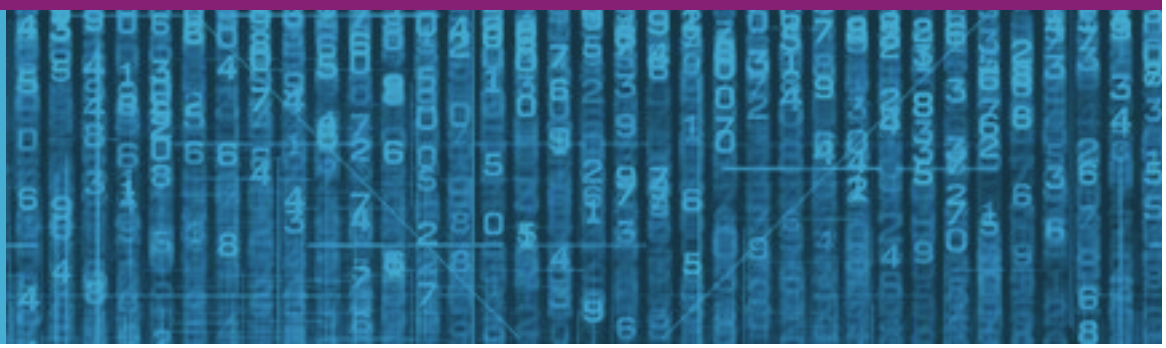
Economic Cluster Reports

Manufacturing



Manufacturing Cluster Report

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Contents

Purpose of Study

The purpose of this report is to examine the Regional Prosperity Economic Development Plan's list of key industries. In particular, this report analyses the key industry of "advanced manufacturing," and seeks to better define manufacturing activity concentrated in the Eugene-Springfield metropolitan area. The report seeks to characterize the clustering of manufacturing sectors in this region relative to other state and national definitions currently in use.

An overview of manufacturing sectors provides policymakers and economic development professionals with a relative sense of the scale, average wages, and contribution of businesses to gross metropolitan product. The report also places the metro's manufacturing into the context of national and global trends. It lists and describes statewide assets such as significant research centers. Likely economic strategies in encouragement of each sector, given local conditions, are described. Conclusions and recommendations for the region to take in support of its manufacturing industries are reached from discussion with individuals close to local companies.

Observations in this report come from consideration of data from County Business Patterns, Bureau of Labor Statistics Location Quotients, the US Bureau of Economic Analysis, and US Census Quarterly Workforce Indicators. Additional information is sourced from online tools like the Harvard Business School's Cluster Mapping Project, and "www.statsamerica.org" developed by the Purdue Center for Regional Development and the Indiana Business Research Center at Indiana University's Kelley School of Business as well as interviews with regional economic development agencies and local manufacturers.

Executive Summary

Background

Manufacturing businesses in the United States and the Eugene-Springfield metropolitan area continue to trend away from semi-skilled, manual labor-intensive jobs towards high-skilled, technical occupations. Manufacturing's share of total employment in the Eugene-Springfield metro is unlikely to grow, but the percentage of high-wage jobs in these sectors requiring practiced expertise or fluency in computer languages is guaranteed to increase. Manufacturing industries and their rising wages still offer many opportunities to a region struggling with below-average incomes.

The driving forces behind these changes in workplace readiness demands may be summarized as automation, the demographics of Asia, and material abundance—or "the three A's," as noted and described by University of Oregon education expert Dr. Yong Zhao. The price of investing in robot fabricators, as compared to hiring human laborers, continues to fall. Low transportation costs means less skilled or less creative work will find its way to larger and cheaper labor markets (like found in Asia). Lastly, the relative abundance of most goods in developed markets reinforces an ever-increasing premium for innovative workers who can contribute valuable creativity to either product design or efficiency.

The Oregon legislature and local education initiatives

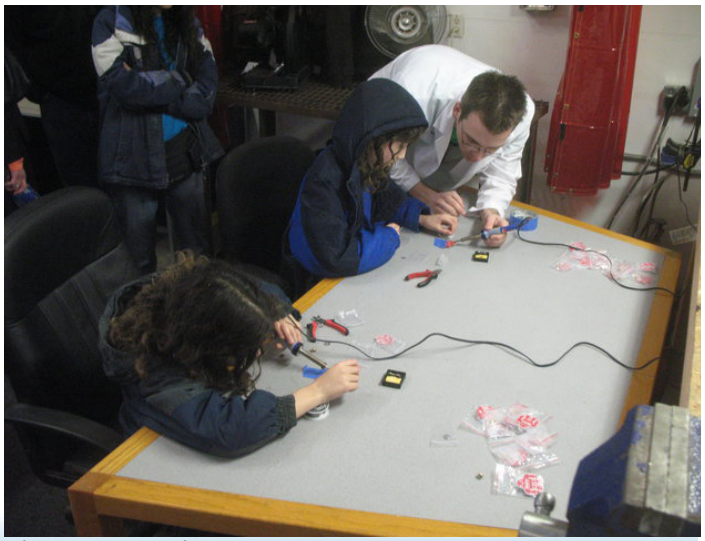


Photo: Eugene Makers Faire

are responding with investments in Science Technology Engineering and Math (STEM) and Career and Technology Education (CTE) grants to increase apprenticeship and mentoring. State investments to improve regional innovation, like the Regional Accelerator and its Innovation Network (Oregon RAIN) may also help complement these advanced workforce investments. However, manufacturing participation currently in this region's workforce advisory groups is self-selected and disproportionately low. Many manufacturers express they would like to be questioned less often, which points to the need for regional coordination to outreach activities. These additional challenges come precisely at a time when global economic competitiveness demands closer participation of industry in education. Local government jurisdictions and economic development agencies will need to do more to deepen relationships to local businesses if this region is to adequately pursue state and federal workforce development funding.

Advanced manufacturing refers either to new ways to make existing products, or the rapid application of emerging technology by industry members to secure competitive advantages.

Project Approach

This report reviewed federal and state data to determine which sectors are most concentrated in the Eugene metro. National studies have related sectors in the North American Industrial Classification System (NAICS) and defined them as industrial clusters. Qualitative comparisons to these studies were made for best fit to regional activity through interviews with local workforce development professionals, staff at significant research centers, engineers, and business owners. Observations and opinions were also drawn from these interviews help to inform recommendations to local policymakers.

Recommendations

The City may foster wider community awareness of successful local manufacturers and celebrate the benefits their employment brings. There are also grassroots activities the public sector could support and help grow. Backing a community "Maker Space" and provision of related manufacturing technical equipment could be a cost effective demonstration of the City of Eugene's interests extending beyond regulation. Assisting educators by stimulating local Science, Technology, Engineering, and Math efforts could also show the City values and invests in useful encouragements to fabrication innovation and engineering education.

Beyond changing tone and cultivating a more welcoming identity towards manufacturers, acknowledging regional advantages presented by companies and publically owned assets in the Advanced Materials Cluster can help guide local lobbying, provide direction to outreach efforts, and inform other aspects of local economic policy. This cluster includes businesses drawn from fabricated metals, chemical manufacturing and the highly concentrated, regional wood product subsectors. Businesses in these sectors deploy technologies which most relate to state investments in its Signature Research Centers and Oregon University System assets.

Advanced Manufacturing

National Definitions of a Regional "Key Industry"

The Regional Prosperity Plan, signed by the joint local elected officials in 2010, envisions becoming a "Learning Region," with growth "Innovation Incubators" and "High Tech-High Growth" businesses. The plan's targeted "Key Industries" to achieve this vision includes "Advanced Manufacturing," a term which encompasses dozens of manufacturing sectors. Regional leaders' clear policy interest is to assist businesses to employ advanced technologies, rather than an overriding concern about supporting specific industries or sectors.

The White House administration's most recent definition of "advanced manufacturing" is "manufacturing that entails rapid transfer of science and technology (S&T) into manufacturing products and processes." The President's Council of Advisors on Science and Technology defined advanced manufacturing as "a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and

networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies…Advanced Manufacturing is not limited to emerging technologies; rather, it is composed of efficient, productive, highly integrated, tightly controlled processes across a spectrum of globally competitive U.S. manufacturers and suppliers."

In sum, advanced manufacturing refers either to new ways to make existing products, or the rapid application of emerging technology by industry members to secure competitive advantages.

Refining Focus and Outlining an Industrial Portfolio

The definitions provided by federal government are very generous and encompass many sectors. Policy-maker interest is not in a pre-determined set of sectors or clusters. Rather, a preference for advanced manufacturing describes a commonly held aspiration by local and national governments to encourage their businesses and industries to "climb the product ladder."

Questions follow this aspiration. Among Eugene-Springfield's manufacturing subsectors, which can be credibly argued form a distinct, regionally-based, cluster characterized by rapid transfer of science to products, a variety of technologically rich firms, and innovation leadership? Moreover, how can economic developers become more strategic in their outreach or advocacy efforts and consider sector specific issues when dealing with individual manufacturing businesses?

Other questions economic developers, policy-makers, university system agencies and public officials will need to ask themselves continuously in pursuit of this goal include:

- Across what scales do businesses and clusters in Eugene-Springfield participate: Eugene-Springfield, the state of Oregon, or the whole Pacific Northwest?
- What niches do Eugene-Springfield manufacturing businesses occupy within their respective sector or within these larger regional or statewide clusters?
- Does the Eugene-Springfield region intend to prioritize supportive actions in areas it's already most technologically competent, or will it play catch-up in new fields through recruitment?
- Is the region seeking to wrest a greater percentage

share of employment from larger state or super-regional clusters by either lowering local costs or boosting productivity?
- What sectors are declining? Which are advancing?
- How should economic developers and officials interact or direct their networking with business leaders drawn from particular sectors?

While all of Eugene-Springfield's manufacturing sectors are best understood as parts of larger statewide and Pacific Northwest clusters, wood products and "advanced materials" alone may be recognized as concentrated in this region at intensities warranting cluster-based strategizing. In reply to the above questions, the report makes the following recommendations:

- The **fabricated metal manufacturing** industry has large employment totals, post-Recession employment growth, and statewide presence. With some exceptions, many area businesses in fabricated metal are connected to the wood products cluster. The decline of forest products has noticeably affected the number of independent metal suppliers, and the competitiveness of fabricated metal manufacturers located in this region. Strengthening Eugene-Springfield's position—its niche—relative to state and super-regional metal supply chains is important. **Heavy machinery** is a traded sector with few local establishments, recent rapid growth in hiring, and small significance as a portion of nationwide industry. Local companies like Bulk Waste Handling or Johnson Crusher increasingly trade and supply products to global markets. Outreach with these businesses may focus on finding ways to boost their regional supplier linkages or fostering "coattail" effects for other regional manufacturing businesses.

- **Wood products** and construction material industries have a long legacy in this region, a recent growth in hiring, and highly efficient production chains. Businesses have undergone dramatic changes in the past ten years which requires renewed economic development attention. Specialized encouragement for start-ups in related tech fields and research and development (R&D) linkages to these industries is recommended to encourage vitality in this older and maturing industrial cluster.

