For the most part, Oregon's technology and market platforms emphasize technology deployment with only electronic components and devices and software, computing and Internet services having a strong foothold in technology development. On the market specialization side, nearly all of the platforms have both identified existing market specializations and emerging areas driven by technology innovation. Two platforms are primarily emerging in Oregon in market position—biomedical technology and clean tech.

These platforms represent areas of economic opportunity—likely economic drivers of the future economy—where Oregon industry has a presence in existing and emerging markets, as well as the competencies to innovate and to deploy technologies needed to be competitive in the global market. development position. They account for 1 in 4 state jobs (25 percent); and though they are identified in this study as the likely drivers of Oregon's future economy, there are numerous critical supporting industries and entities that underlie these platforms. Platform companies rely heavily on supplier and wholesalers driven by logistics, services such as accounting, finance and legal assistance, and fundamental public service provided by utilities, police, and fire departments. The figure below summarizes this critical supporting infrastructure.

Oregon has its own specific technology and market platform opportunities to advance future economic growth and inform likely future drivers of workforce demand in Oregon. These Oregon-specific technology and market platforms represent areas of economic opportunity where Oregon industry has a presence in existing and emerging markets and the technology competencies to innovate and to deploy technologies needed to be competitive.

What Workers with What Skills Will be Needed?

"What workers? What skills?" are pivotal questions for setting a strategic direction for Oregon's future investments in talent generation. To emerge first-in-class, Oregon must meet a global standard of competition for workforce skills across each of the identified technology and market platforms. It is the understanding of global factors and requirements, together with local conditions, that can enable Oregon to properly set a course for the future. Therefore, this section begins with a brief overview of global factors driving change in workforce requirements, followed by a more specific discussion of Oregon-specific data and information relative to future workforce needs.

Backdrop of Change

Dramatic changes in the nature of the work driven by globalization and advancements in technology set a critical context across the broad economy and impact all of Oregon's technology and market platforms. These sweeping changes captured the public's imagination with the publication in 2005 of Thomas Friedman's *The World is Flat: A Brief History of the 21st Century*. The essence of Mr. Friedman's popularization of the broad economic changes underway is reflected in the following quote:

> *"Information and telecommunications technologies have created a platform where intellectual work and intellectual capital can be delivered from anywhere– disaggregated, delivered, distributed, produced, and put back together again, and this gives an entirely new freedom to the way we do work, especially work of an intellectual nature."*

A more refined synthesis of surveys by the Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills and the Society for Human Resource Management offer the following insights.

The workplace across the economy is being reshaped:

- Continued move away from vertically integrated organizations to outsourcing non-core functions
- More decentralized, specialized firms
- Less standardized employer-employee relationships
- New products and services dependent upon maintaining a worldwide technological lead PLUS "deep vein of creativity"
- Increased access by employers to a worldwide workforce that does not have to move to participate in global work teams
- Greater emphasis on retraining and lifelong learning over the course of a worker's career
- Increased labor force participation among women, the elderly and people with disabilities
- Increased levels of entrepreneurism

This reshaped workplace, in turn, is setting a new "bar" for skill requirements. No longer can an industrial age emphasis on narrow skills and following directions support a qualified workforce. Today, a high level of preparation in reading, writing, speaking, mathematics and science, is the foundation for workplace skills even in mature manufacturing settings. Workers must be able to "apply" this foundation into a set of core workplace skills and personal management skills:

The National Center on Education and the Economy, in their recent publication *Tough Choices, Tough Times* comes to a similar conclusion but using slightly different language. After an exten-

Core Workplace Skills	Personal Management Skills
• Creativity/Innovation • Critical Thinking/Problem Solving • Communications (Oral and Written) • Information Technology Application • Leadership Teamwork/Collaboration • High Performance/Lean	• Ability to learn quickly • Agility • Comfortable with ideas • Self-direction/organization • Life long learning • Entrepreneurship • Ethics/Social responsibility

sive analysis of the nation's education and training system, the report identifies the following critical worker characteristics as necessary for success in the future workplace:

- *Comfortable with ideas and abstractions*
- *Good at both analysis and synthesis*
- *Creative and innovative*
- *Self-disciplined and well organized*
- *Able to learn quickly*
- *Work well as a member of a team*
- *Have the flexibility to adapt quickly to frequent changes in the labor market as shifts in the economy become even faster and more dramatic*

The report offers a sobering conclusion: "The core problem is that our education and training systems were built for another era, an era in which most workers needed only a rudimentary education. It is not possible to get where we have to go by patching that system. There is not enough money available at any level of our governmental system to fix this problem by spending more on the system we have. We can get where we must go only by changing the system itself." *(Tough Choices, Tough Times, p. 8)*

It is important to note that the critical core workplace and personal management skills identified above have broad based application for ALL workers in Oregon's economy, not just those employed in the traded sectors. Therefore, investments in building systems with programs benchmarked to those standards will ensure all future and current workers, no matter in what industry sector they are employed, have the critical foundation skills needed to be successful in the 21st century workplace.

Global Factors Driving Development and Their Workforce Implications

The Key Links/Battelle project team reviewed industry and market studies and interviewed key leaders of major Oregon trade associations and cluster organizations to cull out the key factors (both global and regional) driving development for each of the seven technology and market platforms, along with their workforce implications. A synopsis of the findings is provided below, with detailed analyses for each platform provided in the document Appendix 2.

Cross-Cutting Themes: Significant themes and insights on future workforce implications emerge across the findings from all seven technology and market platforms.

- **Rapid process and product innovations places strong need for continued skill enhancements**. This workforce implication is clearly illustrated in critical new technical requirements within traditional manufacturing platforms (wood, food products, and metals) as well as electronics and clean tech. For example,

existing plumbers, electricians, and inspectors transitioning to clean tech installation and maintenance require additional training specific to clean technology systems (solar or wind energy, for example). In wood processing plants, quality managers must be focused on problem-solving, relying on information technologies and statistical process control data.

- **Need for more versatile and multi-skilled technician and production workforce**. There is an increased blurring of lines between technicians and production within a more complex technical environment. Requirements for versatile workers who can perform multiple jobs and apply multiple skill sets is a theme throughout the manufacturing sector regardless of the prod-

WOOD & FOREST PRODUCTS

Key Factors Driving Development	Workforce Implications
_ **Global industry** – characterized by consolidation and serving/competing in markets worldwide _ **Market trending toward "green" product offerings and certification** – demand for certified wood for green building; sustainable forest management _ **Industry technology changes specific to processing /harvesting smaller timber in higher volumes**; falling federal timber harvests force use of smaller timber from private lands _ **Large-scale automated mill facilities** have increased productivity while the number of mills has declined – **Process innovation** includes lasers, scanning, & video for digital imaging and optimal cutting; ultrasonic sound waves used to identify denser pieces, reduce waste – **Product innovation** in composites (i.e. plywood and engineered wood products such as Laminated Veneer Lumber or even wood-plastic composites) _ **Market opportunities in addressing global warming** – biomass energy from mill & logging waste; co-generation of power; future potential in carbon credits	_ **Rapid process innovation** requires production workers versed in quality and process control; engineering simulation and modeling; data and decision support tools _ **Technical skills and knowledge** among workers in composite technologies, especially adhesives; wood chemistry and technology _ **Understanding of wood/forest industry in the context of a "green" marketplace** to optimize market potential across numerous emerging opportunities (biofuels, green building, forest certification)

FOOD PROCESSING & PRODUCTS

Key Factors Driving Development	Workforce Implications
_ **Industry consolidation** pushing costs lower, with rising input costs especially for transportation/energy _ **Shift of market power** to consolidated retailers – "Wal-Mart" phenomenon _ **Increased regulation for food safety & security** – Bioterrorism Act; jurisdictional issues (FDA/ USDA) _ **Major concerns impacting retention and growth**: competitiveness, operational productivity, energy utilization, environmental concerns, climate change, water supply, RFID-logistics _ **Market impacts of changing consumer tastes and preferences** – rise in organics; functional foods & nutraceuticals _ **Adoption of advanced process control systems** (Programmable Logic Controllers-PLC) _ **Next-generation non-thermal processing technologies are emerging** – efficient/less damaging methods _ **Promotion of innovation** through launch of Productivity Innovation Center	_ **Strong demand for versatile, multi-skilled operators and technicians** who can handle the complexity of the increasingly technologically driven food processing production facility. _ **Critical training needs in PLC systems** to effectively run and maintain lean operations _ **Safety and health concerns make food processing a unique industry** – require workers to fulfill strict documentation requirements and comply with heightened food safety standards _ **Major challenge for firms in demographic shifts of workforce** – addressing generational, cultural, and language differences (aging workforce with large share of immigrants) _ **Need for culture shift** within industry to embrace role in global supply chain _ **Rapid technology changes** are driving extensive need to upgrade the skills of the current workforce _ **Leadership development** is critical at all levels to promote innovation and productivity gains.

METALS & TRANSPORTATION EQUIPMENT

Key Factors Driving Development	Workforce Implications
_ **Global competition** increasing pressure to become more productive and innovative. _ **Production orientation** drives most companies in metals/ transportation equipment sector _ **Energy and transportation costs** high; sustainable development becoming essential _ **Modern production technology** allows for better control of complex production process _ **Fabricated metals** has seen shift from pure fabrication to more value-added integration _ **High quality, niche products:** steel parts for machinery, power generation equipment, steel pipes & tubes, titanium castings, rail & street cars, recreational vehicles, heavy trucks _ **Customer base changing:** Oregon metalworking did not grow up as part of local supply chain; recent moves to sell to more local markets	_ **Changing labor mix**, with more automation and robotics. _ **Adoption of high performance manufacturing processes** requires all workers to be trained in and embrace lean/continuous improvment principles; have need for Lean ESL _ **Increasing skill requirements** for production workers is blurring lines of responsibilities between operators and technicians _ **Quality control/assurance and ability to adapt to new technology** are essential requirement of all workers. _ **Priority workplace skills**: teamwork, critical thinking, problem solving and ability to work independently. _ **Ongoing incumbent worker training** essential to maintain skills base due to advancing technology

ELECTRONIC COMPONENTS & DEVICES

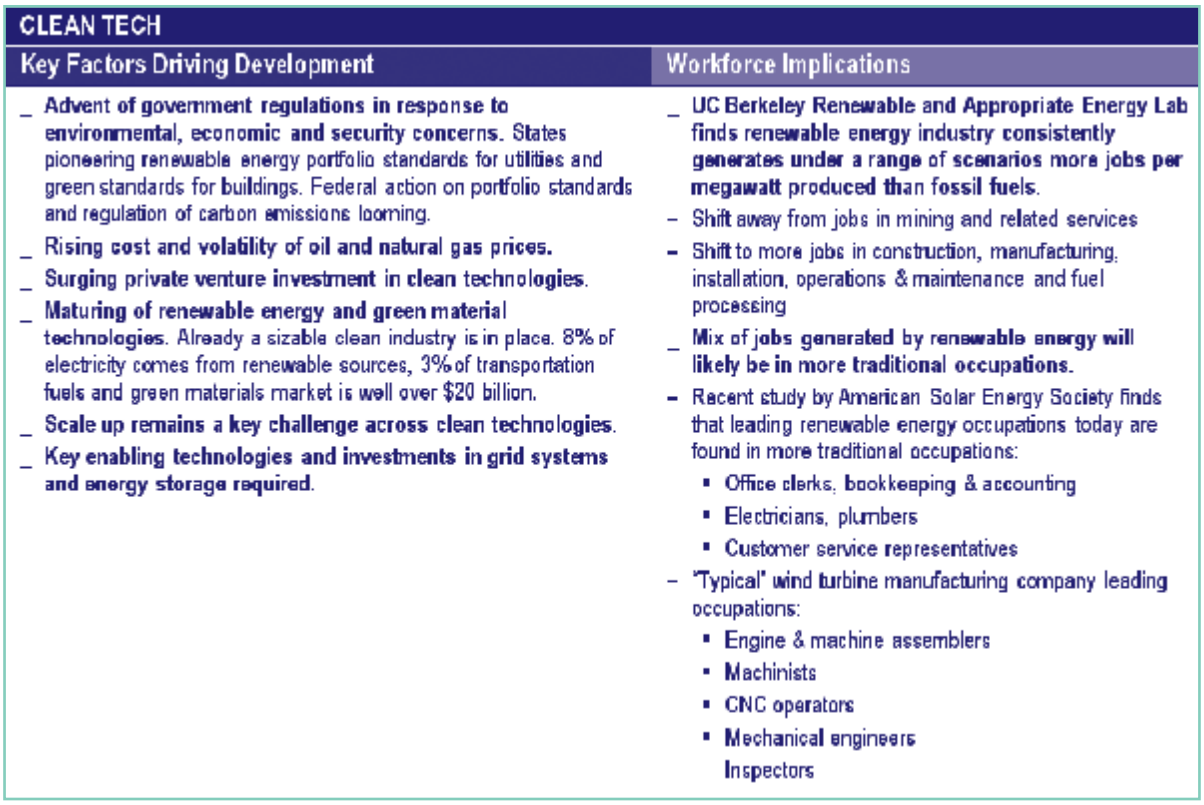
Key Factors Driving Development	Workforce Implications
_ **Fast pace and broad opportunities in new product innovation** – opportunity with integration of voice, video, data & mobility to create new markets, so greater premium on design and production of new products _ **Convergence of software and hardware technologies –** increases complexity and value added of new products _ **Advancements through nanotechnology** _ **Globalization of supply chain** – outsourcing and focus on batch manufacturing of standard products _ Lean **manufacturing** critical for US competitiveness _ **Search for added value critical** to US electronics firms	_ **Critical need for design engineers** _ **Development of new hybrid skill sets for high-end electronics workers –** combine advanced technical skills with soft generic and business-related skills for complex supply chain, customer service and commercial awareness _ Blurring of technician and production **workers in more complex technical environment** – emphasis more on remote operations, preventive maintenance & process technicians. Soft skills of problem solving, learning ability, working in teams & other communication skills _ Increasing **skill demand for technicians to understand system performance**, not just individual business process _ **Working small (nano) is a hands-on skill set** – experience of Penn State's leading education and training program for nanotech technicians (over 450 graduates placed across 64 companies) demonstrates importance of hands-on instruction for AA and BS degrees in characterization, fabrication, basic foundations of micro & nano and professional skills (teamwork, problem solving, documentation)

SOFTWARE, COMPUTING, & INTERNET SERVICES

Key Factors Driving Development	Workforce Implications
_ Rise of **"ubiquitous networking"** with convergence of communications, computing and content generation – "hyper-connected" businesses and individuals _ **Seamless integration of enterprise with its customers & suppliers** is taking place – **rise of web services** to deliver applications, information, etc. _ **Offshore outsourcing** and **globalization** of software and IT services _ **Rise of open source software** – new business model for software products	_ **Pronounced impact of offshore outsourcing on US skill requirements**: – **Less programming and more systems analysts and software applications engineers** with understanding of company/market needs – **More emphasis on project managers** for global development projects – **Continued need for low-level hardware and network maintenance & administration** to serve on-site systems _ **Fast pace of change in skill needs** – platforms, software languages, databases continue to undergo rapid changes with innovations _ **Mismatch of industry needs for emerging "application-specific" knowledge such as open source software** _ **Concern of fall-off in students pursuing degrees and lack of STEM pipeline from K-12**

BIOMEDICAL TECHNOLOGY

Key Factors Driving Development	Workforce Implications
_ **Based in advances in biotechnology and convergence of information technology, imaging, nanotech, electronics** _ **Non-cyclical industry** _ **Broad markets in which states and regions can identify specific niches** _ Favorable **demographic trends** _ **Critical importance of access to venture capital across all stages of investment** _ **Presence of engaged universities and academic medical centers** _ **Increasing use of technology advances in drug discovery process** _ **Rise of molecular diagnostics and personalized medicine** _ **Challenge of translational research**	_ **Fast pace of innovation drives new skill development in the biosciences** – stronger emphasis on technology skills along with bioscience knowledge _ **Biomedical engineering critical since strength is in devices** _ **Critical skill shortages can emerge quickly in the biosciences and pose major impediments to industry growth in niche areas** _ **Breadth of biosciences – involving research, manufacturing and services – drives broad workforce skill demands.** Highest share of employment in biosciences (non-clinical) is for production and technician positions – 50% of medical device and 40% of pharmaceutical _ **Importance of post-secondary education for bioscience positions**, even in more production oriented activities _ **Specific cross-cutting occupational skill needs in good lab and manufacturing practices.** _ **There are distinctive regional characteristics and amenities valued by high-end bioscience workers** – be part of a high-quality life science community, peer recognition, more family quality of life, quality schools



CLEAN TECH

Key Factors Driving Development	Workforce Implications
_ **Advent of government regulations in response to environmental, economic and security concerns.** States pioneering renewable energy portfolio standards for utilities and green standards for buildings. Federal action on portfolio standards and regulation of carbon emissions looming. _ **Rising cost and volatility of oil and natural gas prices.** _ **Surging private venture investment in clean technologies.** _ **Maturing of renewable energy and green material technologies.** Already a sizable clean industry is in place. 8% of electricity comes from renewable sources, 3% of transportation fuels and green materials market is well over $20 billion. _ **Scale up remains a key challenge across clean technologies.** _ **Key enabling technologies and investments in grid systems and energy storage required.**	_ **UC Berkeley Renewable and Appropriate Energy Lab finds renewable energy industry consistently generates under a range of scenarios more jobs per megawatt produced than fossil fuels.** – Shift away from jobs in mining and related services – Shift to more jobs in construction, manufacturing, installation, operations & maintenance and fuel processing _ **Mix of jobs generated by renewable energy will likely be in more traditional occupations.** – Recent study by American Solar Energy Society finds that leading renewable energy occupations today are found in more traditional occupations: ▪ Office clerks, bookkeeping & accounting ▪ Electricians, plumbers ▪ Customer service representatives – "Typical" wind turbine manufacturing company leading occupations: ▪ Engine & machine assemblers ▪ Machinists ▪ CNC operators ▪ Mechanical engineers Inspectors

uct produced or the individual job title. Food processors require workers to handle the complexity of an increasing set of automated tools and processes in the modern processing facility. The "blurring" distinction between technicians and production workers is evident in electronics with increased emphasis on remote operations, preventive maintenance, and interpreting data.

- **An aging workforce is being felt across all occupational areas and numerous platforms**. Image problems affect the attraction of younger workers to more traditional platforms such as wood, metals and food processing as they are viewed as "old economy" or "dying" industries. Institutional or platform-specific knowledge is at risk as older workers retire and leave the workforce, a challenge affecting most knowledge-driven industries nationwide.
- **Offshore outsourcing is raising skill requirements for innovation, new product design and project management**. Global competition is no longer focused solely on low-skill areas of manufacturing, but now reaches into higher skilled activities from computer-related services to electronic production. To compete with higher skilled foreign competition, U.S. business locations must emphasize innovation, managing global supply chains and undertaking high value activities.
- **High growth and newly emerging industries of biomedical and clean technology require a broad range of occupations**. Occupational needs in clean tech are especially diverse; they range from more traditional trades such as plumbers, electricians, and machinists to mechanical engineers, marine-specific occupations (for wave energy applications), and meteorologists. Bioscience sectors require a cross-cutting skill mix in laboratory and manufacturing settings, both of which call for post-secondary degrees.

Identifying Oregon-specific Workforce Issues

Firms within Oregon's technology and market platforms are faced with unique obstacles or issues in pursuing and maintaining a globally competitive workforce. While some issues span platforms and are broader in context, others are truly unique to particular industries. A key component of any assessment of future workforce needs requires strategy and action toward resolving both current and emerging challenges. The Key Links/Battelle project team met with platform-relevant industry associations and decision makers to identify those major workforce issues faced by their stakeholders.

Recurring Oregon-Specific Themes: Recurring themes emerging from the discussions regarding Oregon's specific workforce challenges include:

- ***Much of the pipeline of students exiting Oregon's public K-12 education system is perceived to lack fundamental skills necessary to be productive in workplaces that compete in the national and global economy***. This perceived lack of preparation was voiced repeatedly by industry leaders across all seven technology and market platforms. It spanned a range of issues, including, but not limited to: lack of basic reading, math and communication skills; lack of essential workplace skills such as critical thinking and problem-solving; lack of agility and willingness to learn, a fundamental requirement of the dynamic workplace; and lack of critical science and technology foundations required to pursue post-secondary education and careers in technology, especially among women and minorities.
- ***Continued reliance by Oregon employers on out-of-state recruitment for their high end electronics and software workforce***. On a positive note, the attraction of these high skilled workers to Oregon reflects on the state's high quality of life, and is now a well established path for highly skilled workers in electronics and software fields. More importantly, meaningful steps are being taken to bolster Oregon's higher education, and so create a better balance for the future.

Workforce Issues Identified in Discussions with Industry Associations and Review of Industry Reports

Wood & Forest Products	Food Processing & Products	Metals & Transportation Equip.
_ Serious problems in hiring rural logging workers due to problems with drug use	_ Industry suffers from image challenges—viewed as low skill and low wage	_ Industry perceived as "old-economy"; image issue for recruitment
_ Workforce gaps in basic job skills (read, follow directions, perform simple computer/computational skills)	_ Confluence of challenging demographic issues including aging within key occupations and immigrants as increasing share of production workforce	_ Most difficulty filling technical jobs: CNC operators and programmers, production assembly supervisors, technicians, machine operators.
Vocational forestry programs at high schools, community colleges have been reduced; companies now rely on on-the-job training—significant "PR" work necessary to bring worker pipeline back online (OFRI is heavily engaged in this effort)	Skilled/semi-skilled workers most difficult to hire/retain: maintenance mechanics, technicians, and machine operators.	New entrants lack fundamental skills to meet basic entry job requirements; takes 2–3 hires to find one worker who can do the job (drug free, work ethic)
_ Many young people and other potential workers see industry as having little future potential, despite the fact that there will be significant opportunities created by retiring workers	Majority of employers train and promote from within; need to aggregate demand and develop strategic partnerships with public education and training partners	Issue of finding skilled replacement workers; project 15,000 needed over five years
	_ Unique safety requirements require critical thinking and problem solving skills	_ Immigrant workforce is growing, results in language barriers;
	_ Targeted leadership development needed for succession planning in family owned businesses and for training of women and minorities for leadership roles	Lack of women and minorities at all levels within the workforce

Electronic Components & Devices	Software, Computing, & Internet Services	Biomedical Technology	Clean Tech
Focus on out-of-state recruitment for high end workforce employed by large multi-national electronic firms in Oregon Smaller homegrown Oregon electronics firms tend to draw their engineering and technician workforce from within the state Significant electronics manufacturing base is "commodity-based." More emphasis on production workers. Shift to production of silicon-based products for solar energy. Competes for production workforce – Input from Oregon Business Plan suggests importance of K-12 education and talent pipeline—even to attract high end workers and their families to Oregon	Growing concentration of "open source" software developers within Oregon focused on web services Higher education not able to keep pace with changing skill needs of industry Opportunities in data centers and backend processes Concern that students not returning to computer sciences field even as industry picks up again – Pipeline of students prepared for careers in technology. Overall depth of STEM education in K-12 lacking, especially for women and minorities.	Overwhelming majority of biomedical companies are experiencing challenges in finding employees with the right experience or skills within the local pool. Significant gap in senior managerial and operational talent found in Oregon, and employers must recruit most of these positions from out of state. – Entry and mid-level technical people available within Oregon, but the pool is not deep. Key skills gaps in biomedical-related manufacturing and regulatory skills – reflecting the specialized nature of biomedical industries.	For solar energy, workforce gap in installers, especially for solar energy. Often involve skilled trades such as plumbers, electricians. Rural areas seen as particularly lacking installer workforce. In wave energy, workforce gaps seen in marine operations, merchant mariners, and generation and transmission engineers. In wind energy, lack of operating technicians; meteorologists; electrical, energy & environmental engineers. In energy efficiency, need to orient engineers and engineering technicians of requirements through "on the job experience" using internships and customized curriculum – Create a full talent pipeline with an orientation toward clean tech industries Address skill shortages for range of engineers—biomedical, electrical, electronic, renewable energy, mechanical—and other skilled workforce – Maintain Oregon's leadership position by growing its Renewable Energy Engineering degree program and building pathways with community colleges. – More broadly, integrate sustainability into education system by making it a core part of K-20 educational curriculum; creating integrated degree programs and professional certifications for building trades, etc.

- **Remarkably similar needs and challenges from the more manufacturing-oriented platforms regarding inabilities to hire versatile, talented technician-level workers;** even to the point of luring talent from competitors and from entirely different industries to fill needs. Pay among talented engineering technicians even surpasses that for some engineers based on demand. This challenge relates to a considerable image problem facing these traditional manufacturing-oriented platforms. Simply put, young talent (as well as key persons who influence their decision making, such as parents, teachers, and counselors) view traditional traded sectors in Oregon (wood, food processing, metals and transportation equipment) as dying industries. They lack critical information how these industries have modernized, are well positioned to continue as economic drivers for the state's economy and pay well above average annual wages.
- **Issue of finding skilled replacement workers, given the impending retirements across all levels of employment across all platform areas**. Clearly, this is a national and even global challenge, but Oregon business leaders underscored the urgency of addressing this issue, not so they could grow—but first, so they could survive. This challenge was identified as being particularly acute for the manufacturing-related platform areas.

To begin to fashion an investment strategy that addresses both the overarching and platform-specific workforce issues and skill needs identified, attention turned to assessing the capacity inherent in Oregon's current workforce as well as the capacity of its existing education and workforce training system.

Emerging Cross-Disciplinary Careers in Engineering
(A Niche Market Being Addressed by the Oregon Institute of Technology)

- **Renewable Energy Systems Engineering**: Prepares students for the challenges of designing, promoting and implementing renewable energy engineering solutions. 'Green Collar" engineering graduates will work as power engineers, renewable energy system integration engineers, etc.
- **Embedded Systems Engineering**: This multi-disciplinary degree combines computer engineering technology with embedded systems design, quality assurance, testing and implementation. Teams from software engineering technology, computing engineering technology, mechanical engineering, and other fields prepare students for manufacturing and renewable energy careers.
- **Geographical Information Systems Engineering (GIS):** GIS is a specialization of Information Technology which deals with the creation, analysis, and interpretation of geographic/demographic databases. It spans the fields of environmental science, geomatics, computer software engineering, data management systems, and other engineering disciplines.

CROSS-CUTTING SKILLS

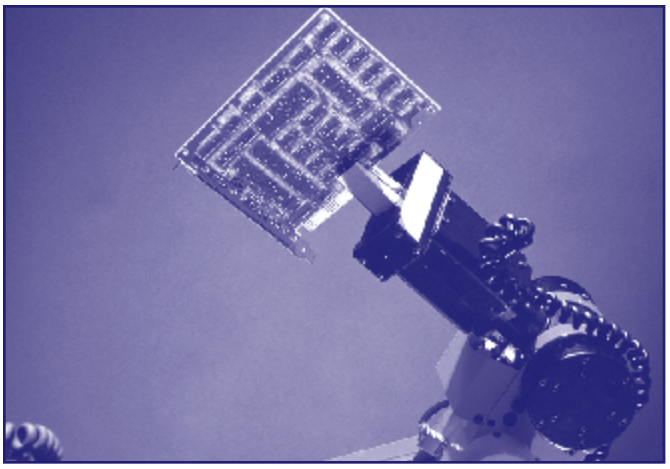
Several cross-cutting skill needs and workforce pipeline issues emerge specific to Oregon's manufacturing-oriented platforms.

Specialized technical skill needs:

- High performance/lean manufacturing methods; Control/PLC systems/SPC; Industrial electricity/electronics; Documentation/recordkeeping; Regulatory Knowledge; Integrated systems maintenance

Cross-cutting pipeline themes:

- High labor demand among major manufacturers with engineer-to-technician needs of 1:12 or 1:15 in medium and large operations
- Cross-industry demand has put a wage *premium* on technicians with broad skill sets and versatility (some earning more than engineers)
- Student pipeline is insufficient ,forcing firms to hire away technicians from other industries or competitors
- Need for greatly expanded career technical education, apprenticeship programs and experiential learning including internships



The Critical Link to Sustainability

The seven technology and market platforms play a critical role in positioning Oregon as a potential global leader in sustainable development. "Economies built on sustainability will better navigate constraints in resources and regulation by reducing their environmental footprint, making better use of raw materials, producing products more efficiently, and reducing costs and profit margins. At the same time they will tap growing markets where sustainable practices and products appeal to customers…Oregon already has a head start, and it should leverage and sustain that lead. If it does, we believe that Oregon will be a place where innovative companies and talented people flock and where traded-clusters beat their competitors in operating efficiencies, waste, cost reduction, and sales." p.4.

Policy Playbook and Initiative Guide
6th Annual Leadership Summit

What Capacity Does Oregon Have Now?

The answer to this question is fundamental to prioritizing future investments. With the understanding of the workforce requirements across and within each of the technology and market platforms that are positioned to drive Oregon's future economy, it is critical to take stock of the capacities found in its current workforce and the ability of its education and training systems to generate future workers with skills that align to those requirements.

Oregon's Current Workforce Development Position

Similar to the economic performance analysis of traded industry sectors, it is helpful to consider Oregon's performance across key occupational groupings that relate to particular skill sets and education and training programs. By moving beyond individual, highly-detailed occupations to broader groupings critical across all Oregon technology and market platforms, this study can better characterize the state's existing workforce specializations and identify those occupations that will likely play a significant role in the future.

The project team examined the full Standard Occupational Classification (SOC) structure and corresponding employment data for Oregon in order to identify major groups of occupations most critical to Oregon's technology and market platforms. A framework was developed and refined in order to balance the need for broader groupings with some intermediate level of occupational detail. Four key occupational groupings were identified in order to highlight trends that span the majority of technology and market platforms and provide guidance for future workforce investments. These include: production occupations, engineering technicians, engineers and computer related occupations, presented in the table below. The selected groups represent nearly 200,000 individual jobs in Oregon critical to generating and implementing product and process innovation and driving economic growth.