- **Advanced materials** companies have extensive

Figure 1: Eugene-Springfield's "Manufacturing Sector Portfolio" 2012

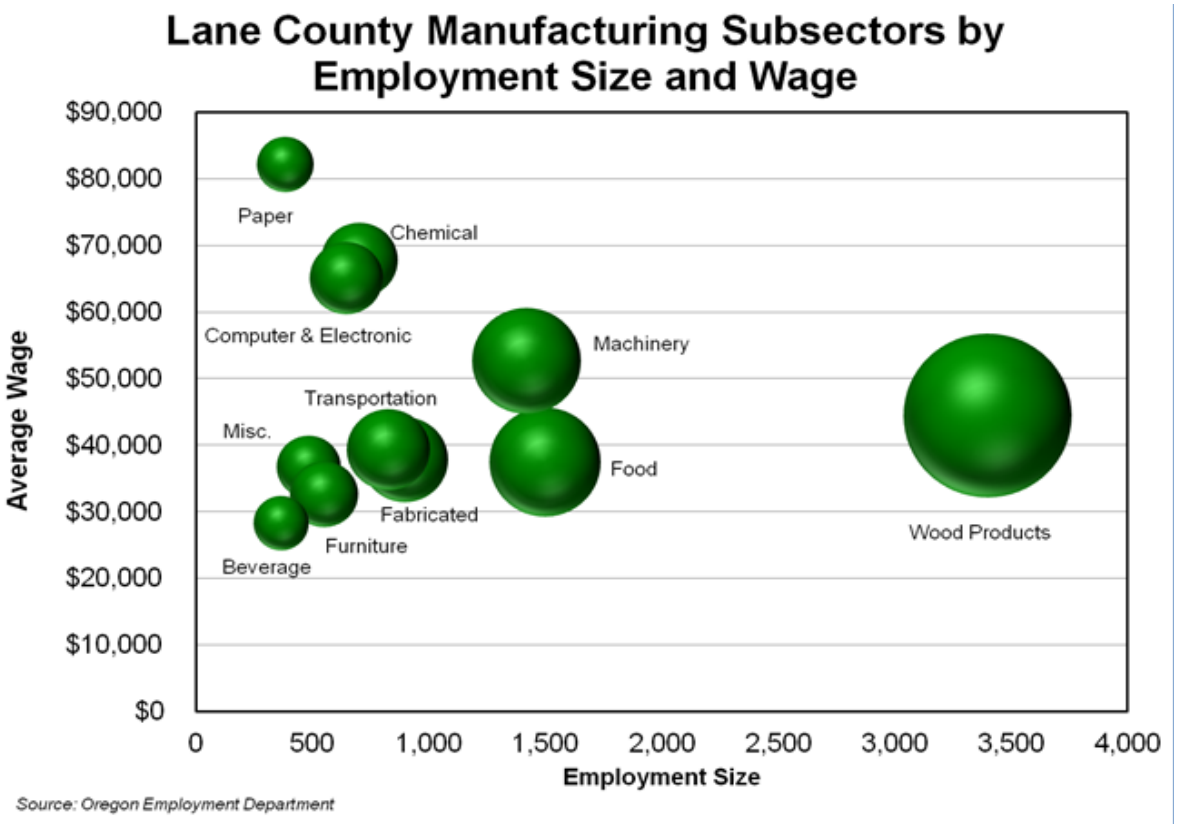


Table 1: Eugene-Springfield MSA 2012 Manufacturing Cluster Employment

Eugene-Springfield MSA, 2012	QCEW Cluster - Employment	QCEW Cluster - Total Wages	Industry Cluster Employment LQ	Industry Cluster Establishment LQ
Total All Industries	136,790	$5,147,994,426	1.00	1.00
Advanced Materials	2,286	$110,902,172	0.52	1.03
Chemicals & Chemical Based Products	915	$52,264,447	0.47	0.84
Forest & Wood Products	5,771	$269,776,063	4.54	3.69
Manufacturing Supercluster	3,054	$167,199,182	0.60	1.11
Machinery Mfg	1,173	$73,082,598	1.34	1.26
Fabricated Metal Product Mfg	918	$38,829,534	0.71	1.17
Transportation Equipment Mfg	622	$33,350,621	0.48	1.82
Computer & Electronic Product Mfg	265	$17,347,241	0.25	0.74
Electrical Equipment, Appliance & Component Mfg	67	$4,243,739	0.18	0.48
Primary Metal Mfg	9	$345,449	0.04	0.27
Software publishing (NAICS 5112)	1,707		5.92	
Computer systems design and related services (NAICS 5415)	413		0.25	

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment & Wages (QCEW) and Purdue Center for Regional Development (cluster definitions).

Manufacturing Cluster Employment with Geography of Regional Accelerator Innovation Network (RAIN)

South Willamette (Albany, Corvallis, and Eugene-Springfield), 2012	QCEW Cluster - Employment	QCEW Cluster - Total Wages	Industry Cluster Employment LQ	Industry Cluster Establishment LQ
Total All Industries	211,342	$8,178,341,009	1.00	1.00
Advanced Materials	5,545	$418,334,636	0.81	1.19
Chemicals & Chemical Based Products	1,647	$94,481,682	0.54	0.92
Forest & Wood Products	9,399	$455,209,319	4.78	3.88
Manufacturing Supercluster	6,119	$450,541,543	0.77	1.13
Machinery Mfg	1,468	$89,045,976	1.08	1.18
Fabricated Metal Product Mfg	1,336	$57,991,500	0.66	1.22
Transportation Equipment Mfg	860	$41,230,896	0.43	1.37
Computer & Electronic Product Mfg	2,360	$256,568,267	1.43	1.09
Electrical Equipment, Appliance & Component Mfg	86	$5,359,454	0.18	0.66
Primary Metal Mfg	9	$345,449	0.04	0.27
Software publishing (NAICS 5112)	1,887		3.48	
Computer systems design and related services (NAICS 5415)	715		0.23	

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment & Wages (QCEW) and Purdue Center for Regional Development (cluster definitions).

Table 2: Manufacturing Sector or Cluster Advantages and Challenges

Area of Manufacturing	Advantages	Challenges	Opportunities/Questions
Fabricated Metals	Hiring is picking up, although total employment is below pre-Recession levels; State-wide there is a strong concentration; Low bar for entry-level employment, but there is a strong career ladder for new employees.	Number of local suppliers is diminished as the wood products industry has changed; Volatile employment with large reductions during Great Recession; Most businesses serve local trade area and only few exporters are part of state, national, and global supply chains; Aging workforce.	Are export oriented fabricated metal producers finding adequate suppliers and employees in this region as the wood products industry changes to more value additive, automated processes?
Forestry, Wood Products and Construction Materials	Heritage industry of significant scale and comparative advantages; Core businesses within the cluster are resilient, technically advanced, and can spur greater job creation in new or complementary industries; Rising wages at leading firms is reflection of this region's technical progress and specialized knowledge.	Long-term decline in total local employment—five years after sharp contraction related to international financial crisis, wood products employment is still just approaching its pre-recession levels; Mature, older companies with few linkages to public sector or to advanced research from the university systems, although several have internal R&D departments.	Do "additive manufacturing" techniques and demands for advanced materials mean there will be innovations/start-ups in this field? Do wood products still offer advancement and careers for lowest skilled workers?
Heavy Machinery and Transportation Manufacturing	Above-average wages not just for region, but among machinery manufacturing regions nationally; Fits with federal interest in increasing traditional manufacturing exports; Likely coattail benefits for local suppliers, support businesses.	Smaller employment total and annual payroll; Few very large firms are in the Eugene-Springfield metro, and these come with corporate ownership from outside the state.	Who are the primary and intermediate suppliers of heavy machinery and transportation manufacturers in this region? Why do they source where they do?
Computer and electrical component manufacture	Highly valuable products made by technically advanced firms with high wages; Part of statewide cluster which arguably is most significant concentration in the nation; Potential intersections with other information technologists and advanced material sciences.	Peripheral to the cluster's center in Portland MSA; Eugene's 678 employees represent a small concentration compared to rest of state or to Portland; Recruitment and retention efforts must contest with agglomerative forces pulling companies to Portland MSA.	Is there a specialized niche among Eugene-Springfield firms in this sector? What ties, formal or informal, do electronic businesses have to Corvallis and Portland companies?
Advanced Materials (Utilizing a cluster definition and NAICS bounds from the Department of Commerce's "StatsAmerica" project)	Includes businesses from widest range of manufacturing sectors (wood products, fabricated metals, electrical components, and chemicals—which even encompasses biotech firm Life Technologies); Chemistry is a forte of both OSU and UO and the SRC's; Innovations have a diverse set of manufacturing applications; High annual wages and is a "traded sector" cluster; Lines up to national strategic priorities and latest definitions of "advanced manufacturing." Larger region of Eugene-Springfield, Corvallis and Albany holds diverse range of materials companies and cadre of basic science researchers.	Resists straightforward NAICS categorization because it refers to furthest edge of innovation, and therefore, more difficult to scope. For example, Life Technologies is a biotech firm listed as a chemical manufacturer. Leading employers and HQ operations are most likely found in construction materials: especially in sectors like paints, resins, and adhesives (heritage of "plywood capital of world,"); Cluster connections and tech co-benefits are theoretical and unconfirmed in local practice by University Tech Transfer office or local businesses.	How can Regional Science and Tech Transfer operations improve outreach and connection to local industry? Is there an opportunity for an "Advanced Materials Col-laboratory" in this area? Is there a Community College role now missing? How can leading regional innovations connect with local business and workforce development—especially at entry level?

research and development functions in the region, are the most connected to state investments in Significant Research Centers (ONAMI, BEST, CAMCOR, and SNNI)*; and are best situated technologically to form linkages to the most prestigious University-based research. This cluster best complements the Oregon RAIN investment and benefit from its approach to regionalism (connecting industry and institutions in Albany and Corvallis with Eugene and Springfield). The cluster's scope includes businesses from the related sectors of fabricated metals, wood products, and chemical manufacturing. Its component sectors are likely resistant (if not immediate beneficiaries) to disruptive technologies on the horizon like additive manufacturing (also known as 3D printing). It best fits "advanced manufacturing" national policy priorities. Many of its businesses pay higher than average wages.

The preceding statements are based upon a review of data collected from the Harvard Business School's US Cluster Mapping Project, Bureau of Labor Statistics, Department of Commerce, and the US Census. Relative size and wage of manufacturing employment by subsector may be seen in Figure 1. In Table 1 employment figures of clusters—which are comprised of subsectors—are displayed. Industry groupings advantages, challenges, and opportunities for exploration are shown in Table 2.

Utility of Cluster Analysis

While cluster analysis may help contextualize strategic choices, accounting for clusters does not by itself dictate policy, tactical actions, or form competitive federal grant proposals. A review of quantitative data tells a bit about industry composition and relative scale, but alone is insufficient ground for policy decision-making. Gathering qualitative evidence is necessary for discerning potential cross-sector synergies and determining plausible actions agencies and institutions can use to foster agglomerative effects, like: shared workforce training programs, branding initiatives, personnel networking, joint asset development, special public services, etc.

An alternative approach to creating a cluster strategy would be to simply acknowledge manufacturing sectors

* Oregon Nanoscience and Microtechnologies Institute (ONAMI), Built Environment Sustainable Technologies (BEST), Comprehensive Materials Characterization Center (CAMCOR), Safer Nanomaterials and Nanomanufacturing Institute (SNNI)

are blending as trends in automation and customization muddy traditional occupational distinctions. This posture is inherently an opportunistic approach to economic development. Detailed analysis of quantitative data screened by NAICS codes and similar information has limited daily utility in this strategy and clusters mainly become a convenient package for marketing. Building out this kind of strategy's programs will depend greatly on direct personal connections to key stakeholders.

However, industrial specialization is often noted as proof of regional comparative advantage for a given sector. Documented evidence of a cluster enhances the confidence that state and federal investments in technology transfer or manufacturer supports will have positive spillovers. Cluster analyses can help prove regional funding proposals fit regional comparative advantages, leverage local assets, and integrates with existing employers. Likewise, it gives contextual understanding to economic developers in their approaches in dealing with the diversity of sectors within manufacturing.

Which Manufacturing Sector is Most Significantly Clustered in Eugene-Springfield?

Clustering of closely related business is known to promote and catalyze innovation, but within Eugene-Springfield manufacturing is less concentrated and specialized in those industries most typically associated with "high technology." One local industry expert noted there was "no gold standard, advanced manufacturing" located in either Eugene or Springfield. Rather, with few exceptions, successor activities associated with the region's heritage in farming and logging still characterizes the vast majority of local industrial activity.

The combination of primary and secondary wood products (including wood product manufacturing, paper, and furniture sectors) with food and beverage industries (food manufacturing, breweries, and wineries) accounts for approximately 49% of the 12,553 manufacturing employees in Lane County in 2012. There are several advanced materials establishments and heavy machinery businesses operating near, or at, the innovative edge of their sectors

here. Yet, the manufacturing data for Eugene-Springfield does not strongly indicate regional specialization or clustering in these sectors. They also do not appear to have larger significance compared to other regions nationwide.

Generally, Eugene-Springfield's comparative advantages in manufacturing are likely to be traced to relative lower costs in utilities, labor, or transportation costs for providing service to localized trade areas or regional markets. Long-term, this position is precarious to employment totals because of the vulnerability of the older workforce to skill-biased technological advancements and the heightened prospect of mass layoffs during cyclical downturns. Indeed, this is demonstrated by Eugene's experiences of higher and more protracted unemployment during many of the nation's recessions and recoveries since the early 1980s.

Certain subsectors within manufacturing, some of which have potential ties to the University and "Signature Research Center"-based innovation, are meaningful exceptions to these generalizations. Industries with local heritage, such as wood products and heavy machinery, are export-oriented with advanced, locally-based headquarter operations, international trade presence, and significant internal R&D departments. The wages of Lane County businesses in these sectors sometimes pay higher than state industry averages, and it may be inferred their local competitiveness is on the basis of advanced technical prowess and specialized skills—not just reliance on low

operational costs. Knowledge spillover benefits in this region emanating from concentration in those sectors are likely slight.