For each of the broad occupational groups and their more detailed components, employment levels, trends, and concentration relative to total employment were tabulated in order to identify state specializations and growth compared with the nation

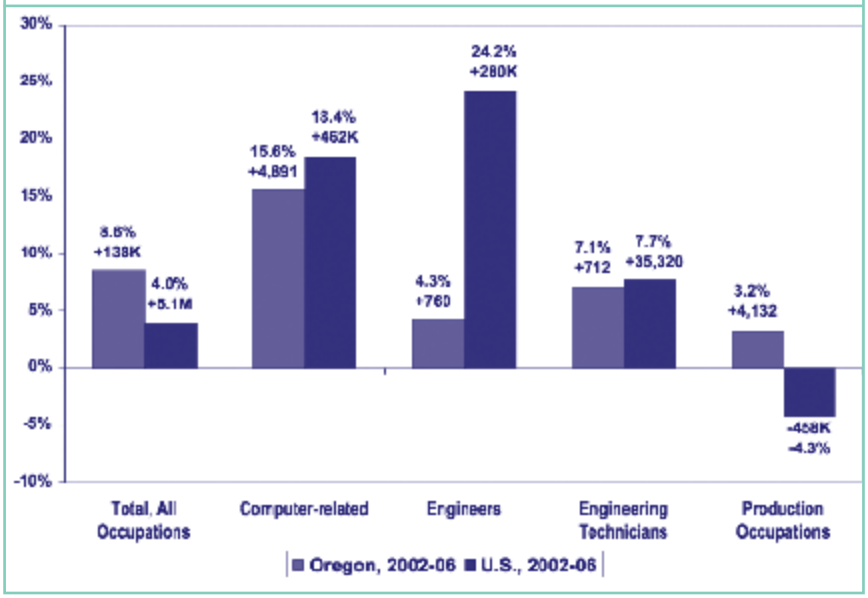
Four Critical Occupational Groupings Spanning Technology and Market Platforms

SOC Code	Occupations		
15-1000	Computer-related	17-3020	Engineering Technicians, Except Drafters
15-1010	Computer and Information Scientists, Research	17-3021	Aerospace Engineering and Operations Technicians
15-1020	Computer Programmers	17-3022	Civil Engineering Technicians
15-1030	Computer Software Engineers	17-3023	Electrical and Electronic Engineering Technicians
15-1040	Computer Support Specialists	17-3024	Electro-Mechanical Technicians
15-1050	Computer Systems Analysts	17-3025	Environmental Engineering Technicians
15-1060	Database Administrators	17-3026	Industrial Engineering Technicians
15-1070	Network and Computer Systems Administrators	17-3027	Mechanical Engineering Technicians
15-1080	Network Systems and Data Communications Analysts	17-3029	Engineering Technicians, Except Drafters, All Other
15-1090	Computer Specialists, All Other		
17-2000	Engineers	51-1000	Supervisors, Production Workers
17-2010	Aerospace Engineers	51-2000	Assemblers and Fabricators
17-2020	Agricultural Engineers	51-3000	Food Processing Workers
17-2030	Biomedical Engineers	51-4000	Metal Workers and Plastic Workers
17-2040	Chemical Engineers	51-5000	Printing Workers
17-2050	Civil Engineers	51-6000	Textile, Apparel, and Furnishings Workers
17-2060	Computer Hardware Engineers	51-7000	Woodworkers
17-2070	Electrical and Electronics Engineers	51-8000	Plant and System Operators
17-2080	Environmental Engineers	51-9000	Other Production Occupations
17-2110	Industrial Engineers, Including Health and Safety	17-3000	
17-2120	Marine Engineers and Naval Architects	Note: SOC = Standard Occupational Classification System.	
17-2130	Materials Engineers		
17-2140	Mechanical Engineers		
17-2150	Mining & Geological Engineers, Incl. Mining Safety Engineers		
17-2160	Nuclear Engineers		
17-2170	Petroleum Engineers		
17-2190	Engineers, All Other		

as a whole. Data for Oregon are from the Occupational Employment Statistics (OES) program and were provided by the Oregon Employment Department. National OES data were provided by the U.S. Bureau of Labor Statistics (BLS).

A measure of relative job concentration—a location quotient (LQ)—is calculated here for each broad/detailed occupational group and throughout this study. This metric provides a comparison of Oregon's concentration of jobs in a particular occupation versus the national average relative to total employment. If it meets or matches the national

Occupational Employment Changes for Oregon and the U.S., 2002-06



Oregon Position Across Major Occupation Groups, 2006				
Major Occupational Group	Oregon Employment, 2006	Relative Concentration Compared to National Avg. (1.00=Nat'l Avg.)	Oregon Percent Change, 2002–2006	U.S. Percent Change, 2002–2006
Computer-related	36,151	0.92	15.6%	18.4%
Engineers	18,340	0.97	4.3%	24.2%
Engineering Technicians	10,701	1.63	7.1%	7.7%
Production	132,365	0.98	3.2%	-4.3%

average, the LQ equals 1.0. If it exceeds 1.0 it has a greater concentration of jobs. For this portion of the analysis, an occupational LQ of 1.2 or greater is considered to be *"specialized."*

These mega-level occupational data reveal a number of important trends, as discussed below.

Discussion of Oregon's "Mega-Level" Occupational Trends

Oregon's overall economic success and ability to create jobs is illustrated by its strong growth among all occupations. Indeed, by this measure, Oregon grew at more than twice the national average—8.6 percent job gains from 2002 to 2006 versus 4.0 percent nationally.

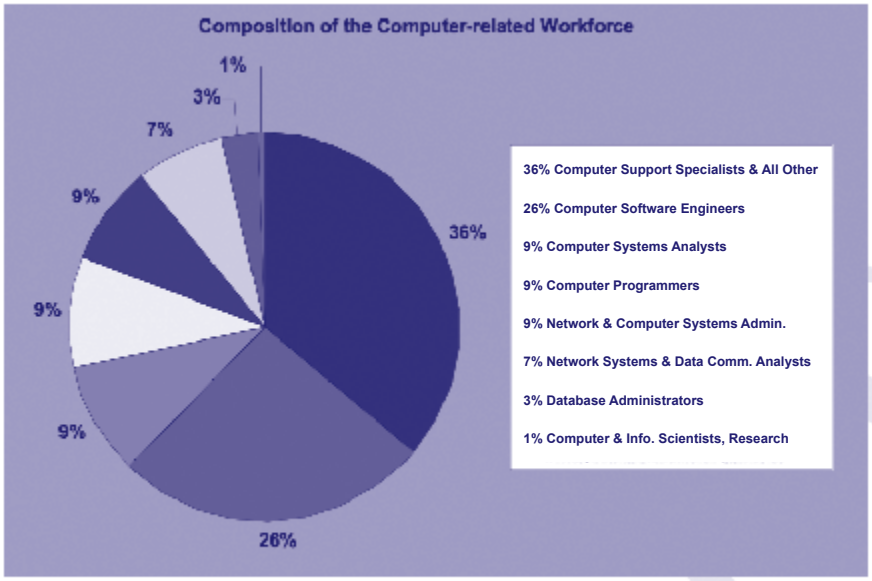
But there are particular patterns of development that stand out:

- **While not specialized in production workers, Oregon recorded healthy growth in its production workforce at a time when the U.S. production workforce fell**. Oregon's unique niche and strengths in production-level work are striking, showing a 3.2 percent job gain during this period while, on average, U.S. production workers lost jobs (-4.3 percent).
- **Oregon is highly specialized in its technician workforce in Oregon**—the state has a 63 percent greater concentration of these technicians and has matched U.S. job growth.
- **In computer-related workforce, Oregon stands at the national average in its share of the workforce and in recent growth rates**. Oregon's computer-related workforce has rebounded following the recession of 2001, with a nearly 5,000 employment gain.
- **Employment in engineering is the one workforce category where Oregon is not keeping pace with the nation**. Of concern is the modest job growth among engineering professionals during this period. Product and process innovations hinge upon the abilities of specialized engineers and the relative lack of demand in Oregon in recent years is striking. Though as a group they've added jobs (up 4.3 percent), it does not come close to the exceptional growth among engineers nationally, where the job base is up nearly one-quarter since 2002.

Below are pie charts that summarize: (1) composition and distribution of the specific occupations that comprise the four mega-occupational groupings; (2) information on the mega-grouping including the occupations with the largest number of jobs; and (3) those occupations that are specialized in Oregon, reflecting a higher concentration of employment than found nationally.

Detailed Composition of Major Occupations in Oregon:

Computer-related Occupations

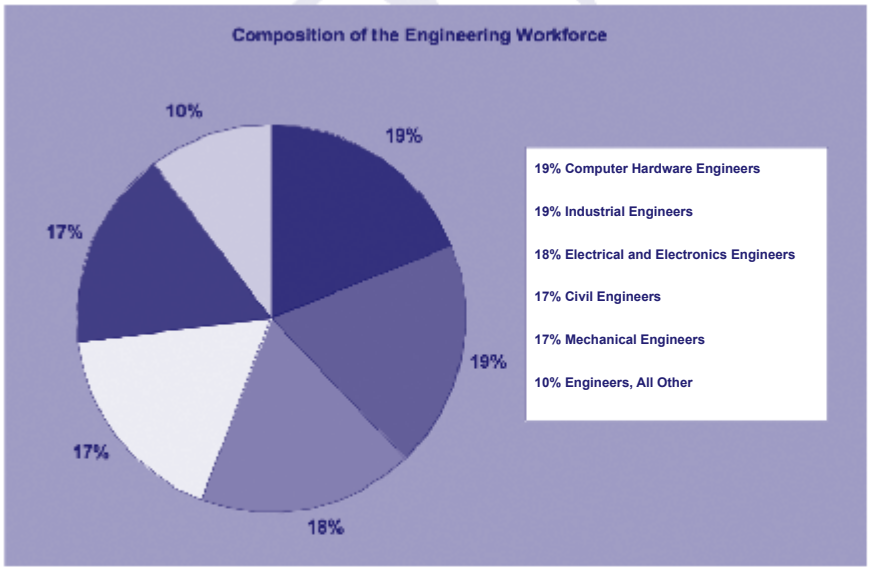


Computer-related occupations span each of the technology and market platforms and additional industries throughout Oregon. In total, this occupational group includes more than 36,000 jobs in 2006 across eight detailed components. Largest among the computer-related occupations in Oregon are computer support specialists (13,070 employed; 36% of total) and software engineers (9,471 employed; 26% of total).

The largest among the computer-related occupations is also considered to be *specialized* in Oregon:

- Computer Support Specialists & All Other (LQ is 1.42)

Engineering Occupations

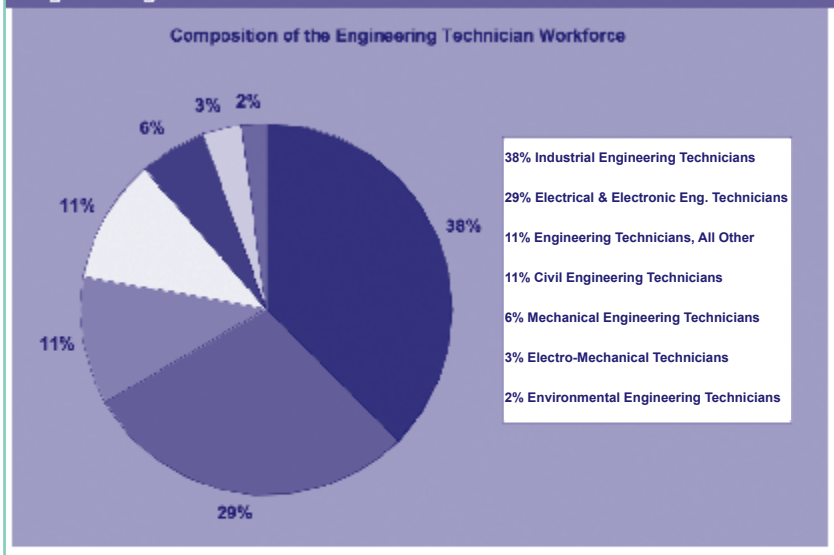


Engineering occupations drive innovation in both products and industrial processes and are critical to a state economy. Among the more than 18,000 engineering professionals in Oregon, there is a remarkably even distribution of jobs with five of the six engineering professions each accounting for between 17 and 19 percent of the total.

Three engineering occupations are state *specializations*:

- Computer Hardware Engineers (LQ is 3.27)
- Electronics Engineers (LQ is 1.20)
- Materials Engineers (LQ is 1.48)

Engineering Technicians

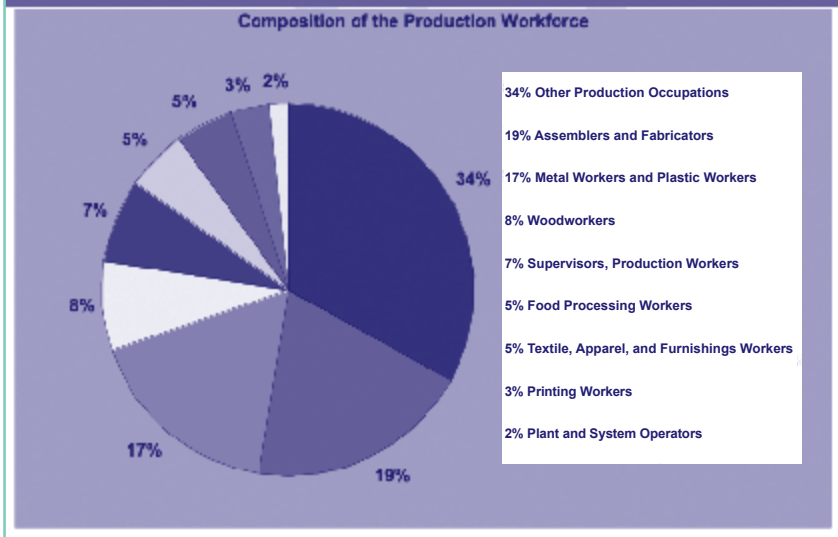


Overall, the state has a specialized employment concentration across all engineering technicians as it is 63 percent more concentrated within the state compared to the nation.

- Overall Engineering Technicians (LQ is 1.63)
- Industrial Engineering Technicians (LQ is 4.13)
- Electrical & Electronic Technicians (LQ is 1.41)
- Electro-Mechanical Technicians (LQ is 1.72)

Much of the hands-on, applied engineering work in industry is performed by **engineering technicians**. These technicians apply engineering principles and theory, usually under the guidance or direction of engineering staff, to create or improve upon processes and products. In larger production environments, engineers may require and oversee up to 12 or 15 technicians to do much of the hands-on work. In Oregon, industrial engineering technicians (38 percent of total) and electrical and electronic technicians (29 percent) comprise the bulk of these jobs.

Production Workforce



Though large and growing, the production workforce has but one state specialization.

- Woodworkers (LQ is 2.40)

Oregon's production workforce, more than 132,000 individuals, carries out the numerous tasks involved in bringing state products to market. Showing remarkable resiliency in recent years given a struggling national manufacturing sector, the demand for these workers remains robust in Oregon. Each slice of the pie chart represents dozens of occupations. The largest groups are "other production occupations" (34% of total); assemblers and fabricators (19%) and metal and plastics (17%).