Agglomerative effects—such as the rapid distribution of innovations attributable to geographic proximity—may be occurring between the above sectors in ways not captured by this national, one-size fits-all-localities set of cluster boundaries from research sponsored by the Economic Development Administration. Sector boundaries customized to Eugene-Springfield and based upon on-going outreach and interviews could help adjust Location Quotient (LQ) results to reflect the local context. There might be other pathways for shared worker inputs and other complementarities occurring between firms of the various manufacturing sectors than revealed by a review of wages and location quotients.

Establishments drawn from the chemical manufacturing, wood products, and fabricated metal product sectors are most likely to possess the scale and requisite technical knowledge needed to rapidly implement science and technology advancements from the Universities and Signature Research Centers, especially in the fields of nanotechnologies, metals, and other advanced materials.

Manufacturing Overview and Sector Strategies

In 2012, average monthly earnings in Eugene-Springfield manufacturing sectors continued the long-term trend of rising faster than all other industries (Figure 3). Meanwhile, hiring growth from 2011 to 2012 also showed large increases. Although the long-term trend of manufacturing employment from the 1980s to now—as a percentage of overall Eugene-Springfield workforce—shows steady decline, the earning potential for a career in manufacturing is—by average comparison—much better than most any other industry. These higher earnings are reflected in the greater requirements for experience and education for the jobs created today in manufacturing.

Broadly, the primary challenge for government and economic development agencies is not to attempt to arrest the decline of manufacturing employment totals, but to support the industry's rising wage growth.

Broadly, the primary challenge for government and economic development agencies is not to attempt to arrest the decline of manufacturing employment totals, but to support the industry's rising wage growth. Declining employment in manufacturing alone should not cause panic about

Table 3: Eugene-Springfield: 2012 Sectors with Fastest Hiring Growth
High Growth Industries

10 industries ranked on the greatest growth in hiring (Private Firms Only)

	Hiring Growth (%) (2011Q2 to 2012Q2)	Average Quarterly Employment (2011Q3 to 2012Q2)	Average Monthly Earnings ($) (2011Q3 to 2012Q2)
722 Food Services and Drinking Places	20.80%	10,702	1,346
561 Administrative and Support Services	22.60%	7,154	2,382
541 Professional, Scientific, and Technical Services	29.10%	5,375	3,886
333 Machinery Manufacturing	76.30%	1,559	4,646
321 Wood Product Manufacturing	36.90%	3,333	3,842
623 Nursing and Residential Care Facilities	11.30%	4,256	1,994
334 Computer and Electronic Product Manufacturing	140%	678	5,894
445 Food and Beverage Stores	22.70%	4,097	2,213
311 Food Manufacturing	44.70%	1,455	3,340
441 Motor Vehicle and Parts Dealers	21.10%	2,354	3,399

Source: U.S. Census Bureau, Local Employment Dynamics

Figure 2: Composition of Eugene-Springfield Manufacturing Workforce: Older and Male

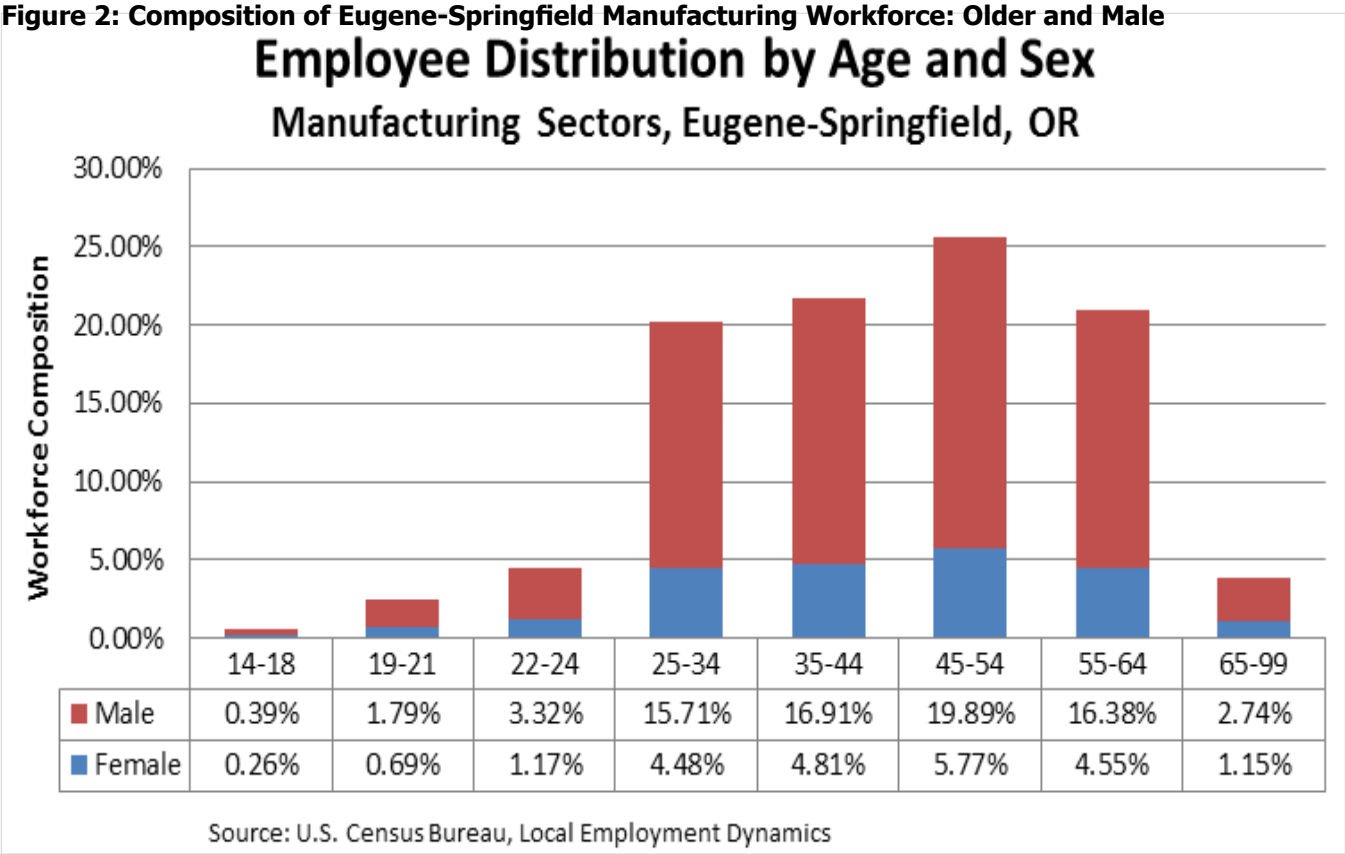
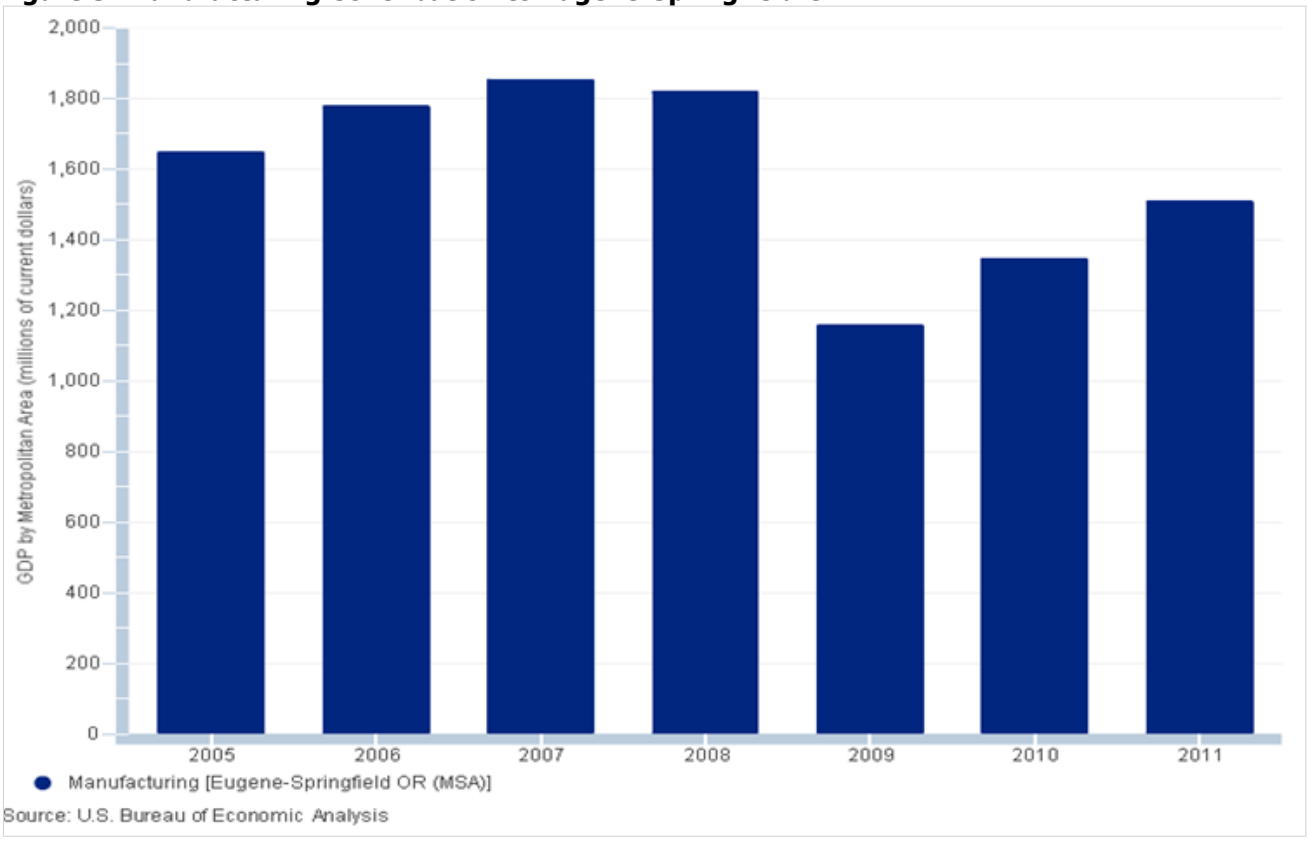


Figure 3: Manufacturing Contribution to Eugene-Springfield GDP



economic weakness, especially if increasing employment in other well-paid sectors more than compensates. Instead, policy makers and their representatives can focus on devising public support for research and innovation within manufacturing.

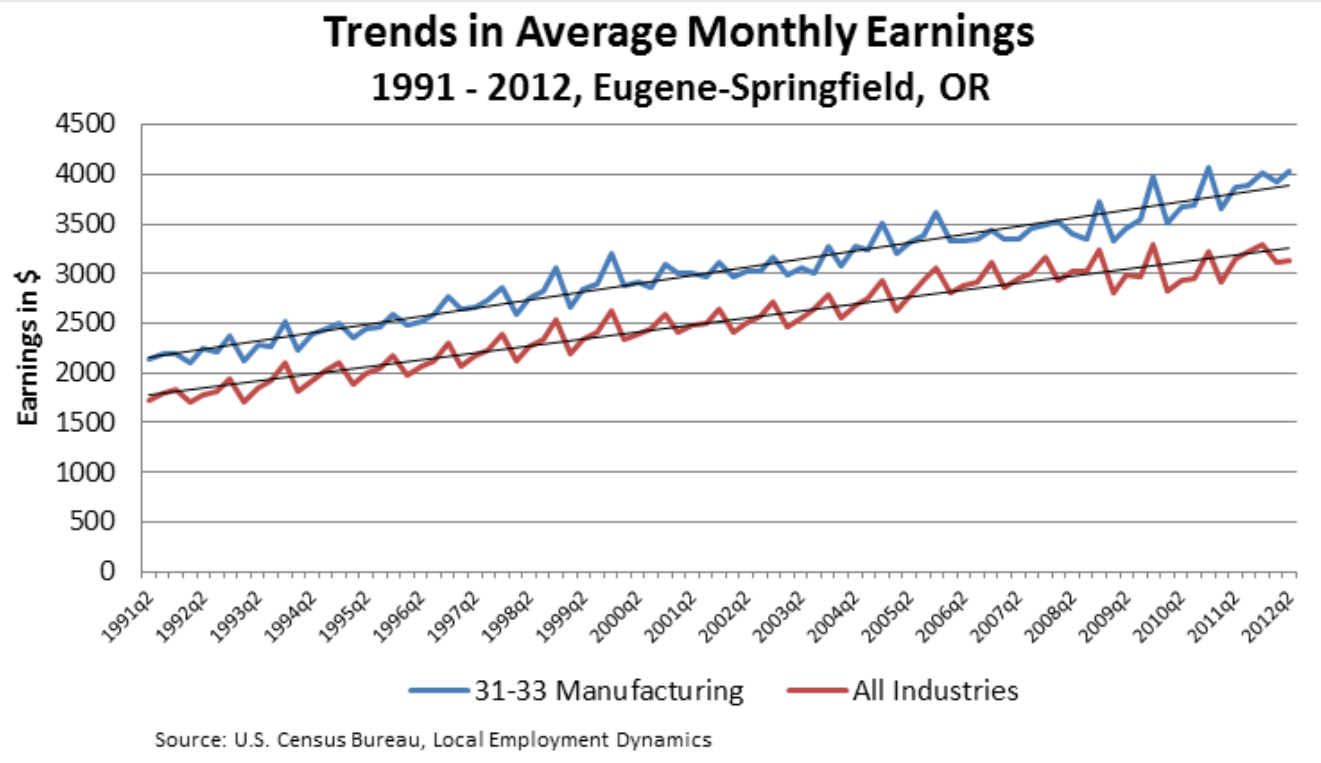
Table 3 ranks the top ten industries on basis of greatest growth in hiring from 2011 to 2012. The results reinforce the recent narrative of steady growth in food manufacturing and durable goods manufacturing bouncing back post-recession.

Computer and electronic product manufacturing experienced rapid growth in terms of hiring, but the industry remained less concentrated in terms of total employment when compared to state averages. Indeed, as one of the larger metropolitan areas in Oregon, Eugene-Springfield's relative concentration in computer and electronic manufacturing may be judged as small. There are continuing opportunities because of the overall strength of the state's cluster, but the recent departure of VersaLogic corporate and R&D headquarters to Portland emphasizes the headwinds economic developers will face in recruiting and retaining firms in this sector. The most advanced, high-paying functions will be especially drawn to concentration in the Portland MSA.

Wood product manufacturing—a heritage industry with long-standing ties to the area—suffered immense employment reductions during the Great Recession. As the national housing market has recovered strength, it has picked up hiring, especially over those four quarters shown in Table 3. Machinery manufacturing employment growth and production also returned after the financial shock. Both industries will continue to recoup some, if not all, their former size in employment.

For its part, food and beverage manufacturing continued its growth in hiring straight through the Great Recession, and probably would continue to grow at a fast pace as long as the American consumer recovers confidence. Food and beverage manufacturing in the region is a success story for the region. Eugene-Springfield metro has managed to completely recover employment in these sectors after the loss of the major employer Agripac and grew jobs in higher value-added products like frozen desserts, breweries, specialty or "natural" food products, as well as specialty food distributors. For more on this aspect of regional

Figure 4: Comparing Manufacturing Earnings to All Industries in Eugene-Springfield



manufacturing, see the Food and Beverage Cluster Report separately.

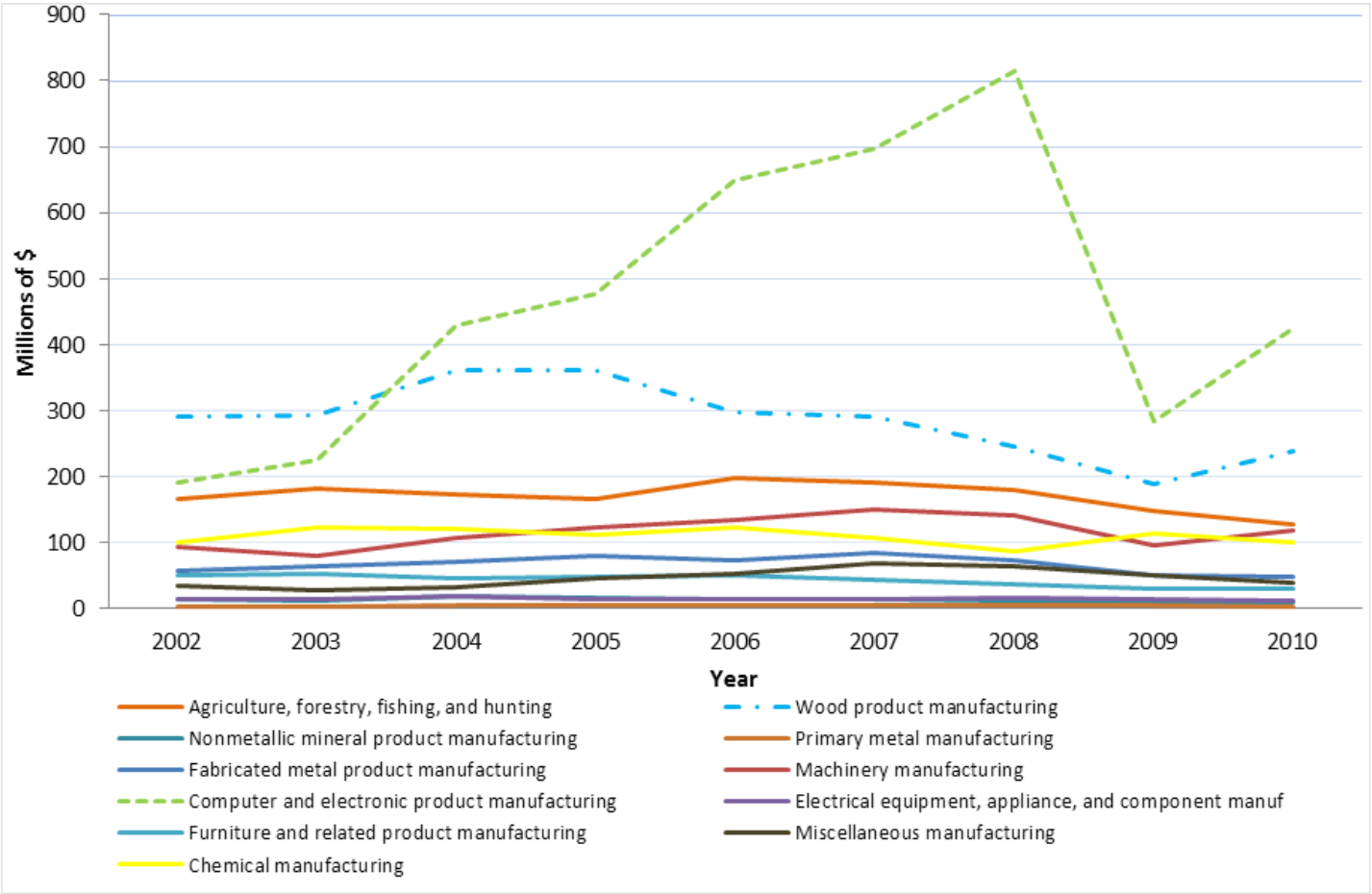
Heritage Industry Considerations

The national shift in federal policy focus back towards exports and manufacturing is, in part, led by theories related to an age-old manufacturing problem of bridging gaps between product conception and execution. Loss of basic skill work to foreign competition and other openings in the worker pipeline undercuts businesses' capacity to build recursive loops allowing for the knowledge acquired by "shopfloor" workers to feed back into the higher value conceptions of engineers, designers, and managers. Some policy experts theorize loss of basic manufacturing functions undermined not only the upward mobility of lower-skill workers, but American businesses' ability to innovate, too.

Workforce initiatives and cluster-based recruitment outreach efforts can highlight for breakdowns in linkages between entry-level work and advanced operations in the region's older businesses and established clusters—especially if employers are shedding the less value additive functions. Eugene-Springfield's heritage industries of wood products and machinery industries are the most likely candidates to observe these issues.

Industries with long heritages in a region, in a manner similar to large institutions like military bases or universities, often exhibit a propensity to "spin-off" new industries through supporting services or direct investments in technology. A classic example is how garment and textile businesses in New York gave way to a fashion industry, which in turn fostered the creation of ever more sophisticated advertising and media businesses. A more contemporary example may be viewed in the slow demise of traditional photography (i.e., Kodak) in Rochester, NY concurrent to continued robustness and growth in its related cluster of optics, photonic services and related manufacturing firms. A smaller—but local—example of this phenomenon may be witnessed in the story of MDI (Metal Detectors Incorporated). It began as a company with technology to detect metal pieces on processed logs about to be sent

Figure 5: Comparing Manufacturing Earnings to All Industries in Eugene-Springfield



Source: Bureau of Economic Analysis

through sawmills, but has since found useful applications of its proprietary technology for military use as well as in constructing heavy machinery for sorting recycling refuse.

Likewise, wood product manufacturing in Eugene, even if its total employment is observed to decline from an earlier baseline, giving the appearance of a static cluster—one even possibly in decline—is still of such concentration, diversity, and potentially creative force that regional development agencies may reasonably expect previously unconsidered industries to grow from it. Advanced wood product operations at company headquarters exert specialized knowledge proximity benefits on related industries. This can lead to job creation and increasing wages. Although the age and maturity of the wood products or machinery industries suggest they are unlikely to surpass previous employment totals, local establishments are observed as increasingly sophisticated and value-additive in their internal operations and diverse in their range of products.

Significant Research Centers, University Institutes, State and Federal Initiatives

A key characteristic of manufacturing in the Eugene-Springfield metro is the few number of firms setup to take direct advantage of state or federally funded research and advanced technical resources. Although Eugene hosts the University of Oregon and pivotal assets in the state's Signature Research Centers, connections of these to this region's employers in its largest sectors appear limited to a few businesses. A concerted effort to build-up relationships and make available state resources and knowledge to Eugene-Springfield construction material businesses is an opportunity.

University officials, economic development agencies, and policy makers interested in improving Eugene-Springfield's competitiveness can increase their outreach to local businesses in the Advanced Material cluster's sectors to discover more about how often Eugene-Springfield companies utilize the following list of research assets. This information could be shared and monitored by economic development agencies as an indication of regional industrial performance.

Wood Based Composite Center

The Wood Based Composite Center (WBC) at Oregon State University is the only example of a federally granted Industry/University Cooperative Research Center in Oregon. The membership fee is $30,000 per year. The Center is also on campuses at University of British Columbia, University of Maine, and Virginia Tech. It provides an international forum for exchange and interaction among professionals and students interested in adhesives, materials science, and the manufacture and performance of wood-based composites. Oregon State University currently offers two graduate level research assistance positions.

Eugene and Lane County can do more to market and claim these incredible technological assets as their own when recruiting both startup businesses and large industries

Industry members from the Eugene-Springfield metro include Willamette Valley Company, Arclin, and Momentive. Current research, supported with funding from Oregon BEST, is investigating developing cross-laminated timber, or CLT, capability in North America. The process of CLT originated in Scandinavia in the 1990s and is now used to construct tall buildings in Europe and China. It promises to re-establish wood's primacy in constructing buildings over four stories. Lighter, cheaper, and less-energy intensive than steel, the use of CLT in buildings up to ten stories is a revolution in architecture. It has lead to some to write wood is once more "the most advanced building material in the world" and the green choice for reducing climate change causing emissions.

Future City of Eugene, City of Springfield, or Lane County public building projects should consider deploying this building technique to demonstrate its value, create example for code inspectors in North America, and give local architects and engineers' practical experience in using this material.

University of Oregon Materials Science Institute

The Materials Science Institute is an interdisciplinary

institute of the University of Oregon to study the structure and properties of materials, educate, and serve Oregon as a resource in these sciences. Over 28 years, the institute has collaborated with more than 25 companies and tripled the size of its research program. The institute's faculty as well as undergraduate and graduate school programs works with CAMCOR, ONAMI, and SNNI. Graduate students perform year-long internships at regional companies as portions of their degree programs, and research results are shared with regional businesses.

Oregon State University: Center for Advanced Materials Research (CAMR)

The Center for Advanced Materials Research was established in 1986 to strengthen research and education in the synthesis, properties, and understanding of new materials, with special emphasis on materials of importance to Oregon's economy. At OSU, materials science is an interdisciplinary program spanning nine departments in the colleges of Engineering, Forestry and Science: the Departments of Chemical Engineering, Civil Engineering, Electrical and Computer Engineering, Mechanical Engineering, Nuclear Engineering, Forest Products, Chemistry, Mathematics, and Physics.

Areas of Research include Optical Materials, Metallurgy, Superconductivity, Electronic Materials, Composites, Fiber Composites, and Ceramics. Fiber composites relates most strongly to Eugene-Springfield business strengths in adhesives and forest products.

Oregon Nanoscience and Microtechnologies Institute (ONAMI) and CAMCOR

ONAMI is Oregon's first Signature Research Center and received federal appropriations for research in areas of specific interest to the national government. It is composed of several statewide and regional institutional partners: Oregon Health and Science University, Oregon State University, Pacific Northwest National Laboratory, Portland State University, and the University of Oregon. Laboratory space is split between facilities in Eugene, Corvallis, and Portland.