Specialized Occupations Driving the Technology and Market Platforms

Oregon's seven technology and market platforms are likely to drive the future state economy. In an occupational framework, then, what are the jobs that drive these platforms? Industry-occupation matrices, provided by the Oregon Employment Department at the state level and BLS at the national level allow for a within platform analysis of detailed occupations. Insights gained into ***"What occupations in Oregon today are critical to the likely future drivers for economic growth in Oregon?"*** will inform the OWIB in making strategic and targeted workforce investments.

To determine specialized and concentrated occupations within the technology and market platforms two measures of occupational significance were utilized. One requires that occupations comprise at least 2.0 percent of total platform jobs, the second requires that those with at least 2 percent of employment have a location quotient of at least 1.50.

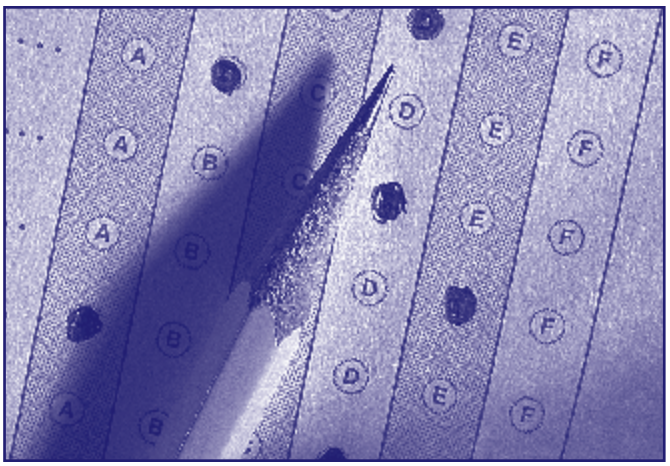
Assessing the occupational make-up of the technology and market platforms, which is summarized on the following page, reveals a **high concentration of production workers across several platforms** (production occupations begin with the "51-"SOC codes). Further, **the specialized occupational structure in Oregon generally reveals a concentration of key occupations that tend toward lower-end skill requirements.**

Other cross-platform analysis highlights include:

- **Technology and market platforms record a number of specialized occupations, but the majority require relatively lower-end skills and limited education, i.e., high school plus on–the-job training.** Three of the manufacturing-oriented platforms (wood products, food processing, and metals/transportation equipment) illustrate this with a varied set of specializations but limited with respect to higher skill sets. State biomedical jobs are also concentrated in production, reflecting the focus in manufactured medical devices.
- **While software, computing, and Internet services has a specialized core of computer support jobs, in the broader context of computer-related jobs these support specialists are on the lower end of the skill spectrum.** Though software engineers (applications) just miss the location quotient threshold, the lack of concentration among high-skilled computer jobs in a modern IT context is concerning from an innovation perspective.
- **The electronic components and devices platform bucks the lower-skill trend with a number of engineering, technician, and management jobs among its most concentrated.** Reflecting a high value-added product and complex processes, electronics firms tend to demand workers with more education and high-end skills. However, one has to reconcile this with the increased movement of the semiconductor industry in Oregon towards a commodity-orientation, as revealed in lagging productivity data compared with the national average. While the industry has needs for skilled workers, its largest specialized occupational group is production-focused—semiconductor processors, which currently often requires just a high school diploma and on-the-job training.

In setting the course for a world-class innovation economy, Oregon must address this high (and growing) concentration of lower skilled workers, in addition to technology and market platforms that are increasingly geared more toward commodity production as revealed in the productivity data. Indeed, the current occupational specializations within the majority of Oregon's technology and market platforms do not represent a particularly strong platform from which to springboard into future global competitiveness, given the relatively higher concentrations of generally lower-skilled workers.

While Oregon has managed to maintain its strong economic position with this current skill profile, the emergence of biomedical and clean technologies, aggressive efforts to spur innovation, advocacy for the adoption of high-performance practices, implementation of lean manufacturing strategies, commitment to reduce the carbon footprint, and other factors are sure to drive up skill requirements in Oregon's traded sector workforce across the board. Given Oregon's current relatively weak position in terms of specialized occupations that feed the technology and market platforms, this will require an aggressive, multi-faceted strategy designed to strengthen this critical specialized workforce across all skill levels. The post-secondary education and training system will, of necessity, be a critical component of that strategy.



Current Capacity in Post-Secondary Education and Training

A substantial student pipeline in higher-education institutions and registered apprenticeships is a recognized critical component for supplying a state's knowledge workforce and talent base. While all graduates who build their skills through some sort of post-secondary education and training can add value to the state's knowledge base, the innovation economy relies heavily on the more technical fields of engineering, science, computer sciences, and related areas of study.

While graduates of traditional 4-year colleges and universities are extremely critical, additional sets of graduates from community and technical colleges, and formal apprenticeship programs, comprise the full complement of higher-skilled technician and production workers. Associate's degrees, apprenticeships, and numerous certificate programs graduate new workers with necessary applied workplace and technical skills to contribute significantly to increases in innovation and gains in productivity.

To assess Oregon's workforce capacity, it is therefore important to study recent trends among graduates of state post-secondary institutions as well as the output of the registered apprenticeship system in relevant industrial trades. Not all graduates will remain in the state following graduation or completion of a formal credential; however, they represent a primary source of talent to fill both new and replacement jobs. Conversely, the "in-migration" of skilled workers adds to the state's labor pool on the supply side, but is virtually impossible to calculate.

The analytical approach adopted for this study to address post-secondary institutions involves using a crosswalk of educational degree programs defined by federal Classification of Instructional Programs (CIP) codes to the major sets of highly-related occupations introduced in the previous section—computer-related, engineers, engineering technicians, and production. This framework builds in a useful workforce focus as it makes direct links to the major potential state labor supply for each broad set of occupations. (To view the crosswalk and a discussion of methodology see Appendix 1).

National and state educational award data from the National Center for Education Statistics (NCES) provides a snapshot of both current and recent trends across degree and certificate programs. The crosswalk to the four major occupational groups reveals:

- **Computer-Related Graduates:** Oregon's computer-related degree graduates totaled 1,247 in 2006; 51 percent of these were bachelor's

Specialized Occupations within the Seven Techology and Market Platforms

Occupation		Oregon Employment, 2004*	Share of platform employment	LQ (within platform)
WOOD & FOREST PRODUCTS				
53-7063	Machine Feeders and Offbearers	3,642	7.00%	2.39
51-9199	Production Workers, All Other	2,121	4.10%	2.78
45-4022	Logging Equipment Operators	1,873	3.60%	1.74
45-4029	Logging Workers, All Other	1,753	3.30%	8.02
49-9041	Industrial Machinery Mechanics	1,555	3.00%	2.16
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	1,401	2.70%	1.76
45-4011	Forest and Conservation Workers	1,341	2.60%	70.72
FOOD PROCESSING & PRODUCTS				
51-9111	Packaging & Filling Machine Operators & Tenders	4,418	11.90%	2.07
53-3031	Driver/Sales Workers	2,930	7.90%	1.87
43-5081	Stock Clerks and Order Fillers	1,347	3.60%	1.92
45-2041	Graders and Sorters, Agricultural Products	963	2.60%	4.43
METALS & TRANSPORTATION EQUIP.				
51-2041	Structural Metal Fabricators and Fitters	1,228	2.50%	2.08
51-2099	Assemblers and Fabricators, All Other	1,198	2.40%	2.01
ELECTRONIC COMPONENTS & DEVICES				
51-9141	Semiconductor Processors	4,550	8.80%	5.13
17-2199	Engineers, All Other	3,911	7.50%	10.31
17-3029	Engineering Technicians, All Other	3,341	6.40%	55.35
15-1031	Computer Software Engineers, Applications	1,734	3.30%	2.87
17-2072	Electronics Engineers, Except Computer	1,339	2.60%	1.65
11-9041	Engineering Managers	1,041	2.00%	1.98
17-2112	Industrial Engineers	1,013	2.00%	1.77
SOFTWARE, COMPUTING, & INTERNET SERVICES				
15-1041	Computer Support Specialists	1,383	5.70%	1.88
51-2022	Electrical and Electronic Equipment Assemblers	1,006	4.20%	1.91
41-4012	Sales Representatives Non-technical and Scientific	634	2.60%	1.99
41-4011	Sales Representatives; Technical and Scientific	584	2.40%	1.64
17-2199	Engineers, All Other	514	2.10%	6.30
BIOMEDICAL TECHNOLOGY				
51-9081	Dental Laboratory Technicians	496	6.90%	1.94
29-2011	Medical and Clinical Laboratory Technologists	367	6.60%	2.43
31-9099	Healthcare Support Workers, All Other	298	5.30%	2.13
29-2012	Medical and Clinical Laboratory Technicians	294	5.30%	1.96
51-2099	Assemblers and Fabricators, All Other	202	3.60%	4.11
51-9199	Production Workers, All Other	190	3.40%	4.31
51-9083	Ophthalmic Laboratory Technicians	185	3.30%	3.24
43-5021	Couriers and Messengers	133	2.40%	2.30
29-1199	Health Diagnosing & Treating Practitioners, All Other	118	2.10%	9.75

*Note: *Oregon industry-occupation matrix data are only available through 2004. Data for Clean Technologies platform are not available due to the inability to classify under the current NAICS industry coding structure.*

degrees and 30 percent were associate's. Together these bachelor's and associate's degrees comprise the minimum skill requirements to fulfill the broad range of occupations in computer related fields. For a more "competitive" workforce in computer fields, it is critical to have graduate level students. The supply of all graduates is down 23 percent since 2003; and though this is not as large a decline as at the national level (down 31 percent), it is substantial indeed and reflects the major shift away from computer-related degree programs following the dot.com bust of the late 1990s and early 2000s. In combined associate and bachelor degrees, Oregon declined by 21 percent since 2003, while graduate degrees were down 18 percent.

- **Engineering Graduates:** Oregon is successfully increasing its production of engineering degrees—up 15 percent overall since 2003, a slightly greater rate than for the U.S. as a whole. In 2006, Oregon institutions awarded 1,053 degrees and certificates in fields that translate into engineering occupations. Nearly all of these degrees are bachelors (71 percent) or graduate degrees (27 percent). To meet a "minimum" skill level for engineering positions a bachelor's degree is required, while a graduate degree sets out a competitive level. Engineering bachelor's degrees have increased by 19 percent since 2003, while graduate degrees rose by only 3 percent.
- **Engineering Technician Graduates:** Degrees and certificates highly related to engineering technician jobs number 350 in Oregon in 2006 and more than half (53 percent) graduate with an associate's degree from Oregon's community colleges. These programs tend to be job-specific by nature and train students to perform key technician tasks. Oregon's institutions have seen a steep drop in this pool of graduates since 2003, with degrees/certificates dropping by 54 percent.
- **Production:** Based on current industry profiling, most production jobs in Oregon do not require much, if any, formal higher-education, relying instead on work experience and on-the-job training. Oregon's postsecondary institutions are, however, producing increasing numbers of graduates of associate's and certificate programs that fill production jobs requiring a higher-end skill set. Of the 501 production-related graduates in 2006, 83 percent were awarded an associate's degree or certificate. Though a modest base of graduates, it is up 38 percent since 2003 compared with a decline across these programs nationally. This trend bodes well for the state, as more companies begin to move to high performance and require higher skill sets of their production workers. Also, the more highly trained production workers will be well positioned to move into technician level positions, as older workers begin to retire.

Changing Nature of Work

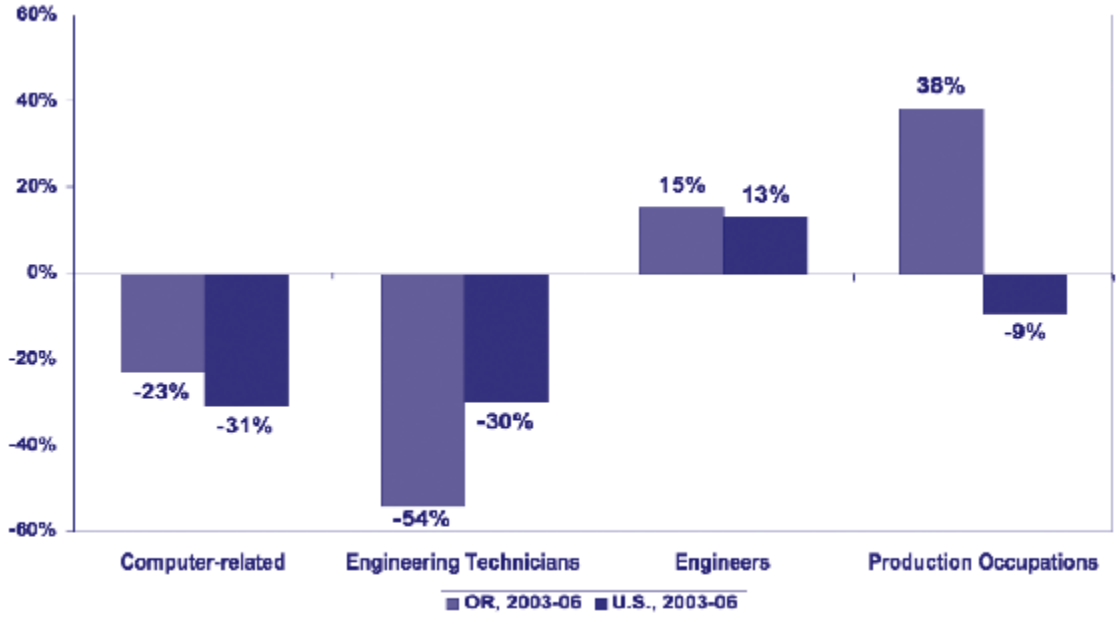
"The major force creating the skills gap…is the changing nature of work. Virtual work-teams are being formed around mission critical projects. The skills gap is a by-product of a knowledge- and innovation-fueled global economy in which specialized skills needed to succeed are highly coveted. Rapidly mobilizing and capitalizing on a company's best talent has become a strategic imperative and workers can no longer be treated like interchangeable or disposable parts."

Dave Lefkow, Jobster

Registered Apprenticeship

The registered apprenticeship system, sometimes referred to as "the other four year degree" is another important source for addressing the skill short-

Change in Total Graduates/Degrees in Fields that Map to Major Occupations, Oregon and the U.S., 2003-06



Source: Battelle analysis of National Center for Education Statistics (NCES) award data, 2003 and 2006.

ages. While apprentices are technically already employed, and therefore would not figure directly in a supply-demand scenario, the capacity of the system to graduate industrial apprentices is a critical component of the post-secondary education and training system.

The Oregon Apprenticeship and Training Division identifies 28 apprenticeship industrial trade program areas, including but not limited to: air frame and power plant mechanic, equipment operator, machinist, maintenance mechanic, programmable controller technician, stationary engineer and tool and die maker. Many of these apprenticeship areas cross walk directly with specialized and high-demand occupations that cut across the technology and market platforms.

The processes and systems are in place to recruit and train industrial apprentices. Employers that are interested must be registered as training agents with the Division, and select apprentices from among their own employees to participate in the training and advancement opportunity, using fair and nondiscriminatory approved selection methods.

However, while the infrastructure exists, the numbers of registered apprenticeships in industrial trades is very low. Based on data supplied by the Apprenticeship and Training Division, fewer than 500 individuals are currently enrolled in formal apprenticeship programs in trades that support the technology and market platforms. Enrollments are as follows: Agriculture and Food Processing (59); Metals and Transportation Equipment (186); Forestry and Wood Products (122); Clean Tech (4) and "High Tech" which includes electronics and information technology (0).

The lack of registered apprentices in critical industrial occupations is a key factor in the state's overall capacity to address the skilled worker short-

KNOWLEDGE SUPPLY CHAIN

A decade ago the National Alliance of Business advocated a talent pipeline development concept that was ahead of its time. To stay competitive, they argued, U.S. companies make a science of pulling together the right supplies at the right time in the right place.

What would happen, they questioned, if companies could apply this process, known as supply chain management, to *people*? **What if talented workers with the right skills were easy to find and ready to perform when companies needed them?** Employers suggested likely baseline benefits would include: a minimum 20 percent reduction in the cost of finding skilled workers; a 50 percent in cycle time to deliver products and services; etc.

From a "Push" to a "Pull" System

The Knowledge Supply Chain concept requires a paradigm shift. Rather than education and training providers "pushing" people out into the world of work, regardless of their skills, businesses help create demand-driven systems by reaching deeper into the system to "pull" out people with the skills they need.

This orientation supports the "priming the talent pipeline" concept because it is built on a platform of strong business, labor, government and education partnerships. Business and labor work side-by-side with educators at all levels to open workplaces for learning, shape curriculum, and spell out workplace specifications. It promotes a "grow your own" strategy and joint ownership of addressing the talent development challenges.

age in the critical areas of production and technician level workers. As skill requirements continue to rise, more advanced training beyond high school will be required. While formal, post-secondary training may be required for some occupations, the apprenticeship model of structured on-the-job training plus applied, hands-on related instruction will be critical for others.

Public Delivery System Infrastructure

In recent years Oregon leaders have worked hard to position the state to be a winner in the global economic race through targeted investments in increasing talent, technology and innovation. A number of critical new initiatives have been launched that build on and enhance the overall education and workforce infrastructure of the state.

In order to evaluate the capacity of this infrastructure, a set of criteria was developed against which to compare Oregon's current position. These criteria were synthesized from three recently released reports developed by the National Governors Association (NGA) as part of its multi-year initiative to better position states to compete in the world marketplace relative to economic development, workforce development and innovation. They included: A Governor's Guide to Cluster-Based Economic Development, A Governor's Guide to Building State Science and Technology Capacity, and a Governor's Guide to Creating a 21st Century Workforce. Key initiatives undertaken in Oregon were then mapped against the NGA recommendations, as summarized in the chart on the next page.

Oregon has developed an impressive infrastructure for building and delivering the next generation of workforce development: the talent pipeline. The state has a long history of innovation in the areas of workforce and education, and over the past several years the state and local workforce partners in both the public and private sectors have made some smart decisions about how to leverage limited resources. Partners at the regional level also enjoy extraordinary levels of collaboration.

NGA State Policy Recommendations	Major Initiatives in Oregon
• Develop a cluster-based approach to economic development • Link workforce development to economic needs	• Adoption of a traded-sector focus and cluster-based framework for economic and workforce development activities across all state agencies and alignment of resources
• Work with networks of firms to promote cooperation & leverage private investment • Target investments to clusters • Organize service delivery around clusters	• Targeting of investments to industry-specific and high performance consortia • Statewide investments through the Statewide Opportunity Fund in three major industry focus areas: Clean Technologies, Manufacturing and Health Care** • Provided training and support to economic and workforce development practitioners in identifying and providing services to business clusters regionally.
• Build on core strengths in existing and emerging industries • Invest in specialized research and research facilities • Catalyze knowledge transfer and technology commercialization	• Creation of Oregon Inc. to cultivate new economic ecosystems that leverage Oregon's inherent strengths and help expand technology-based markets for Oregon's companies • Increases in funding for engineering related programs through the Engineering and Technology Industry council (ETIC)
• Build a stronger education pipeline to produce trainable graduates who have strong foundation skills	• Increased requirements for high school graduation • Creation of the Education Enterprise to create a seamless transition across K-20 education • Funding restorations for K-12, community colleges, universities and other targeted programs such as Head Start • Implementation of the Expanded Options program for qualified high school students to earn postsecondary credit. • Made student transfer and dual enrollment procedures more accessible to students • Provision of two years of mentoring for K-12 teachers/administrators to stop high rate attrition during early years of employment
• Strengthen work supports including education and training to promote employment retention and career advancement • Enhance workers' ability to manage their own careers • Expand/create incentives for continuous learning • Create pools of specialized talent	• Development of a strategic workforce plan by the Oregon Workforce Investment Board: *Winning in the Global Market* • Continued progress of state and regional Workforce Investment Boards to create demand-driven, responsive delivery systems • Establishment of the Employer Workeforce Training Fund focused on capacity-building through strategic investments in high growth industry sectors, workforce training and retention of living wage jobs • Expansion of Career Pathways to all community colleges to provide "chunked" curriculum, accelerated formats and easy access to working adults or the unemployed to upgrade skills • Significant increases in the Oregon Opportunity Fund, a needs-based program for college students • Identification and promotion of effective models of work-based learning, such as the successful Multiple Engineering Cooperative Program (MECOP) • Launched pilot efforts to develop and implement a Career Readiness Certificate

** *These investments have resulted in (1) Development and implementation of Oregon's Manufacturing Workforce Strategy, that focuses on promoting high performance consortia statewide, providing private sector guidance to workforce system efforts, and promoting the importance of manufacturing to the state's economy; (2) Establishment of the Oregon Healthcare Workforce Institute, a public private entity focused on research the workforce needs of the healthcare industry and (3) Funding for the Sustainable Oregon Workforce Initiative to identify workforce needs in of the emerging clean energy industry.*

At the same time, however, the hard truth is that over the past decade Oregon has not invested in the education and training of its human resources as aggressively as have many other states and industrialized nations. Compared with other states that have consistently maintained a human capital agenda, Oregon is in a "catch up" posture. Moreover, this lack of investment may be compromising Oregon's position relative to overall educational attainment, as summarized below.

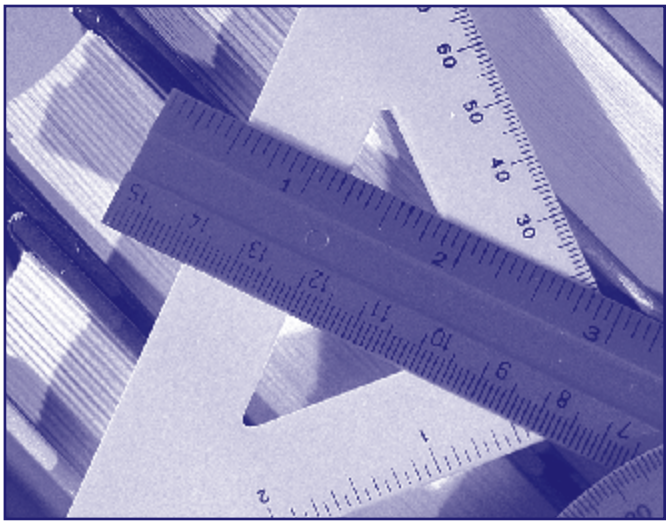
Educational Attainment and Other Key Factors

The Oregon Progress Board's 2007 Benchmark Report continues to show that Oregon faces considerable workforce challenges.

- Educational attainment of adults is still lagging:
  - "High School" Completion Rate in 2006 was 90.4 percent, below the 1996 level of 91.1 percent and well below the target of 93 percent set as a goal for 2005
  - "Some College" Completion has been stagnant since 1996; the 59.6 percent level in 2006 was well below the target of 70 percent set as a goal in 2005
  - "Post-Secondary Credentials" remains unmoved since 1998 with just under 30 percent of the adult population completing even an associate's degree or occupation-related credential
- Few Oregon workers receiving job training:
  - Labor Force Skill Training: Only 33 percent of Oregon's workers received 20 hours or more of training in 2006—well below the target set in 2005 of 56 percent.
- Some improvements seen in K-12 student performance, but not sufficient to meet benchmarks:
  - 8th grade math – 66 percent of eighth graders achieved established skill levels in 2006, which was up from 49 percent in 1997; 2005 benchmark of 69 percent not reached
  - 8th grade reading – 66 percent of eighth graders achieved established skill levels in 2006 up from 56 percent in 1997; 2005 benchmark of 71 percent not reached

Moreover, Oregon Progress Board's 2006 Report on Progress of Oregon's Racially and Ethnically Diverse Population presents data revealing that the state's changing demographics—led by strong growth in the Hispanic population—is likely to result in even lower educational attainment for major segments of Oregon's workforce of the future. Against this backdrop, the Oregon Business Plan 2007 Competitiveness Index reports that Oregon ranks lower than a majority of the states for its primary and secondary education spending per pupil, government expenditures on higher education and the number of students per high-speed computer.

Despite its impressive infrastructure, educational attainment data suggest that Oregon faces challenges on multiple fronts relative to its capacity to meet future workforce requirements. The next section of the report outlines the major gaps identified through the integration of both quantitative and qualitative data and information gathered during the course of this inquiry.

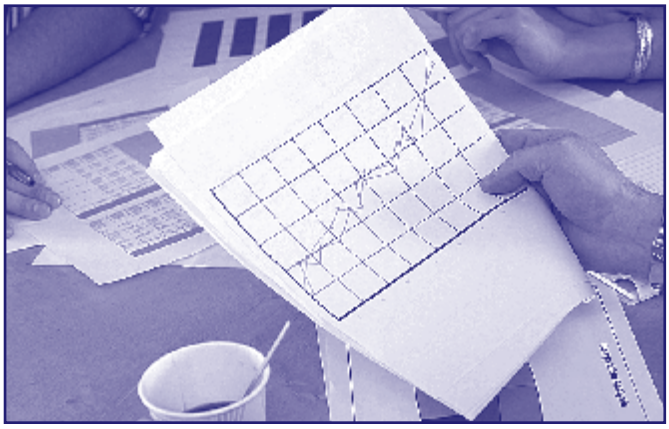


What are the Major Gaps in the Workforce System?

Aligning a dynamic workforce and its moving targets of labor supply and demand is akin to fine-tuning a fast moving train. There are inherent challenges in reconciling current data sources regarding supply, which have their own shortcomings, with projections of future demand, given the rapidly changing nature of technology and the modern workplace.

While no one has a crystal ball in terms of projecting the future, what is abundantly clear is that a demand-driven education and workforce training system must be agile—able to respond quickly to the rapidly changing demands of the global economy. It must be grounded in qualitatively different kinds of partnerships than in the past among business, labor, education, government, elected officials and other key policy makers at the regional and state levels. It must aggressively communicate, to educators, students, and working adults, the career opportunities available, the importance of life-long learning, and the resources available to help individuals access that opportunity.

This *Future Workforce Needs Analysis* has examined the current challenges, needs, and capacity in Oregon's workforce system and has provided a broad new lens, in the form of technology and market platforms and their underlying occupations, which will likely drive future workforce needs. In working to align supply and demand it is critical to work through those gaps in the system that are apparent from this assessment. This section will present a framework for understanding the state's demand for the occupations likely to drive the future economy and will assess alignment among the major occupational groups as well as address other systems issues.



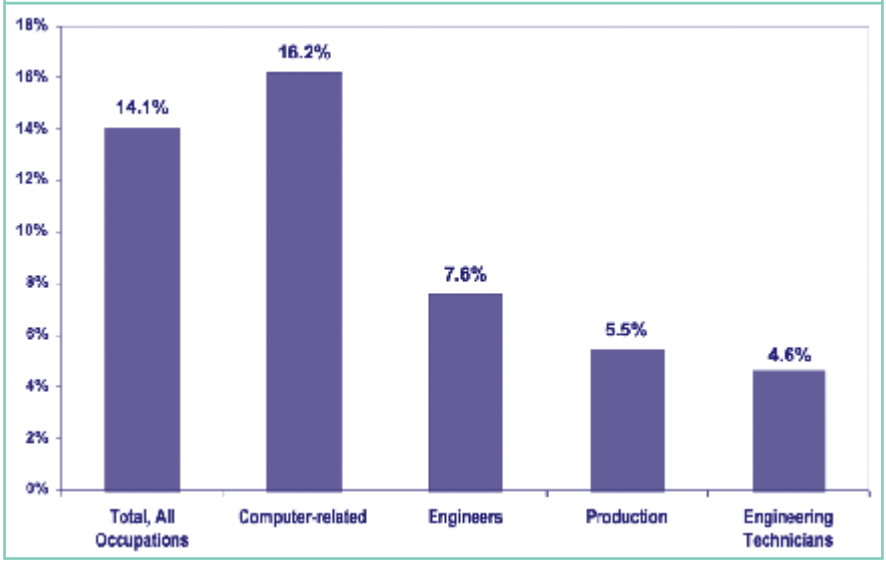
Forecasting Occupational Demand in Oregon

A traditional and useful proxy for assessing the demand for future workers is provided at the national and state levels through the biennial occupational employment projections overseen by the Bureau of Labor Statistics and state employment departments. By projecting occupational demand through both expected net growth and replacement jobs out 10 years, the data provide a useful guide for labor market analysis and workforce resource allocation going forward. One must understand, though, the inherent difficulties involved in trying to project future demand for labor given the complexities of national and state economies and the fact that emerging, cross-content occupations (i.e., health informatics and embedded systems engineer) are not even listed in current occupational databases. Nonetheless, projections provide a starting point for this and similar discussions of the future.

The Oregon Employment Department produces the state's forecast on a timely production schedule, releasing its 2006–2016 projections well ahead of the nation and other states[2]. The state has freedom to adjust for state-specific "change factors" in the eco-

[2] *Oregon Employment Department, "Employment Projections by Industry and Occupation, 2006-16," December, 2007 (http://www.olmis.org/pubs/projections/projections.pdf)*

Oregon Projected 10-year Employment Increased in Major Occupations, 2006-16



nomic models as well as to adjust for key company and industry knowledge at a local level that make its forecasts highly Oregon-specific and generally more state-specific compared with the methodology in other states. Key findings relating to the occupational structure designed for this report are presented here.

- Overall occupational growth in Oregon is forecast over the 2006 to 2016 period—despite current concerns of a looming economic recession in 2008—to be a robust 14 percent or nearly 250,000 jobs added during the 2006 to 2016 period.
- Among the major occupational groups seen as drivers of Oregon's future workforce, the strongest growth is projected among computer-related occupations—a 10-year growth projection reaching over 16 percent.
- The OED projects steady growth for engineers (7.6 percent), production workers (5.5 percent), and engineering technicians (4.6 percent).

Job growth is but one component of future workforce needs and does not alone drive a labor forecast. Annual job demand also reflects the need for replacement workers, one that is generally much larger than pure growth needs and rising with the aging of the workforce and impending retirements of baby boomers. Though it's not expected to grow the fastest, the future demand for production workers in Oregon is striking when one factors in replacements. Likewise, the bulk of annual demand for engineers will be in replacing existing workers. A strong growth forecast for computer-related occupations translates into annual job creation that exceeds even replacement needs.