In Eugene, the Center for Advanced Materials Characterization in Oregon (CAMCOR) facilities housed at the Lorry I. Lokey Laboratory has the capability to make some of the quietest (nano-scaled) measurements in the world. Equipment and operating staff are made available at low cost to companies statewide who come to use it. In addition to equipment and space, ONAMI co-invests state funds with member institutions to recruit talented researchers by offering competitive salaries, benefits, and specialized lab equipment. ONAMI also runs a small "proof-of-concept" seed grant fund and its own networking of industry, business members and science community researchers.

CAMCOR is an example of a fixed, shared asset that draws basic scientific researchers to the Eugene-Springfield area (regardless of the capability of remote access). Its core capabilities include capital-intensive equipment for microanalysis, surface analysis, electron microscopy, semiconductor device fabrication, as well as traditional chemical characterization. Staff members who run the facilities, in addition to preparing samples, collecting and analyzing data, periodically offer workshops with hands-on training for facility users. The increase in science research occupations alone is an economic benefit for the asset, but it also represents potential to make the region a "first comer" in areas of applied sciences.

Safe Nanomaterials and Nanomanufacturing Initiative (SNNI)

SNNI is a collaboration of faculty and researchers from academia, government, and industrial labs to ensure the field of nanotechnology develops responsibly with new technologies that are inherently safer and greener by design to protect human health, the environment, and workers. The group hosts conference series and collaborates with the science risk management firm Intertox and the federally funded Center for the Environmental Implications of Nanotechnology (CEINT). Two enterprises from the Eugene-Springfield region to emerge from its technology transfer operations include Dune Sciences and Floragenex. An example enterprise from Corvallis is Microflow CVO.

NETL-Albany (National Energy Technology Laboratory): formerly the Albany Research Center

In November, 2005 the Albany Research Center was realigned by the Department of Energy and joined the National Energy Technology Laboratory's (NETL) agency as a branch under NETL management. The realignment was meant to broaden NETL's material science capability. The NETL consists of 1,100 public and private sector employees at 14 major research centers nationwide. The research site in Albany is one of three (the other two are in Pennsylvania and West Virginia) to offer a wide range of facilities and capabilities for technology transfer. The federal agency devotes the majority of its funding to R&D partnerships with industry, university, and other government entities.

Oregon Built Environment & Sustainable Technologies Center (BEST) in Portland, OR

Oregon BEST includes member faculty from throughout the state university system, provides shared-user lab facilities, sustainable built environment research and features both a commercialization and proposal matching program.

It was established as an independent, nonprofit organization in 2007 as part of the Oregon Innovation Council's legislative recommendations. Initial funding came from the Oregon Legislature, with additional support from the Oregon University System and the Meyer Memorial Trust. Oregon BEST is funded in part with Oregon State Lottery Funds administered by the Oregon Business Development Department. Partner universities include the Oregon Institute of Technology, Oregon State University, Portland State University, and the University of Oregon.

Advanced Materials Manufacturing Cluster

Summary

The Purdue Center for Regional Development, in research and reporting sponsored by the Economic Development Administration, has put forward definitions of clusters by NAICS boundaries. Many of Eugene-Springfield's manufacturing subclusters are best understood as part of much larger scale agglomerations distributed either across the state or primarily centered in the City of Portland. However, sectors with observed prominence in the Eugene-Springfield area, either in terms of their total employment or concentration above national averages, are highlighted in Table 1.

An "advanced materials cluster," as a "key industry," is predicated upon assumed relationships of shared technical knowledge (in contrast to supply chains or shared work forces which are indeterminate factors from current research) and the capacity of its component businesses to apply regionally sourced innovations. This framing of the cluster conceptually connects public manufacturing assets hosted by the Eugene-Springfield MSA to businesses in its highest-paying sectors. Businesses from adhesives to wood to semiconductors share the technology frame of material sciences. It also aligns best with local and national manufacturing policy aspirations of becoming more "advanced."

Eugene-Springfield hosts major assets, such as: the Materials Science Institute, CAMCOR at the Lorry I. Lokey Laboratory, Oregon Nanoscience and Microtechnologies Institute (ONAMI), the Safer Nanomaterials and Nanomanufacturing Initiative (SNNI) as well as research and development headquarters for several adhesives, chemistry, and wood product companies. Businesses from all of these sectors

Table 4: Chemical Manufacturing Earnings in Oregon MSAs from 2011 to 2012 (Q2)

Workforce Indicators 2011Q2 - 2012Q2	Oregon	Portland	Salem	Corvallis	Albany-Lebanon	Eugene-Springfield
Avg Monthly Earnings	$4,709.00	$4,730.25	$3,771.25	$3,309.75	$4,980.75	$6,166.50
Avg New Hire Earnings	$3,233.25	$3,208.25	$1,997.25	$2,503.00	$3,643.25	$4,638.75

Source: US Census Bureau-Center for Economic Studies / QWI Online / LEHD Oregon Industry Reports.

have related technological inputs and may find benefit from proximity to basic science research in material sciences.

Only forty-minute's travel northbound on I-5 in the City of Albany is home to metals and materials businesses with illustrious histories of innovation, such as: Oregon Metallurgical Company, Oremet, and Wah Chang. In 1942, the U.S. Bureau of Mines established a research center for development of new metallurgical processes, which today is the Albany Research Center—a member of the National Energy Technology Laboratory.

The linkages between local establishments in the sectors displayed in Table 2 as well as the major institutions listed earlier are minimal. However, it is noted large multinationals and elected officials from the Portland-Hillsboro-Beaverton, MSA, when touring equipment and assets at the Universities, will refer to them as simply "annexes" to their own city and company research capabilities. The governments of Eugene and Lane County can do more to market and claim these incredible technological assets as their own when recruiting

CLT Building image from City of Seattle CLT Brochure

Table 5: Comparison of Employment and Earnings in Paint, Coating, and Adhesive Manufacturing

Quick Workforce Indicators (Avg: 2012 Q2 + 3 Prior qtrs)	Lane County	Marion County	Multnomah County	State of Oregon
Total_Employment	239	120	153	601
Average Monthly Earnings	$4,841.00	$3,685.50	$4,264.50	$4,372.25
Average New Hire Earnings	$3,234.75	$1,400.00	$3,128.75	$2,749.25

Source: US Census Bureau-Center for Economic Studies / QWI Online / LEHD Oregon Industry Reports.

Table 6: Lane County Workforce Earnings in Plastics and Rubber Product Manufacturing

Plastics and Rubber Products Manufacturing: NAICS 326		
	Avg Monthly Earnings	Avg New Hire Earnings
Plastics and Rubber Products Manufacturing (2012Q2)	$3,481.00	$1,792.00
Plastics and Rubber Products Manufacturing (Avg: Selected + 3 Prior qtrs)	$3,245.25	$1,615.50

Source: US Census Bureau-Center for Economic Studies / QWI Online / LEHD Oregon Industry Reports.

Plastics and Rubber Products: Employees and Establishments in Eugene – Springfield, OR MSA	
Industry code description	Plastics and rubber products manufacturing
Paid employees for pay period including March 12 (number)	320
First-quarter payroll ($1,000)	2,651
Annual payroll (1,000)	12,725
Total establishments	18

Source: US Census 2011 County Business Patterns

both startup businesses and large industries.

Chemical Manufacturing

Eugene-Springfield's Chemical Manufacturing sector wages are skewed by the presence of a Life Technologies manufacturing and research laboratory facility. Compared to another representative subsector for chemical manufacturing, "Paints, Coatings, and Adhesives," then the wage profile of Eugene resembles other Oregon metropolitan areas. However, the Life Technologies facility in Eugene, a descendant of Eugene-based Molecular Probes, also utilizes advanced materials, like applied nanotechnologies, in its research and development of advanced biological and medical equipment.

Paints, Coating Adhesives and Resins; Wood Treatments and Resin, Synthetic Rubber and Artificial Synthetic Fibers and Filaments Manufacturing (NAICS: 3252 and 3255)

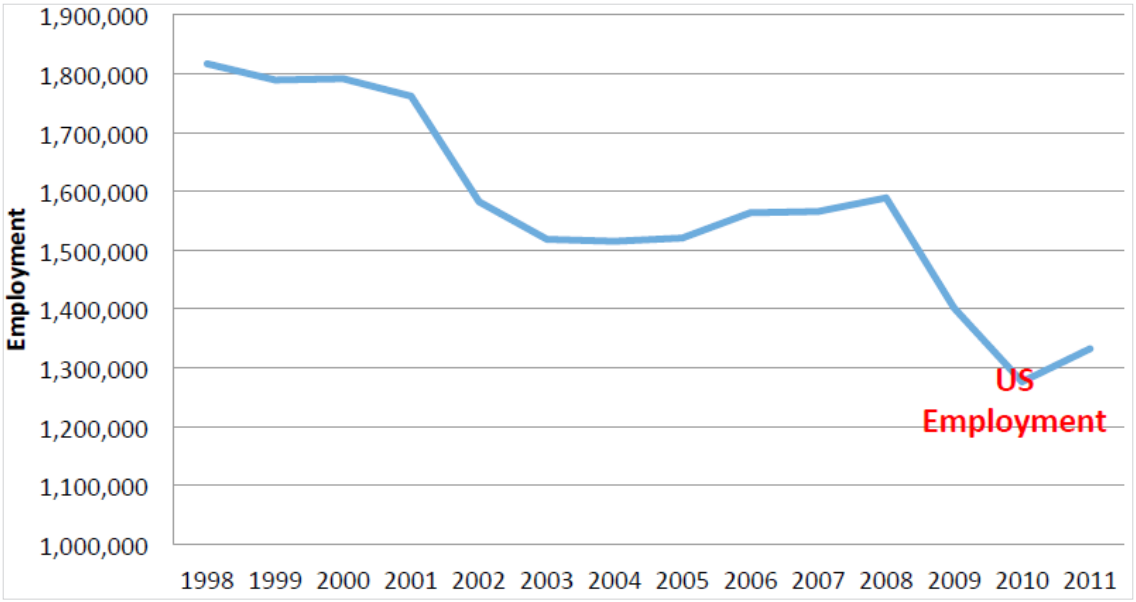
Eugene-Springfield manufacturing has a specialization in resins, wood treatments, and adhesives. The high location quotient for this sector (3.62 with US Total as the base area) is a reminder of the legacy of the region's heyday as "plywood capital of the world." Highly innovative firms, such as the Willamette Valley Company, contribute to the sector's above-average LQ scores. In 2011, the sectors NAICS-coded 3252 and 3255 in Eugene-Springfield consisted of eight establishments, more than 230 employees, and more than $9 million in annual payroll.

Table 7: Lane County Workforce Indicators for Fabricated Metals Manufacturing (NAICS 332)

Lane County Quarterly Workforce Indicators	Fabricated Metal Product Manufacturing (2012 Q2)	Fabricated Metal Product Manufacturing (Avg: 2012 Q2 + 3 Prior Quarters)
Total Employment	1,028	1,001
Job Creation	49	56
New Hires	86	102
Average Monthly Earnings	$3,288.00	$3,341.25
Average New Hire Earnings	$2,383.00	$2,452.50

Source: US Census Bureau-Center for Economic Studies –QWI Online— LEHD Oregon Industry Reports

Figure 6: US Metal Fabrication Employment 1998-2011



Source: Cluster Analysis of the Fabricated Metals Manufacturing Sector in Salem, Oregon,

Prepared by: Phillip Andrews, Spencer Gibson, Under the supervision of Professor Bruce Blonigen

Table 8: Comparing Fabricated Metal Subsectors by Location Quotients and Employment

Sector	Eugene LQ	Eugene Employment	Portland LQ	Portland Employment	Oregon LQ	Oregon Employment
NAICS 332 Fabricated metal product manufacturing	**0.7**	**994**	**ND**	**ND**	**0.88**	**15,396**
NAICS 3327 Machine shops and threaded product mfg.	0.6	219	1.05	2,952	0.89	3,640
NAICS 3329 Other fabricated metal product manufacturing	1.79	487	ND	1,903	0.88	2,943
NAICS 332999 Miscellaneous fabricated metal product mfg.	5.24	397	2.3	1,345	2.16	2,006

ND: No Data. Source: US Bureau of Labor Statistics Location Quotient Calculator. 2012. Base Area: U.S. Total

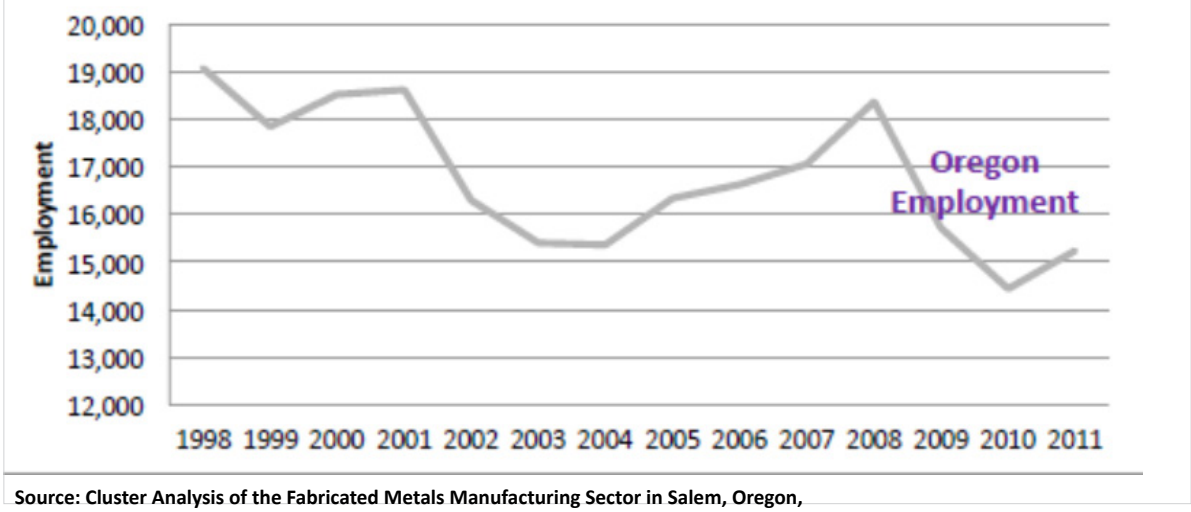
Unknown is the capability of local establishments to co-benefit from advancements in other areas of chemical manufacture and metals research. Networking between manufacturing in Eugene-Springfield generally appears as informal and happenstance, with little collaboration or joint venturing.

The scale and size of these types of manufacturing operations in Eugene are less than other, similarly sized metropolitan areas such as Akron, OH with its 17 establishments and 700 employees, or the coating and adhesive business grouping in Evansville, IN and its annual $130 million payroll. The Eugene-Springfield area firms are bound up historically with wood products, but applications for paint, coating, and adhesive products have diversified substantially to now serve a wider range of industries. The businesses classified as paints, coatings, and adhesive manufacture represent approximately less than half of the total number of establishments and employees in this region's Chemical Manufacturing (NAICS 325) sector, yet they represent only one-quarter of the chemical sector's annual payroll ($41,606). The skew is likely due to Life Technologies classification as Chemical Manufacturer.

Sector Strategies

Companies with products in this field of technology are at the innovative edge and a sector to watch as 3D printing techniques will likely create new market opportunities.

Figure 7: Oregon Metal Fabrication Employment



Source: Cluster Analysis of the Fabricated Metals Manufacturing Sector in Salem, Oregon,
Prepared by: Phillip Andrews, Spencer Gibson, Under the supervision of Professor Bruce Blonigen

Connecting local businesses in technologies like resins, adhesives or constructional materials to the R&D in the University systems and Signature Research Centers—especially to Oregon BEST in context of updates to LEED Green Building standards and advancements in 3D printing equipment—should be an area of local interest.

Fabricated Metals and "Other Fabricated Metals Products"

Fabricated metal is forged, stamped, bent, machined, welded, or fabricated to create parts or final products. The preponderance of fabricated metal products producers use subtractive techniques like stamping, although additive manufacturing techniques may find wider application in this sector in the near future. Examples of local businesses from this field include Farwest Steel, Northwest Stamping, and Clarke's International. Employment numbers for 2011 topped 899 across 83 regional establishments. The industry is projected to grow at a greater than average rate between 2010 and 2020, and offers above-average wages ($37,758) in Lane County.

Fabricated metal product manufacturing, despite employing nearly 8% of all manufacturing occupations in Eugene, does not appear particularly concentrated when compared to national averages. Local firms primarily constitute elements of larger national and international supply chains for small parts, or serve regional markets in products like pre-made sheds or storage units.

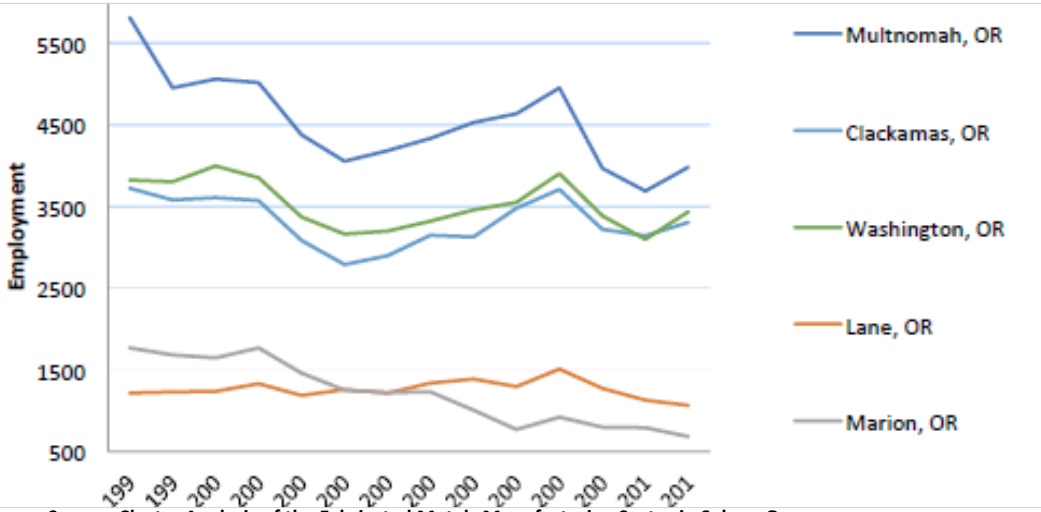
However, this sector possesses some unique specializations within the enigmatic sounding NAICS categories of "other" and "miscellaneous." Miscellaneous fabricated metal product subsectors include establishments engaged in industrial valves, pipe fittings, plumbing fixtures, pieces for industrial trucks and tractors, and other metal products. Employment in these kinds of products, which can resemble commodities, comprises half of all employment in the industry locally.

Sector Strategies

Several fabricated metal businesses, while viewed in isolation, are less significant to regional and federal aspirations of "advanced manufacturing." However, establishments within fabricated metals are, along with other construction material products, most likely to be affected by 3D printing or additive manufacturing. For instance, metal stamping traditionally is a subtractive form of manufacture, cutting components out of materials. An open question is whether additive manufacturing will complement, or supplant, these techniques.

Preparing fabricators to benefit, rather than suffer from, possible disruptions implicit in looming technical innovations like additive manufacturing is worth further exploration. Another major issue facing fabricated metal products

Figure 8: Metal Fabrication Employment: County Trends 1998-2011



Source: Cluster Analysis of the Fabricated Metals Manufacturing Sector in Salem, Oregon,

Prepared by: Phillip Andrews, Spencer Gibson, Under the supervision of Professor Bruce Blonigen

businesses in this region closely mirrors national concerns: an aging workforce with grave industry uncertainty as to where skilled replacements will come. Interviews conducted by Lane Workforce Partnership and other agencies documented business concerns that its aging workforce and reveal an inability of the sector to fill well-paying, high-skilled positions.

Metal stamping traditionally is a subtractive form of manufacture, cutting components out of materials. An open question is whether additive manufacturing will complement, or supplant, these techniques.

An important avenue to explore is how to translate the geographic proximity of the fabricated metal industry to advanced materials research into some kind of competitive advantages for this region's firms. One difficulty of examining fabricated metals, from an even larger regional perspective, is that companies like Wah Chang, despite sharing a sector and statistical classification, are very different businesses with greater research and development capacity than Farwest Steel, Northwest Stamping or Precision International. Outreach and networking activities can seek to assist the establishment of knowledge feedback loops between local metals fabricators and alloy producers.

Wood Products

Regional Significance and Scale

Among wood and forest product manufacturing clusters in the nation, Eugene-Springfield remains a national leader with a total workforce and annual payroll comparable to much larger metropolitan areas in the United States. The long-term slide of employment, which began in the early 1980s and accelerated in the Great Recession, could lead many economists to discount the sector's prospects for economic developers. However, its continued presence in this area is no longer entirely predicated upon basic extraction of natural resources or even a specialized labor force, but capital investments in technology and advanced process efficiencies.

The survival of its top businesses and large proportional share of national production through multiple business shocks gives credence to this local cluster's resilience. It points to the "stickiness" of wood products most advanced operations to locating in this region—despite growing global competition or reduction of logging on federal lands.

Furthermore, the sheer size of its payroll (which is rising even as total employment trended downward) also means it cannot afford to be ignored in discussions of local jobs and wages. Its remarkable recovery over the past year is swifter and larger than other manufacturing subsectors as

Figure 10: Comparing Lane County Wood Product Manufacturing to State of Oregon

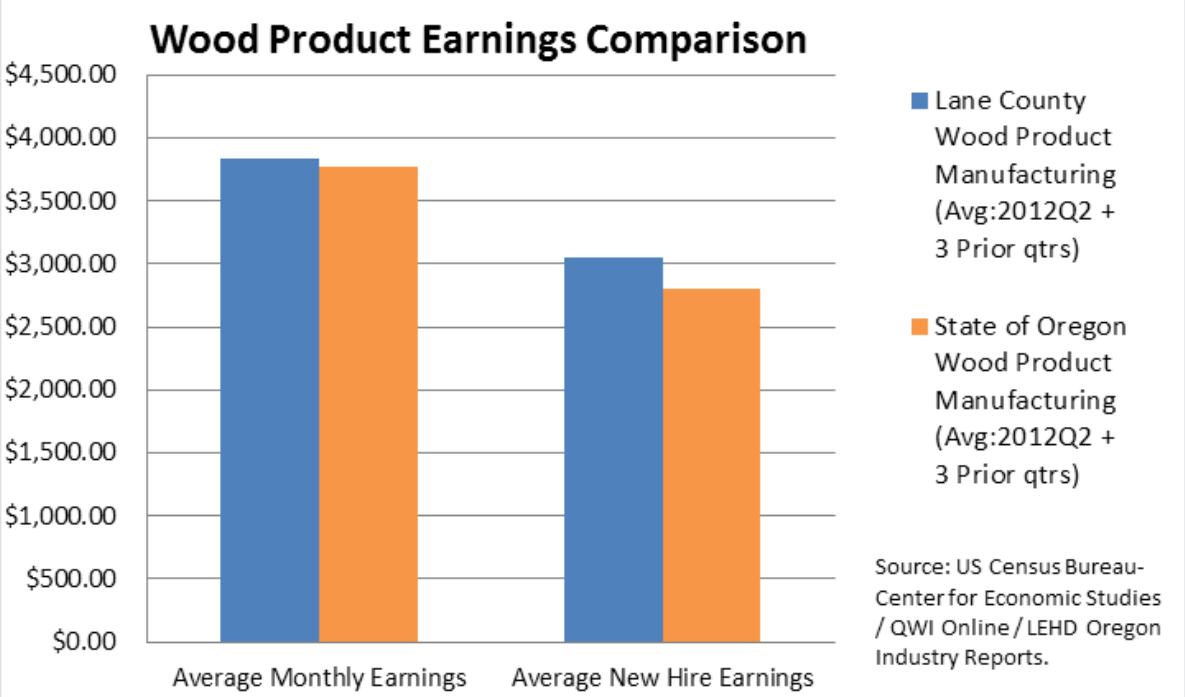


Table 9: Comparing Metropolitan Areas by Wood Product Payroll Size (2009)

Metropolitan Statistical Area	Number of Employees	Annual Payroll ($1,000s)	Number of Establishments
< 500 workers		**< $10,000**	**< 20**
Akron, OH	222	$7,132	16
Brookhaven, MS	303	$8,505	9
Sheboygan, WI	220	$8,264	13
500 – 2,400 workers		**< $50,000**	**< 30**
Centralia, WA	1,612	$70,855	25
Boise City-Nampa, ID	1,511	$41,694	60
Boston-Cambridge-Quincy, MA-NH	1,157	$47,322	104
Albemarle, NC	1,156	$38,097	17
2,000+ workers		**$50,000+**	**50+**
Sacramento-Arden-Arcade-Roseville, CA	2,321	$78,930	76
Atlanta-Sandy Springs-Marietta, GA	3,556	$106,691	152
New York-Northern New Jersey-Long Island, NY-NJ-PA	3,600	$136,707	255
Seattle-Tacoma-Bellevue, WA	3,766	$138,318	149
Los Angeles-Long Beach-Santa Ana, CA	5,397	$150,870	327
Eugene-Springfield, OR	3,844	$164,645	65
Dallas-Fort Worth-Arlington, TX	6,108	$180,095	182

Source: US Census 2009 County Business Patterns

measured by either its portion of metro GDP or by hiring growth. This productivity buoyancy in response to cyclical shocks to demand may be attributable to its innovation, product diversification internal to firms (for instance, WVCO makes products ranging from flooring to custom robotics to agriculture treatments) and strong clustering between the wood, forest, furniture and related construction material sectors.