Assessing Labor Supply and Demand

The traditional approach to assessing labor supply versus demand applies degrees and certificates awarded by Oregon's institutions of higher education to projected demands detailed in the occupational forecast.

Several caveats or limitations must be understood with this quantitative approach. On the supply side, a crosswalk of degrees to occupations cannot capture graduates that enter a much different line of work, for example, an individual with an engineering degree who enters into law or medicine or a general business profession.

For higher skilled computer-related and engineering fields, there is also a difference between the full supply of recent graduates that includes those with highly competitive graduate level degrees and those with minimum education for a particular profession.

On the demand side, the published OED forecast provides a base "traditional" scenario for forecast-

ing annual job needs in Oregon. These projections point to very large annual needs for production workers, about 4,000 per year (largely for replacements). Computer-related annual needs register about 1,000 per year; engineers at 537 per year; and technicians at 282 per year.

Projected Annual Job Openings for Oregon by Major Occupational Groups, 2006-2016 Forecast			
Major Occupational Group	Projected Annual Growth Openings	Projected Annual Replacement Openings	Total Annual Openings
Production	780	3,293	4,073
Computer-related	587	479	1,066
Engineers	141	395	537
Engineering Technicians	50	233	282

In order to more accurately assess demands for the major occupational groups, this approach was "expanded" to include demand for workers in additional occupations outside of the specific occupational coding structure.

For example, a number of related jobs outside the specific engineering occupations are likely to be filled by graduates such as engineering managers, postsecondary engineering teachers, materials scientists, and sales engineers. With this rationale, a second "expanded" approach was developed to capture this additional labor demand. (For a full listing of both core and expanded occupations used here, see Appendix 1)

It is important to underscore again that not all graduates of state institutions will remain in the state following graduation or completion of a formal credential; however, they represent a primary source of talent to fill both new and replacement jobs. Conversely, other factors impact supply, such as the "in-migration" of skilled workers from other states and the return of qualified workers to the labor force after periods of nonparticipation. These factors are virtually impossible to measure.

Bringing together demand for the occupations and supply of new graduates suggests a variety of scenarios set out in the table below. The table lays out a range of possible supply vs. demand situations facing Oregon:

- Traditional forecast of occupational demand vs. full supply of graduates across all degree levels;

High-Demand Detailed Occupations

Diving deeper into the state forecast reveals those "high-demand" occupations that lead each of the major occupational groups assessed here from a more detailed perspective. Occupations with the largest overall job needs—for meeting both growth and replacement—are considered to be most in demand. Overall 10-year projected job openings are in parenthesis.

- **Projected high-demand occupations, computer-related:**
  - Computer Support Specialists (2,181)
  - Computer Software Engineers, Applications (1,675)
  - Network & Computer Systems Admin. (1,405)
  - Computer Programmers (1,322)
  - Computer Specialists, All Other (1,262)
- **Projected high-demand occupations, engineers:**
  - Mechanical Engineers (1,108)
  - Civil Engineers (985)
  - Industrial Engineers (776)
  - Electronics Engineers (610)
  - Computer Hardware Engineers (535)
- **Projected high-demand occupations, engineering technicians:**
  - Industrial Engineering Techs (836)
  - Electrical & Electronic Engineering Techs (820)
  - Civil Engineering Techs (428)
  - Engineering Technicians, All Other (355)
  - Mechanical Engineering Techs (215)
- **Projected high-demand occupations, production workers:**
  - Assemblers, Multi-task or Team (3,625)
  - Production Workers, All Other (2,754)
  - Supervisors & Managers of Production (2,472)
  - Welders, Cutters, Solderers, & Brazers (2,104)
  - Production Worker's Helpers (1,929)

Assessing Oregon's Demand for and Supply of Workers in Critical Major Occupations

Demand-Supply Scenarios	Major Occupational Groups			
	Computer-Related	Engineers	Engineering Technicians	Production
Demand Side				
Traditional Forecast of Annual Job Openings*	1,066	537	282	4,073
Expanded Forecast of Annual Job Openings	1,369	804	375	4,138
Supply Side				
Full Supply: Total degrees & certificates 2006	1,247	1,053	350	501
Supply of Graduates w/ Minimum Education**	1,004	752	N/A	N/A
Alignment: Demand & Supply				
Traditional Demand, Full Supply	181	516	68	-3,572
Traditional Demand, Minimum Education	62	215	N/A	N/A
Expanded Demand, Full Supply	-122	249	-25	-3,637
Expanded Demand, Minimum Education	-365	-52	N/A	N/A

**Note: Demand data represent OED forecast of annual job openings 2006-2016 and include both growth and replacement jobs. **The supply of those with "minimum" education credentials includes adjustments to both computer-related and engineering graduates for minimum standards. For computer-related jobs this minimum is an Associate's or Bachelor's degree; for engineering jobs this minimum is a Bachelor's degree.*

- Traditional forecast of occupational demand vs. minimum education levels for graduates;
- Expanded forecast of occupational demand vs. full supply of graduates across all degree levels;
- Expanded forecast of occupational demand vs. minimum education level for graduates.

Supply-Demand Gaps for Mega-Occupational Groups:

Under the expanded approach, the state shows generally strong alignment in terms of numbers between projected demand and supply, as measured by the full supply of post-secondary system graduates, across three of the mega-occupational groups. The clear exception is among production-level workers, where vast gaps of over 3,500 workers per year are projected. While the majority of these workers currently are recruited from high school or off the street, the sheer postsecondary shortfall commands attention.

- **Computer-Related:** Under a traditional view of occupational demand both under a full supply (all degrees) or minimum education supply (not including graduate-level degrees awarded), supply is approximately aligned with expected demand. However, using a more expanded definition of occupational demand for computer-related jobs, including graphic arts, management and teaching positions, suggests that there might be significant shortfalls in supply compared to the expanded demand. Further, this shortfall would be much more pronounced if considering only the much smaller supply of graduates with competitive degrees.
- **Engineers:** Under both the traditional and expanded scenarios, the analysis shows a slight oversupply in engineering talent in the state, but, as discussed earlier, this may be mitigated by the return of foreign students to their native countries. A small undersupply is indicated when the expanded forecasted demand is compared to the supply of those with a minimum education, a bachelor's degree in engineering. As with computer-related, the undersupply is greatly exacerbated if only the supply of master's level engineers is considered.

- **Technicians:** Data suggest general alignment between supply and demand. However, growth projections in this area over the 10-year horizon are modest (projected 4.6 percent increase). If the future looks more like the recent period of economic growth, this may be a problem area for Oregon, particularly because of the steep decline in education programs in technician fields.
- **Production:** The supply-demand analysis shows a large structural gap in the production area. Data suggest that the output of certificate and associate's degrees, though they increased by 38 percent from 2003–2006, is still very small, at 501 credentials.

Factoring the output of the current apprenticeship registrations in industrial trade areas adds only approximately 500 skilled workers into the mix. Since these apprentices are already employed, they technically do not help close the supply-demand gap in the area of production workers. However, as a long-term strategy for building skill capacity among this critical production workforce, the low level of industrial apprenticeships directly impacts the capacity of the overall delivery system to meet the increasing technical skill needs of the employer community.

Skills Mismatch Gaps for Mega-Occupational Groups

This quantitative approach to supply and demand alignment, based on levels of degrees awarded and projected annual job openings, is important, but must be supplemented with qualitative information. The following summary highlights the qualitative trends identified in each of the four mega-occupational categories, based on input from trade associations and cluster organizations.

- **Computer-Related:** The supply versus demand data suggest that there may already be a considerable undersupply of computer-related graduates to meet annual job demand, which is only exacerbated by the mismatches identified in industry association interviews regarding the types of skills required in the workplace and skills being taught relative to platforms, software languages and databases.
- **Engineers:** Oregon has been successful at increasing its supply of engineering talent over the past several years, but a question looms relative to the level of preparation of graduates to drive innovation across the technology and market platforms. Moreover, there appear to be few linkages between the future engineering talent in the state and many of the more traditional platform areas, including food processing, metals/transportation equipment, and wood products, all of which have embraced an agenda of enhanced innovation and increased productivity.
- **Technicians:** Engineering technicians are not projected to have large numbers of annual openings based on forecasts, therefore a major gap between supply of current graduates and future demand does not emerge. Employers suggest, however, that this scenario could change quickly, especially if more companies adopt high performance practices and ratchet up the skill requirements within their workplaces, requiring more technician level workers.
- **Production:** The supply-demand analysis shows a large structural gap in this area. While the primary source of workers in this area is currently the secondary school system and workers off the street, the lack of fundamental workplace skills and the lack of information about career opportunities pose a serious challenge to filling the huge replacement demand. While current employer demand for production workers with some postsecondary education is moderate, it will likely increase in the future, given increased automation and the changing nature of the workplace.

Industrial Apprenticeship Gaps

Based on a report developed by the Oregon AFL-CIO in December, 2006, reflecting input from key stakeholders, discussions with the Jobs and Economy Committee, research and conversations with state agency staff, the following were among the gaps identified in the current industrial apprenticeship system:

- New hires lack basic skills necessary to move into existing apprenticeship programs, especially in math and science knowledge and application skills;
- Lack of candidates within the plants who meet minimum qualifications force employers to look outside, where it is still a challenge (or just not bother);
- Registered industrial programs (such as welding, mechanics, instrument techs) are underutilized by employers, the management argument being—in good times, it takes too long to train, in bad times we can't afford it;
- Special needs in rural areas included lack of connections with secondary schools, lack of classes at community colleges, lack of prepared applicants, lack of applicants who can pass drug tests and/or are willing to work other than day shifts;
- Employers are interested in cross-training but unions see it as a possible means of by-passing negotiated seniority agreements.
- Union representatives wrestle with the difficulties of maintaining worker protections and job integrity, while acknowledging the need to update traditional job descriptions to align with new technologies and work processes.

The report concluded with sobering language about the impact of skill gaps: "The resistance of employers—even unionized employers—to investing in longer-term training programs for their workers is a difficulty not easy to overcome…Among companies that have operated [apprenticeship] programs in the past, many have reduced the size of their programs or are not bringing in new apprenticeships, in spite of the growing need for skilled workers…Clearly, shortages may threaten the ability of companies to continue to operate in the state. More immediately, such shortages may lead to increased down time, lost production, longer down time repairs, higher costs per unit produced, more injuries to maintenance workers, higher compensation claims, and severe barriers when trying to introduce innovations like computerized maintenance programs, electronics and PLCs." [3]

Foundation Skills Gaps

Much of the pipeline of students exiting Oregon's public K-12 education system is perceived to lack the fundamental skills necessary to be productive in workplaces that compete in the national and global economy. This perceived lack of preparation was voiced repeatedly by industry leaders across all seven technology and market platforms. It spanned a range of issues, including, but not limited to: lack of basic reading, math and communication skills; lack of essential workplace skills such as critical thinking and problem-solving; lack of agility and willingness to learn, a fundamental requirement of the dynamic workplace; and lack of critical science and technology foundations required to pursue post-secondary education and careers in technology, especially among women and minorities.

[3] *Oregon AFL-CIO, Final Report to Oregon Workforce Investment Board, Grant # 06115.*

Systems Gaps

As discussed in the capacity section, Oregon has an impressive infrastructure for building and delivering the next generation of workforce development: the talent pipeline. In aligning recent public efforts against a set of components identified by the National Governors Association in the areas of cluster-based economic development, 21st century workforce systems, and strategies for supporting emerging technologies, the state fares well. And public partners at the regional level generally report high levels of collaboration.

Oregon has most of the necessary policy and structures in place to compete successfully in the global marketplace, based on national best practice, BUT, results of interviews with public and private leaders as a result of this study, complemented by additional work completed by Key Links in Oregon over the past five years, suggests the following:

- **Approach to Workforce Development**: In terms of general policy and budget development, public education, higher education and workforce development operate as generally disconnected entities. While coordination of efforts has increased in recent years, in many forums across Oregon the term "workforce" is still associated with federally-funded programs that have historically been associated with moving disadvantaged individuals into the labor force. This narrow view is in stark contrast to more progressive states which recognize that developing the resident **talent pipeline** of agile, skilled workers needed to fuel the drivers of the future economy spans the efforts of multiple education and training systems, both public and private.
- **Pilot Mentality:** Oregon has a rich history of supporting pilot programs and identifying effective models. Unfortunately, many proven effective pilots are not replicated, nor are they adopted systemwide. There are likely many factors, including, but not limited to, available funding to sustain effort and strong commitment to local and regional autonomy vs. "top down" initiatives. This general orientation often results in a failure to leverage scarce resources for the benefit of building statewide capacity.
- **Levels of Funding:** Proven effective strategies are often underfunded, so they never get to scale and are not sustained. While the state has made significant progress in developing initiatives that address targeted sectors, such as heath care and manufacturing, and provided multiple-year funding support, often the levels of sustained funding handicap initial investments in achieving full potential. Case in point, the Manufacturing Workforce Strategy invested in the establishment of "learning networks" of small and mid-sized companies struggling to adopt high performance/continuous improvement practices. Unfortunately funding significantly decreased in year two, leaving fragile regional groups of mostly small, traded sector companies struggling to achieve sustainability. Many states provide three-year funding support through gradual declining formulas so business-driven consortia can have time to create value, charge dues and become self-sufficient. Underfunding tends to compromise the ultimate return on the initial investments.
- **Sources of Funding:** Several critical programs are funded from restrictive sources which inhibits innovation and creativity in program design and delivery. For example, 32 states have a combination of state funded training programs and training tax credits, ranging in size from $10 – 35M. Oregon's Employer Workforce Training Fund (EWTF), $5.6M, which supports upgrading the skills of current workers, is funded totally from federal dollars, which severely limits the kinds of activities that can be undertaken. An evaluation of the EWTF completed in 2005 highlighted the need to secure additional, flexible and longer term sources of funding, emphasizing the fact that the level and source of funding for Oregon's initiatives, while significant, falls short of competitor and comparative states, creates

barriers in terms of maximizing the potential of the effort, and puts Oregon at a competitive disadvantage. Additional sources of flexible, multi-year funding should be pursued with vigor, including state general revenues, lottery proceeds, UI tax offsets and interest accounts, and state bonds.

- **Communications/Messaging:** This study identified numerous gaps in critical "messages." The primary gap is the pervasive expectation that to be "valuable" all students should go directly to a four-year college after graduation from high school. Employers point to the fact that most high school counselors provide "guidance" about college entrance requirements, but know virtually nothing about the requirements of the modern workplace. A second gap is lack of information about the growing availability of good "middle-skill" jobs that require more than a high school diploma but less than a college degree, as well as the continued needs in computer-related fields to offset the (dotcom) perception that jobs are dwindling. A critical message to all adults is the importance of lifelong learning, including shared responsibility in gaining more and better education and effective ways to plan, finance and complete that education. Finally a message gap for businesses is the importance of continued investment in keeping worker skills current in the rapidly changing marketplace.

The table below summarizes the major gaps identified as a result of this research inquiry relative to the talent development needs of employers in technology and market platforms. The letters associated with each gap will be used to cross-walk with recommendations in the following section.