Scale

A review of concentrations in wood product occupation and the number of regional establishments reveal the scale of this quintessential, natural resource-based cluster. The addition of other sectors to this cluster, such as so-called "secondary wood product" industries like Household and Institutional Furniture and Kitchen Cabinet Manufacturing, plus the basic extractive activities like "logging," only then may the extent and enduring importance of both primary forest and secondary wood product manufacturers be enumerated. In 2011, Eugene's employees listed as working in "forestry and logging" at a rate greater than 10 times national average, wood products manufacturing at 9.88 times, and within the subsector of "plywood and engineered wood products": 26.5 times with 1,682 local employees.

Indeed, Table 9 displays a rarity: the Eugene-Springfield, MSA sitting comfortable in statistical company with two of the largest metros in the Western Hemisphere. In fact, there are only a handful of metropolitan areas in the country with wood product workforces greater than 3,000 according to US Census Business Patterns statistics. The local wood products cluster cannot be dismissed from view on theories of portfolio diversification or just the observation that employment is trending towards business services. Average wages in wood products were approximately $44,413 in 2011. Lane County's wood product manufacturing wage was a bit higher than the Oregon's statewide average of $41,919.

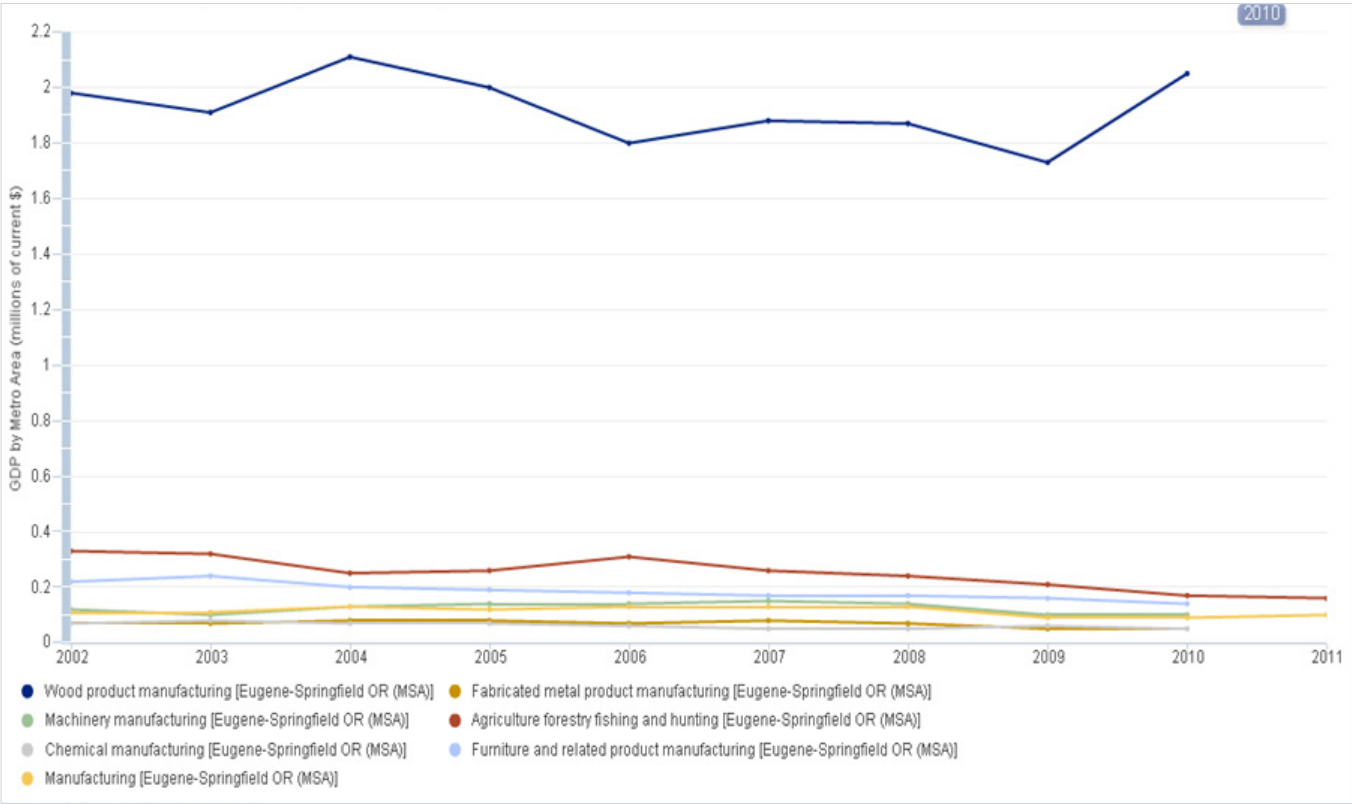
The wood products cluster continues to account for an enormous share not only of Eugene-Springfield's metropolitan GDP, but a significant portion of all United States metropolitan area wood production. Figure 2 shows

Table 11: 2011 MSA Payroll & Establishments for NAICS Code 321 – Wood Products

Metropolitan Area	Annual Payroll ($1,000s)	Total Establishments	2010 MSA Population
Rochester, NY	$7,066	35	1,054,323
Ann Arbor, MI	$8,363	8	344,791
Corvallis, OR	$12,575	5	85,579
Baton Rouge, LA	$15,394	33	802,484
Yakima, WA	$16,439	23	243,231
Tuscon, AZ	$21,897	17	980,263
Mobile, AL	$25,775	20	412,992
Milwaukee-Waukesha-West Allis, WI	$28,867	47	1,555,908
Redding, CA	$32,178	14	177,223
Hickory-Lenoir-Morganton, NC	$39,524	80	365,497
Boston-Cambridge-Quincy, MA-NH	$44,792	98	4,552,402
Birmingham-Hoover, AL	$44,828	48	1,128,047
Portland-Vancouver-Beaverton, OR-WA	$126,864	139	2,226,009*
Chicago-Naperville-Joliet, IL-IN-WI	$127,143	203	9,461,105
Elkhart-Goshen, IN	$127,998	75	197,559
Seattle-Tacoma-Bellevue, WA	$131,119	145	3,439,809
Eugene-Springfield, OR	**$152,870**	**60**	**351,715**

Source: US Census Business Patterns, 2011

Figure 10: Eugene-Springfield's Manufacturing as Percentage Share of All U.S. Metro's



Source: US Bureau of Economic Analysis

wood product manufacturing in Eugene-Springfield accounts for more than 2% of all wood product manufacturing GDP by metropolitan areas in the United States. In contrast, local machinery, chemical, furniture, and fabricated metals manufacturing industry contributions do not individually rise above 0.3% of the United States' metropolitan GDP.

Trends

This increase in production (although local wood product employment totals remain below previous highs) can be attributed to capital improvements in automation and other production efficiencies. Shocks to national housing markets and changes to industry practice thinned employment and the number of establishments, but it did not drastically cut the region's share of national production or stop production value from rising. The remaining firms within the region's cluster are profitable, sustainable operations with deep-seated, place-based comparative advantages. Eugene-Springfield possesses industry leadership and concentration of integrated wood product operations with sophistication incomparable to most any other subsector of this region's manufacturing.

Wood products are a critical and continuing part of Eugene-Springfield's manufacturing mix. Inarguably, policy-makers must contend with this industry's legacy. Ongoing rises in productivity and higher wages in this sector should be acknowledged—and to any extent possible, leveraged. Coincidentally, when comparing metros for industrial scale and regional character, Elkhart, Indiana—an RV manufacturing capital of the US—is the only other metropolitan area in the United States with an annual payroll in wood product manufacturing above $120 million and a metropolitan area population below 400,000.

Sector Strategies

Economic developers should prioritize outreach and assistance to the ecosystem of suppliers, smaller ancillary businesses, and secondary wood product start-ups. This can reflect a tactical choice by economic development agencies to prevent the attributes of this cluster from becoming too static and the long-term, strategic interest in retaining advanced, high-paying, and globally well-connected headquarter operations.

Table 11: Lane County Workforce Indicators for Machinery Manufacturing (NAICS 333)

Lane County Quarterly Workforce Indicators	Machinery Manufacturing (2012 Q2)	Machinery Manufacturing (Avg: 2012 Q2 + 3 Prior Quarters)
Total Employment	1,638	1,558
Job Creation	57	67
New Hires	110	115
Average Monthly Earnings	$4,496.00	$4,646.00
Average New Hire Earnings	$3,183.00	$3,288.25

Source: US Census Bureau-Center for Economic Studies –QWI Online— LEHD Oregon Industry Reports

Table 13: Location Quotients in Eugene-Springfield: Select Machinery Subsectors

Sector	LQ	Employment
NAICS 333 Machinery manufacturing	**1.44**	**1,602**
NAICS 3331 Ag., construction, and mining machinery mfg.	1.86	464
NAICS 33311 Agricultural implement manufacturing	2.14	178
NAICS 3332 Industrial machinery manufacturing	3.32	352
NAICS 333243 Sawmill, woodworking, and paper machinery mfg.	20.04	268
NAICS 3333 Commercial and service industry machinery	0.6	54
NAICS 3339 Other general purpose machinery manufacturing	2.16	550
NAICS 33392 Material handling equipment manufacturing	**5.02**	**362**

Source: US Bureau of Labor Statistics Location Quotient Calculator. 2012. Base Area: U.S. Total

Furthermore, recruitment of a branch campus of the Oregon Institute of Technology and Oregon BEST researchers to the Eugene-Springfield area could have a two-fold, proximity impact on the local wood products industry: helping educate regional youth for the more technically advanced work of today, and firming up connections between local industry and basic research into "greener" construction materials.

A networked community of related wood products entrepreneurs, innovators, and investors would improve upon a place-based case for wood product management to retain a Eugene presence. There are many locational co-benefits accompanying hosting the functions of an industrial headquarters. The need to retain, in the words of one local business owner, the "native intelligence" of local personnel is more compelling than any public subsidy package and resistant to the lower cost pulls of larger labor or consumer markets.

Heavy Machinery Manufacturing

Lane County heavy machinery manufacturers serve diverse markets with the strongest concentration of employers in agriculture, construction, mining machinery, industrial machinery for sawmills, and material handling equipment. The origin of many of these businesses lay in creation of industrial equipment for use by farms, sawmills and woodworking plants servicing the natural extraction industries. Today, leading businesses are reported to sell a significant portion of their equipment to countries in South America and South Asia on the basis of attention to higher quality and customer services.

Given this reported emphasis on product design and quality at Eugene-Springfield machinery firms, it is unsurprising the average annual wage in machinery was approximately $52,591 in 2011—higher than wood products. Two of the three leading employers, Johnson Crushers and Peterson Pacific, are subsidiaries of ASTIC Industries based in Chattanooga, TN.

Sector Strategies

Significant employment in heavy machinery in Eugene-Springfield may be attributed to three firms in particular: Bulk Handling Systems, Peterson Pacific, and Johnson Crushers. Two of these are part of a larger entity known as "ASTIC." These businesses showed considerable employment volatility during the recession, but are reportedly becoming even more export intensive in their business models. Their export-led growth could bring more dollars to the region and indirectly create a plethora of support service jobs. Therefore, a strategy of "import substitution" is appropriate to economic development activities with members of these industries.

Table 13: Transportation Equipment Workforce Indicators in Lane County (NAICS 336)

Lane County QWI	Transportation Equipment Manufacturing 2012 (Q2)	Transportation Equipment (Avg: Selected + 3 Prior qtrs)
Total Employment	715	815
Job Creation	22	16
New Hires	22	26
Avg Monthly Earnings	$3,694	$3,377
Avg New Hire Earnings	$1,910	$2,157

Source: US Census Bureau-Center for Economic Studies –QWI Online— LEHD Oregon Industry Reports

Table 14: Select Transportation Equipment Subsectors Location Quotients in Eugene-Springfield

Sector	LQ	Employment
NAICS 336 Transportation equipment manufacturing	0.43	643
NAICS 3362 Motor vehicle body and trailer manufacturing	1.11	143
NAICS 3363 Motor vehicle parts manufacturing	0.15	75
NAICS 336991 Motorcycle, bicycle, and parts manufacturing	5.27	62

Source: US Bureau of Labor Statistics Location Quotient Calculator. 2012. Base Area: U.S. Total

Table 15: Computer and Electronic Product Manufacturing Workforce Indicators in Lane County 2012

Lane County Workforce Indicator Quick Facts		
	Computer and Electronic Product Manufacturing 2012 (Q2)	**Computer and Electronic Product Manufacturing (Avg: Selected + 3 Prior qtrs)**
Total Employment	640	677
Net Job Flows	-21	-13
Job Creation	7	12
New Hires	20	32
Avg Monthly Earnings	$6,531.00	**$5,894.25**
Avg New Hire Earnings	$5,583.00	$4,355.00
Source: US Census Bureau-Center for Economic Studies –QWI Online— LEHD Oregon Industry Reports		

Encouraging their growth to be embedded within a local network of industrial suppliers and support services could be beneficial for job creation, and would likewise hedge against possible future decisions made in Tennessee or elsewhere to relocate these local manufacturing operations. Economic developers can work to facilitate connections between these leading companies to local suppliers.