	Major Identified Gaps/Needs	Overview
A	Lack of 21st Century Foundation Skills among high school graduates, post-secondary students and current workers	Foundation skills include applied math, reading, science and technology, as well as workplace skills including creativity/innovation, ability to learn, critical thinking, decision making, teamwork, communications, technology applications and lean/continuous improvement.
B	Significant need to increase supply of production workers (3,500 per year for ten years)	The gap between supply and demand for skilled production level workforce is already significant, and will continue to increase over time, with new clean tech employers "stealing" skilled workers from other sectors.
C	Growing need to increase technician level certificate, AA and apprenticeship program enrollments	As more companies that compete in global markets adopt high performance/continuous improvement practices, skill requirements will increase and more structured training will be required. Current output in community college and industrial apprenticeship programs lags well behind demand.
D	Need to address skills mismatch in computer-related program areas	Given the fast pace of changes in computer technologies, applications and software, a persistent concern is whether graduates in computer related fields have the right skills to meet the needs of industry
E	Need to strengthen employer linkages in engineering programs	Engineering is a key skill set for both process and product innovation. Oregon's traditional manufacturing industries—wood products, food processing and metals—all face significant challenges in advancing process and product innovation, yet the connection between these industries and the growing base of engineering talent needs to be strengthened.
F	Eliminate stovepipe approach to talent development	While coordination has increased in recent years, the public K-12, post-secondary education and federal workforce systems still function relatively independently. A systems approach linked closely to economic development and the talent development needs of businesses in the seven technology and market platforms is required.
G	Move beyond pilot mentality/ increase funding levels	The decade-long history of underinvestment in human capital development has left many systems compromised. Bold—but targeted—investment are needed to move Oregon beyond its current "catch up" status to position its talent development systems to function at full capacity.
H	Broaden funding sources	Policy leaders and decision makers must think outside the box and be willing to explore new, flexible sources of funding for talent development opportunities. Support for new and/or expanded initiatives must reflect joint public/ private investment.
I	Improve messaging	Lack of information and misinformation abound regarding high wage career opportunities; the pervasive message is that "value and success" equal college directly out of high school; the critical importance of life long learning is not communicated to the general public

Leadership Challenges of the Future

- ***Leveraging Rapid Change.*** *The game is not managing or coping with change, but leveraging the rapid change all around us so that we move in preferred directions.*
- ***Creating Learning Organizations and Communities.*** *Organizations with people who learn continuously will do the best.*
- ***Moving Beyond Continuous Quality to Sustained Innovation.*** *Continuous improvement will matter more than ever, but continuous innovation in product and service will be critical to gaining competitive advantage.*
- ***Managing Interconnectedness.*** *More stakeholders must be included in more decisions and old boundaries dissolved.*
- ***Re-Training for Knowledge-Based Work.*** *An increasing percentage of U.S. jobs will require scientific, technical and/or advance thinking skills. All jobs will require the learning of new knowledge, continuously. We under train our workforce today.*
- ***Environmental Stewardship:*** *Economic success and caring for the environment go hand-in-hand and make good business besides. A sustainable economy is a requirement.*

Glen Hiemstra, Futurist (See: Futurist.com)

What Should We Do?

This section offers implications and recommendations to policy leaders about how to position Oregon to maximize the inherent strengths of the seven identified technology and market platforms through strategic and targeted investments in talent pipeline development. It offers a generalized set of implications/recommendations for each of the four mega-occupational areas, followed by a set of more specific strategies and actions to be taken beginning immediately and over the next two to five years to address identified needs. This section concludes with additional specific recommendations for overall systems-building.

Winning in the Global Market

While this is fundamentally a research paper, it is also a message of opportunity and choice. Oregon finds itself in the enviable position of having a relative robust, increasingly diversified economy, with several highly specialized traded sectors in Wood & Other Forestry Products; Electronics & Advanced Materials; Agricultural Products; and Processed Food and Beverage Products. Oregon particularly stands out in terms of economic competitiveness in that ALL traded industry sectors outpaced national trends in employment growth from 2001 to 2006.

These traditional traded sectors, in combination with emerging industries in biofuels, green building, wave energy, biosciences, network/ homeland security and open source technology are driving strong economic growth across the state through seven technology and market platforms that provide linkages and interconnections among the thousands of businesses in Oregon that sell their goods and services in the global economy.

At the same time, Oregon is generally well positioned in terms of its infrastructure to build the

talent pipelines needed to drive innovation and productivity in these seven technology and market platform areas. Over the past several years Oregon has adopted a traded-sector focus and cluster-based framework for economic and workforce development policies and practices; developed a strategic workforce plan, Winning in the Global Market; established an Employer Workforce Training Fund focused on capacity building in high-growth industry sectors and current workforce training, increased funding to stabilize and enhance public education systems pre-K-16, and implemented other critical strategic workforce initiatives.

The combination of a strong technology-based, specialized sectors PLUS a talent pipeline of agile, skilled workers to drive innovation and productivity growth within those targeted sectors will be key to Oregon's future competitive advantage. This formula will enable Oregon to **differentiate itself** in the global marketplace by cultivating and sustaining specialized areas of expertise where it can be recognized as a world leader.

Each of the seven Technology and Market Platforms emerged with a slightly unique profile in term of their industry technology competencies and industry market specializations. At the same time, however, all seven technology and market platforms, even those in emerging industries, share many of the same needs for talent across four mega-occupational groupings: production, technician, engineering and computer-related.

What this means is that Oregon does not have to pick "winners" from among the potential future drivers of the economy. Investing in the common, shared workforce needs that cut across all technology and market platforms provides an integrated investment framework that can bolster all traded sectors while simultaneously maximizing opportunity for individual sectors to cultivate areas of expertise where they can differentiate themselves in the global market. Additionally, many of the same workforce needs identified in this study also impact other segments of the economy that are more indigenous to the local economy, but nonetheless extremely important, such as construction and transportation, so workers in those sectors also benefit indirectly from the targeted investments.

Those shared workforce needs broadly range from "middle skill" production jobs requiring a high school diploma complemented by additional on-the-job training or industry certification, to technician level workers with typically a two-year technical degree or apprenticeship, to computer-related and engineering workers with four-year degrees and beyond. Addressing this range of skill requirements demands an integrated workforce systems approach, involving the entire educational continuum beginning with middle/secondary schools and community/technical colleges to registered apprenticeship programs and four-year institutions. It requires strong, focused partnerships with business to ensure education and training content is aligned

with current and future skill demands, and that programs are delivered using models and technologies that meet employer requirements.

Business and labor leaders, elected officials, government agency heads, and educational leaders at all levels must adopt an investment framework that views K-12, higher education and the current workforce as an integrated system. The sets of policy recommendations that follow are intended as a package of strategies, each contributing to the overall development of a talent pipeline that will fuel the seven technology and market platforms, with much interconnectedness between and among them.

Recommendations: Mega-Occupational Groupings

Based on the findings, a generalized set of implications/recommendations is offered for each of the four mega-occupational areas, followed by a recommended set of more specific strategies and actions to be taken beginning immediately and over the next five years to address identified needs. This section concludes with additional specific recommendations for overall systems-building. Implementation of these recommendations, which constitute an integrated investment strategy, will help set the course for a "shared prosperity" scenario in Oregon for years to come.

- **Production:** With significant job openings projected over the next decade, there is an urgent need to prime the talent pipeline of production workers to meet immediate growth and replacement needs. Training efforts should be focused on the "cross-cutting" skills needs in production that are common across all Oregon technology and market platforms. Growing clean tech jobs are a good fit for Oregon's present occupational mix and share many of the same skill sets as more traditional industries, but without a more focused effort to increase the supply, clean tech will end up competing for the existing production workforce (it has already begun to happen).
- **Technician:** Technician level workers are a highly specialized occupation group in Oregon, with healthy growth from 2002–2006, but significant fall off in certificate and degree generation and low levels of apprenticeship enrollments. While the current supply/demand gap is not large, that may likely change as more Oregon firms begin to adopt high performance practices, which will likely drive required skills sets higher and blur the boundaries between production and technician level workers. More complex technical environments will also underscore the need for critical workplace skills in creativity, innovation, critical thinking, problem solving, etc.
- **Engineering:** Oregon's academic institutions have been successful in raising the output of engineering graduates in recent years, with new increases in Oregon graduates slightly outpacing the nation. However, at the same time, Oregon's demand for engineers in the workforce grew extremely slowly and is expected to continue at a rate far below the nation. Supply is projected to marginally exceed demand, although this finding may be mitigated by the large number of foreign students who attend university in Oregon and likely return to their native countries following graduation. More work needs to be done both in terms of refining the supply/demand issues and alignment with business needs in this area. The primary opportunities in engineering are to increase the numbers of graduates who are competitively to prepare innovation in the workplace, and to create more and stronger linkages with businesses across the technology and market platforms, with a special focus on the more traditional industries of food processing, metals and wood.
- **Computer-Related:** There is a pressing need to address the sharp fall-off in students pursuing computer-related fields in light of projected strong occupational growth. Updated occupational estimates show computer-related occu-

pations to have the largest annual demand, but degrees awarded in computer-related fields are falling fast in Oregon. Additionally, interviews with employers suggest a need to improve alignment of educational programs in computer-related fields to meet current and emerging needs in the marketplace, e.g., open source software and web services and to provide real-world experiences in critical skill sets such as project management, vertical systems analysis and working in culturally diverse teams.

Priority Actions

This approach, patterned after one advocated by the Oregon Council for Knowledge and Economic Development (OCKED) in 2002, is visually illustrated below. It categorizes specific recommendations based on three levels of priority: immediate, short-term (1–3 years) and longer-term (3–5 years). Recommendations at each level of priority reflect possible actions taken across the spectrum of business, labor, government and education partners, in conjunction with support from elected officials across Oregon. All recommendations are crosswalked with the specific gaps identified (See table on page 44), with priority recommendations addressing the largest number of multiple gaps.

Priority A: Timeframe: Immediate

Goal: Address Critical Occupational Shortages

Strategies:

- Set specific, quantifiable targets for high-demand occupations that cut across Technology and Market Platforms and provide incentive funding to community colleges, registered apprenticeship programs and universities to offer additional programs and increase recruitment efforts (addresses gaps A,B,C,D,E,I on p. 50);
- Address the need for more qualified instructors to teach technical courses in high-demand occupational areas at all levels; one strategy might be to create the nation's first "Retired Skilled Workers Corps" in partnership with business to serve as "Emeritus" instructors (A,B,C,D,E).

Knowledge-Based Jobs in Technology and Market Platforms						
▪ Clean Tech	▪ Biomedical Technology	▪ Electronic Components & Devices	▪ Metals & Transportation Equipment	▪ Software, Computing & Internet Services	▪ Agriculture & Food Processing	▪ Wood and Forest Products
Priority A: Addressing Critical Occupations and Immediate Opportunities					*Immediate*	
Priority B: Building Capacity and Excellence					*Shorter Term (1–3 years)*	
Priority C: Preparing for the Future					*Longer-Term (3–5 years)*	

BENCHMARK PROFILE: CROSS-CUTTING SKILLS PROGRAMS AND CERTIFICATION

There is growing consensus on the necessary skills required for entry-level workers across all high-performance manufacturing workplaces. **Georgia** was among the first states in the country, in 2000, to develop and offer a Certified Manufacturing Specialist (CMS) program through their community and technical colleges. The CMS is a 160 hour course of study (8 weeks full time/6 months part-time) based on cross-cutting skills. Over 2,000 workers have received their certification in the past two years alone, with a commitment of an additional $1/hour in salary from many employers. **Wisconsin**'s Governor recently announced a new statewide manufacturing certification program to assess, train and certify workers in four areas: manufacturing processes and production, safety, maintenance awareness and quality/continuous improvements. The goal is to certify 40% of the workforce by 2016. **Oregon** developed the content for a cross industry certification in 2002, by identifying the overlap of skills and competencies required across five traded sectors. The intent was to support a skill-based, rather than occupation-based, approach to job training that allowed greater portability and transferability of skills across a range of occupations, industries and regions. Unfortunately, implementation of the certification, which was perhaps ahead of its time then, was never funded.

- Adopt a career readiness credential for use by all education and training providers that would signal a "readiness for work" based on specific, standardized criteria; the career readiness certificate would be aligned with the Essential Skills of the high school graduation diploma for application with out-of-school youth, adult entrants to the labor pool, etc. (A,B,C,D,E)
- Aggressively expand and promote Career Pathways education and training opportunities as a systems-building strategy across high schools, community colleges, 4 year colleges and graduate education programs. Priority funding in career pathways development and implementation should be in high-demand, technology-reliant occupations that support the Technology and Market Platforms. (A, B, C, D, E, F, I)
- Expand Career Technical Education and focus on the cross-cutting occupations linked to Technology/ Market Platforms and projected high demand/ specialty occupations (A, B,C,I);
- Double the Employer Workforce Training Fund using flexible dollars to serve as an incentive for more employers in traded sectors to upgrade the skills of their current workers to address advancing technology and changing business practices (A,B,C,D,G,H,I);
- Expand and prioritize training programs in clean technologies that have a documented, immediate need, such as wind turbine and solar that will support the state's sustainability agenda (A,B,C,E,G)
- Adopt a standardized certificate program offered by the community colleges and targeted towards "middle skill" production and technician occupations. This standardized certificate program would emphasize critical foundation academic, employability and cross-cutting technical skills, as well as serve as a recruitment strategy (A,B,C,F,I); and
- Expand successful co-op and internship programs and require greater linkages to on-the-job experiences at all levels of the educational system. To facilitate these co-op and internship efforts, use an "engineering extension service" model to make use of students as part of faculty-led teams in innovation centers to advance the shift to higher value, new product development for these traditional industries (A, D, E G, I);

Priority B: Timeframe: Shorter-Term (1–3 years)

Goal: Building Capacity and Excellence

Strategies:

- Expand programs to strengthen science, technology, engineering and mathematics at the middle, secondary and community colleges, which offer project-based, problem solving curriculum along with experiential learning and extracurricular activities, such as Project Lead the Way, Engineering by Design and CISCO Academy (A, C, E, F, I);

- Establish statewide articulation agreements between public schools and community colleges, which would align local secondary programs with any community college in the state, not just the college in the local jurisdiction (A, B, C, D, F, I);
- Incentivize special emphasis on the Essential Skills component of the new High School Diploma requirement immediately; ensure actual standards and content align with core business workplace requirements and are updated regularly (A,F,I)
- Offer more integrated degree programs to ensure more engineering talent is relevant to key Oregon drivers such as food processing, metals, wood products and clean tech. (A, E, F, I);
- Encourage the adoption of an Oregon employer tax credit in the amount of 50 percent of certain educational investments in critical areas of skill shortage and high demand occupations, up to $2,500 per year. (G, H, I)

BENCHMARK PROFILE: PROJECT LEAD THE WAY

Project Lead the Way (PLTW) was created to address the nation's shortage of science, technology, engineering and math (STEM) professionals. It introduces students to the scope, rigor and discipline of engineering and engineering technology prior to entering a two- or four-year college. Fifty-four (54%) of enrollees plan to study engineering or engineering technology versus 10% nationwide. The pre-engineering/engineering technology program is being offered in over 2200 schools in 49 states this coming year. **Indiana** alone has 230 schools participating. PLTW got off the ground in earnest in **Oregon** two years ago, and is currently operational in 7 high schools and one community college. The Oregon Institute of Technology (OIT), which is the affiliate university, has trained 44 teachers and expects growth in the middle school area this coming summer. Private and public grants help to offset costs and pay for professional development of teachers, but costs are high due to the project-based design and individual schools must elect to participate. The goal is to expand participation to 40–50% of schools in the next several years.

BENCHMARK PROFILE: SUPPORT FOR LIFE-LONG LEARNING

Skills2Compete, spearheaded by the Workforce Alliance, focuses policy makers on the fact that roughly 45% of all job opening nationally until 2014 will be middle-skill jobs, those that require training beyond high school, but not a four year degree, including an associate's degree, occupational certification or an apprenticeship. The **Georgia** Hope Scholarship provides two years of free education and training at public two-year colleges and technical schools to all Georgia residents. An additional merit-based College Scholarship pays for costs of attending a public four-year college for students with a B average or better. **Michigan**'s Promise pays community college tuition for anyone in the state to pursue an associate's degree or to attend a technical training program in a high-demand occupation emerging industry, or entrepreneurship program. The goal is to train 100,000 citizens in three years for high-demand occupations, emerging industries or entrepreneurial endeavors. The **Oregon** Opportunity Grant (formerly the State Need Grant) is the state's largest state-funded program to support students planning to go to college. The program is needs-based and students must meet eligibility requirements for a federal Pell Grant. In 2007 the Legislature approved a major expansion of the program, which gave awards to more than 24,000 in 2005–2006. Yet no program currently exists to support two years of post-high school education for all Oregonians.

Priority C: Timeframe: Longer-Term (3–5 years)

Goal: Preparing for the Future

Strategies:

- Create an "Oregon Talent Skills Bank" to give every Oregon worker access to the equivalent of at least two years of education or training past high school—leading to a vocational credential, industry certification, apprenticeship or the first two years of college—to be pursued at whatever point and pace makes sense for individual workers and industries. (A, B, C, F, I);
- Exponentially advance the understanding of students, teachers and counselors about the changing nature of the workplace—through increased work-based learning experiences such as job shadowing, internships, etc. (A, B, C, D, E, H, I);
- Continue to ensure engineering education programs emphasize: "design" and "new product" development skills; workplace skills in project management, commercial awareness and

customer service with hard skills in advanced technologies; and entrepreneurship (A, D, E, I);
- Emphasize across computer related degree programs the real-world skill needs of project management, vertical industry systems analysis knowledge and working in culturally diverse teams. (A, D, E,)

Recommendations: Systems-Building

Oregon's success in ensuring it has the talent pipeline needed to drive innovation and productivity depends upon establishing the systems that can focus on continuous improvement, broadening engagement across employers, workers, students and educational institutions, and results and accountability. The following recommendations address major systems gaps that emerged from the findings of this study.

- Immediately Adopt and Promote Talent Pipelines or Knowledge Supply Chains for each of the seven Technology and Market platform opportunity areas K-adult. The intent is to integrate the discrete parts of the supply side in support of the seven critical Technology and Market Platforms, including public education and training (K-adult); private, for-profit education and training; private sector training; Labor associations/ apprenticeship training programs; and community-based organizations.
- Support Regional Economic Competitiveness through Cluster- and Consortia-Based Activity. Provide predictable sustainability funding and technical assistance to the growing number of currently fragile, regionally-based cluster organizations and consortia around the state that are positioned to serve as intermediaries in creating demand-driven, agile "pull" oriented talent development systems in critical areas of skill shortage.
- Aggressively expand and promote Career Pathways education and training opportunities as a systems-building strategy across high schools, community colleges, 4 year colleges and graduate education programs. Career pathways serve as a vehicle for linking secondary, two-year and four-year colleges, and apprenticeship into a seamless delivery system. Priority funding in career pathways development and implementation should be in high-demand, technology-reliant occupations that support the Technology and Market Platforms.
- Significantly improve supply-side databases. Easy access to accurate, comprehensive data emerged as a major gap during the course of conducting this study.
- Launch a Multi-Faceted Messaging Campaign to promote:
  - The growing availability of good "middle-skill" jobs that require more than a high school diploma but less than a college degree (and how/where Oregonians can get the training they need to qualify) and the expected strong growth in computer-related fields to offset the (dotcom) perception that jobs are dwindling. Target: High School, Out of School Youth, Underemployed; Traditionally underrepresented groups including minorities, women and the disabled
  - The positive value of career technical education and post-secondary alternatives, i.e., it's OK to go to work, start in a community college or apprenticeship, and then pursue more education—a bachelor's or master's degree or another technical certificate—when you need it. Target: High School, Counselors, Parents
  - The importance and benefits of life-long learning, including the importance of shared responsibility in gaining more and better education and effective ways to plan, finance and complete that education. Target: Working Adults
  - The challenges of global competition and the critical importance of continued investment in keeping worker skills current in the rapidly changing marketplace. Target: Businesses, current workforce

Principles Supporting the Recommendations

The recommendations as offered are based on a synthesis of information from various sources: (1) input from business, labor, government and education leaders collected during the course of this study; (2) additional work done by Key Links in Oregon and Battelle across the nation; (3) proven effective strategies and programs already at work in other states; and (4) several significant national policy reports as summarized below:

- **Public Education: A primary role of the public education system is to focus on creating agile, life-long learners** with the applied academic, core workplace and personal management skills needed to succeed in life and in the workplace. As a nation, we rely on rising educational achievement to support long-term productivity gains, sustained economic growth and a competitive edge in a global economy[4].
- **Career Technical Education:** Career technical education is going through a massive transformation responsive to the demands of the innovation economy and grounded in the belief that the skills and abilities students need to succeed in college **and** careers are virtually identical. The new Career Technical Education, which couples a rigorous **academic platform with elective CTE courses that help students apply their knowledge in the real world, must be a critical component of a state's talent pipeline agenda.** Recent research suggests that taking three CTE courses for every four academic courses has the greatest impact, reducing the dropout rate for students taking these courses by up to four times more than for those taking only academic courses, [5]raising earnings potential earnings of graduates by 18 percent more a month after graduation, [6]and increasing the likelihood of post-secondary education and training.[7]
- **Middle Skill Jobs:** The Bureau of Labor Statistics estimates that nearly half of all job openings in the next ten years will be in broad occupational categories that are mostly middle-skill. A recent study completed by the Urban Institute concludes that the demand for post-secondary education and training will remain strong, not only for workers with bachelors and more advanced degrees, but also for those with **more than high school but less than a four year degree**.[8] The findings of this study support the same conclusion.
- **Adult Life-Long Learning:** The gains enjoyed in past decades are today under threat because of a single reality—our workforce is steadily becoming less educated just when better and more diverse educational opportunities are essential for our labor force to maintain its historic lead in productivity, flexibility and ingenuity. Unless we make critical adjustments now to our human capital investment strategies, educational attainment levels will begin to stagnate and future economic growth will slow. We must leave no child behind, but **future gains in labor force educational attainment will come only as we get much better at educating our working adults**.[9]

[4] Tough Choices, Tough Times: The Report on the New Commission on the Skills of the American Workforce. National Center on Education and the Economy. See: www.skillscommission.org

[5] Wonacott, Michael E. "Dropouts and Career Technical Education." Myths and Realities. ERIC Clearinghouse on Adult, Career, and Vocational Education. Columbus. Columbus, Ohio: Center on Education and Training for Employment. 2002

[6]Kemple, James. Career Academies: Impact on Labor Market Outcomes and Educational Attainment, New York: MDRC. 2004

[7]Wakelyn, David. Retooling Career Technical Education. National Governor's Association. Center for Best Practices. June, 2007.

[8]Holzer, Harry J. and Lerman, Robert I. America's Forgotten Middle-Skill Jobs: Educating and Training Requirements in the Next Decade and Beyond. The Workforce Alliance. November, 2007. See: www.skills2compete.org/publications.

[9]Bosworth, Brian. Lifelong Learning – New Strategies for the Education of Working Adults. Center for American Progress. December, 2007. See: www.americanprogress.org/pressroom/releases/2007/12/lifelong_learning.html

Shared Responsibility

Implementation of the recommendations in this report must be a shared responsibility of business, labor, government, education and elected officials in Oregon. No one group, sector, institution, or organization alone can address the myriad of complex, interrelated policies, programs and funding challenges required to develop a resident talent pipeline of agile, skilled workers.

Primary responsibility for considering the recommendations in this report will fall to the Business and Economic Development Committee of the Oregon Workforce Investment Board. Given the purpose of the report, which was to provide a framework for advancing a future-oriented workforce investment strategy for the state, other critical groups potentially impacted by and responsible for implementing the recommendations include regional Workforce Investment Boards, the Board of Education (preK-12 and community colleges), the Board of Higher Education, Economic Development Commission, Oregon Employment Department, Office of Apprenticeship and Training and other government agencies. Elected officials are, obviously, critical partners.

While the recommendations provide a strategic framework for the investment of public dollars and actions, there are similar critical investments and actions businesses must simultaneously take to support this agenda.

Critical actions for business partners include:

- Embrace talent management as an ongoing, integral part of a long-term business strategy, not a short-term tactical problem;
- View upgrading the skills of the current workforce as an investment, not a cost; some national business organizations are advocating that 1 percent of payroll be spent on worker training – across all levels of the organization, not just management.
- Offer workplaces to serve as learning sites; provide internships to local high school and college students. It's a great way to "grow your own" future workforce.
- Participate actively in a state/regional trade association and/or regional cluster organization that can help identify and aggregate common workforce issues and needs;
- Adopt/enhance lean/high performance practices that focus on the elimination of waste and promote a competitive advantage;
- Actively show support for the recommendations contained in this report during the legislative session and advocate for increased investments in talent pipeline development.

Growing Global Competition Makes Talent a Strategic Priority

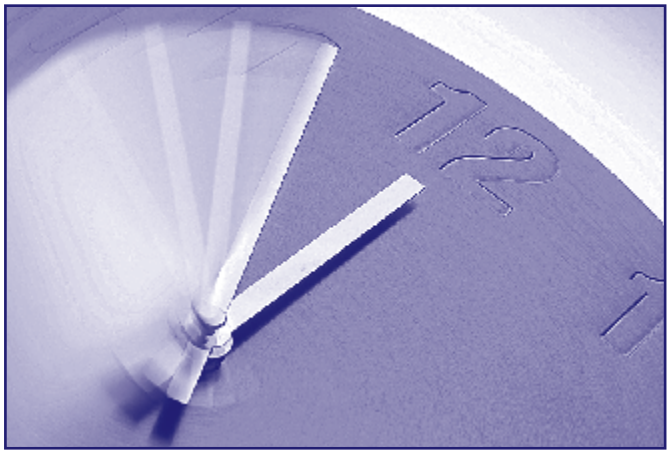
A McKinsey global survey conducted in November 2007 revealed that nearly half the respondents expect intensifying competition for talent—and the increasingly global nature of that competition—to have a major effect on their companies over the next five years. No other global trend was considered nearly as significant.

"Yet the astonishing reality is that most of them are as unprepared for the challenge of finding, motivating and retaining capable workers as they were a decade ago…Too many organizations still dismiss talent management as a short-term, tactical problem rather than an integral part of a long-term business strategy, requiring the attention of top-level management and substantial resources."

Mathew Guthridge,
"Making Talent a Strategic Priority"

Conclusion

Priming the talent pipeline to address the range of skills needed to propel innovation and productivity in all seven technology and market platforms will require bold action and shared responsibility among business, education and government. No one group can afford to assume a passive posture or promote incremental change or the potential opportunities to position Oregon as a world leader in several potential market areas may be lost. The window of opportunity is likely the next three to five years. The time to act is now!



This study points to three possible scenarios that could play out in Oregon over the next decade, which, in reality, constitute choices to be made by both the private and public sectors.

- **Scenario #1: Loss of traded sector business base.** Both the demand side (business) and supply side (government/education) maintains a fairly passive posture in the adoption of innovation, with generally incremental change and typically underfunded approaches to human capital investment. Under this scenario the currently robust Oregon traded sector economy, a critical source of wealth generation for the state, will likely begin to wane, and the economy will increasingly become more service, low-skill/low-wage job oriented.
- **Scenario #2: Global competitive businesses needing to shift jobs outside of Oregon.** Traded sector businesses aggressively implement strategies to increase innovation and improve productivity, while education/training providers and the state government continue with current

trends and fail to respond to the rapidly changing requirements of the high performance workplace. Under this scenario, businesses critical to the state's economy and tax base will not be able to find sufficient high-quality talent pools in Oregon to sustain their productivity and drive innovation, and so will make the choice to expand their business operations out of state where they can find the right talent for their needs, particularly the middle skill production and technician jobs.

- **Scenario #3: Increased shared prosperity.** Both the demand side and the supply side, in partnership, aggressively address the workforce challenges the state faces and create a "rising tide lifts all boats" scenario. This will require bold and unified action from a **systems perspective** that may be uncharacteristic and uncomfortable for a state that prides itself on local/regional autonomy. However, the dynamic challenges that lie ahead in building a skilled workforce will require that Oregon "think and act systemically," while simultaneously honoring the unique needs of the various regions across the state.

Implementation of the recommendations in this report will provide Oregon a competitive advantage in "overwhelming the competition" by building the talent pipeline needed to fuel innovation and drive productivity in the traded industry sectors. As discussed, due to the cross-cutting nature of many of the identified workforce issues related to future skill requirements, other sectors and workers in them will also likely benefit indirectly as a result of this strategic focus.

The purpose of this research study was to provide a focused, future oriented investment strategy for Oregon that will ultimately drive shared prosperity. As the recommended investments are realized, Oregon's workforce education and training system will be strengthened and better positioned to produce the workers critical to the future economic drivers of the state's economy. Those workers will be equipped to fuel the innovation and productivity gains that result in competitive advantage in the global market. The resulting prosperity for Oregon's economy, companies and workers will allow continued reinvestment in building the talent pipeline.

While implementation of the strategic investment plan will result in shared prosperity, it will also require shared responsibility. Key partners—business, labor, education, government and elected officials—must all aggressively embrace the call to urgent action. The three-five year window outlined in the recommendations is likely an outside limit. As illustrated through the Benchmark Profiles, many states have long adopted a much more aggressive posture for talent pipeline development. Oregon is in a "catch-up" mode.

Additional Inquiry

While this study broke new ground in terms of linking industry employment data and technology competency analysis, and also in terms of connecting traded sectors/cluster with workforce issues, additional research in the following areas would provide increased depth of analysis that was beyond the scope of this investigation.

- **Demographics:** How might increased exploration of projected demographic shifts in Oregon over the next decade further inform the findings of this study?
- **Educational Levels:** How might declining general educational attainment levels impact Oregon's long term capacity to compete in the global marketplace?
- **"In-Migration" and Immigration:** What are the specific impacts of "in-migration" and immigration on the overall supply-demand equation?
- **Policy Implication regarding Structure and Finance:** What are the structural and financial implications raised by the recommendations in this report?

It is now clear that the most effective strategies for economic development are technology-based and regionally-focused. It is also clear that the most effective way to provide a real future for people is to provide education and training that is related to the economic future of the region those people live in, for jobs in growth industries.

Tough Choices, Tough Times
National Center on Education and the Economy