Transportation Equipment Manufacturing

Among regional manufacturers, transportation equipment earnings are only slightly above regional averages for all sectors of employment in Eugene-Springfield. Total employment is also much diminished from before the recession. After the recession, Eugene is considered by industry experts as more of a sales and service center than a manufacturing hub. Although some manufacturers, like Marathon, remain in Eugene-Springfield and will hire workers as baby boomers nationally retire and boost sales, total sector employment to pre-recession highs is doubtful.

Studies indicate workers have made lateral moves within manufacturing, possibly fabricated metals or heavy machinery, or took retail trade work.

Most businesses of the much reduced RV manufacturing industrial cluster are small enough in size that although there is variety within the cluster, the overall concentration of employment and employers compared to national averages does not appear very significant.

Sector Strategies

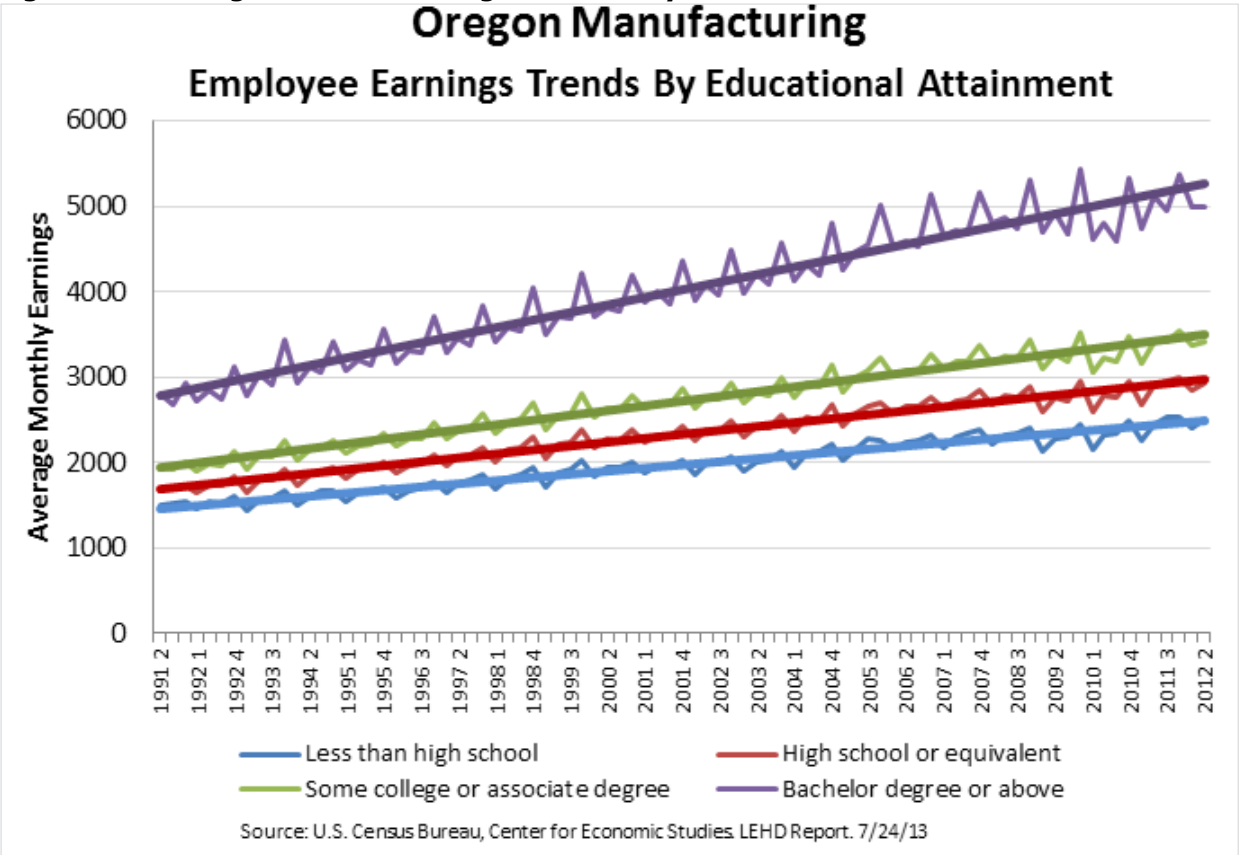
Transportation equipment and recreation vehicle manufacturing do not rise as top priority if judged by earnings, total number of workers, or trends. However, its rapid decline and mass layoffs at the onset of the Great Recession severely impacted the health of this metro's economy. Additional interviewing of individual businesses classified as transportation equipment manufacturing might uncover relationships to larger clusters or other manufacturing in this area.

Table 17: Electronics Location Quotients in Eugene-Springfield (Compared to National Base)

Sector	Eugene LQ	Eugene Employment	Portland LQ	Portland Employment	Corvallis LQ	Corvallis Employment
NAICS 334 Computer and electronic product manufacturing	**0.54**	**595**	**4.14**	**35,289**	**8.06**	**2,012**
NAICS 3344 Semiconductor and electronic component mfg.	**0.22**	87	**9.26**	27,673	ND	ND
NAICS 3345 Electronic instrument manufacturing	0.31	126	1.53	4,780	ND	ND

ND: Not Disclosable. Source: US Bureau of Labor Statistics Location Quotient Calculator. 2012. Base Area: U.S. Total

Figure 12: Earnings in Manufacturing Statewide by Educational Attainment



Computer and Electronic Product Manufacturing

The state of Oregon is a national leader in computer and electronic product manufacturing with a rich heritage and origins in the famous firm Tektronix. Eugene-Springfield is the second largest metropolitan area in the state, but proportionately its employment in this industrial cluster is far below state averages. In fact, a worker in Eugene-Springfield is one-fifth as likely to work in computer and electronic product manufacturing as a worker selected at random from anywhere else within the state (Eugene LQ when using Oregon state as the base area: 0.20/Portland: 1.52; by comparison, a worker in Corvallis is nearly three times more likely to work in this sector than a randomly sampled Oregonian.)

Although average monthly earnings were near double all other sectors, total employment in this sector currently accounts for about 8% of total durable goods manufacturing jobs in the region—about as many as are in the transportation equipment sector. Still, in 2010 after the sector's production in the metro shrank from $814 million in 2008 to $425 million in production, its contribution accounted for approximately half the value of all of Eugene-Springfield's total durable goods manufacture ($959 million).

Since the closure of Hynix and layoffs associated with the Great Recession, employment has begun to rebound. From 2011 to 2012 hiring grew 140% (for instance, hardware maker Feeney Wireless celebrated its 100th Eugene employee in April 2013). However, the departure of other companies (such as VersaLogic's reorganization towards Portland) does not bode well for Eugene as a competitive location for this kind of product manufacture.

Sector Strategies

Significant employers could be visited individually and questioned as to what advantages they find in locating in the Eugene region as well as what might lure them away. Economic development agencies concerned about the precipitous decline in employment and production in this high-wage, traded sector must also avoid committing the

error of ignoring or "writing off" the businesses that remain. Eugene is part of a state and larger region noted for this kind of manufacturing, so the rapid return of businesses within this sector—as quick as their departure—is conceivable.

Notably, Corvallis has a large concentration of workers in this sector due to the presence of Hewlett Packard. This computer manufacturer specialization contrasts with the Eugene-Springfield area's 1,707 custom software publisher employees (Eugene LQ in 2012: 5.93/Corvallis: 2.77/Portland: 2.92). Corvallis and Eugene-Springfield, if taken as one economic region, they together present a far more complete industrial portfolio in technology with very significant concentrations in both software and computer component manufacture. Policies and actions that enrich and substantiate this presentation also build the basis of a more potent brand for South Willamette Valley.

Cross-Sector Strategies

This Section of the report will discuss importance of regional scale, metro productivity and responsive actions.

An Approach to STEM

Elected official interest in "advanced manufacturing," where wages for highly skilled workers are known to be rising, reflects a growing concern for regional low productivity and lowering standards of living. A common assumption is formal education, specifically college attendance, is the antidote to a deficient workforce pipeline. Recent studies indicate a more complicated picture of STEM skills—decoupling worker performance from degrees. The lack of informal education opportunities—chances for learning-by-doing on real life projects—is needed to bolster what is commonly referred to as "STEM" skills. Economies with higher concentrations of employment in STEM fields are shown to perform better in patent production, exports as share of GDP, employment growth rate, median household income, unemployment, and tech employment share.

Many high-paying occupations in manufacturing are not concerned in professional degrees, but individual competencies and experience. Practice is the only method deemed fully adequate by most employers and, indeed, is still the only way known for transference of the most valuable workplace skills. Chances to practice on real work projects, however, is increasingly in short supply even as employers demand more of it before entrusting their valuable technical equipment, time, and high-paying jobs to new or re-trained workers.

Youth exposure to manufacturing careers is likewise circumscribed; commonly held perceptions of manufacturing as inherently dangerous, "dirty," and menial persist. Increasing ways of gaining access to opportunities to practice on meaningful projects will require the direct, significant, and sustained collaboration of public and private sectors.

Addressing Regional Low Productivity and Low Wages

Unemployment in Eugene-Springfield is now high, but the widening gap in wages and productivity are more troubling. Local employment follows national trends, albeit sharper in its contraction and slower in its recovery. Compared with other state metropolitan areas, Eugene-Springfield's productivity and wages are falling behind other Oregon cities at a pace suggesting a failure to adapt to new economic circumstances. In the "knowledge-based economy," cities boasting high technical expertise are usually rewarded with growing productivity and increasing wages.

Manufacturing is unexceptional to these changes. The public sector must approach "low-skill manufacturing" not as a panacea for job creation and low employment rates, but view it as any other high-wage sector. The 21st century economic competition is based upon more than the price of land or the expense of water, but the ability of local workers to think critically, collaborate, problem-solve, and innovate solutions. The Eugene-Springfield region has many "human capital" advantages in its pursuit of "advanced" manufacturing. However, the public sector capacity to collaborate in their development is severely hampered. The recent difficulties in coordinating several separate industry-led tech or STEM advisory boards to the various education districts is an example.

The legacy of regulations adopted by the City of Eugene, like the "Toxics Right to Know" law (which remains very unpopular amongst many close to local manufacturers), still colors public agencies ability to conduct outreach and form partnerships. Substantial measures must be taken to combat commonly held perceptions, such as: the City of Eugene is uninterested in increasing manufacturing employment, is primarily punitive in its approach to fabrication-type industries, and as a result manufacturers prefer to keep a "low profile" to avoid government attention.

Important, incremental steps towards deepening relationships must include public sector initiated celebrations of local manufacturing achievements. There is marketing value in trumpeting accomplishments of local manufacturers, such as the hiring of 100th employees or promotion of tech companies' acumen.

What Influences Manufacturing Concentrations?

The geographic scales across which clusters are observed to work vary by industry type. All clusters span across different scales. For example, craft breweries are a statewide phenomenon in Oregon with an observed concentration in Eugene; financial services are found throughout Connecticut with exceptional banking concentrations in Stamford and insurance in Hartford. Services or product development that is human expertise driven—like software, financing, or advertising—tend to agglomerate more intensively in fixed geographic areas because of the importance of person-to-person contacts in formulating trust, crafting deals, transferring valuable "tacit" knowledge and in sharing new skills.

Manufacturers (different from the aforementioned professional or technical services which rely heavily on creative talent, individual expertise, and cost efficient information technologies to market their goods and services) must also contend with competing production factors like distance to resources, consumers, and transportation costs. Although the locations of manufacturing operations and clusters are pulled over larger areas compared to the purer "knowledge creation" industries, the design and skill intensive aspects of manufacturing still tend to cluster tightly in physical proximity because of human network effects and agglomerative economies—such as shared labor pools or access to R&D labs.

What Impact will 3D-Printing have?

Notably, some of today's tech futurists predict innovations in "additive manufacturing" will reinforce close geographic

clustering in manufacturing sectors by turning the labor and transportation cost calculus of prior generations completely on its head. Some industry experts and economists forecast the advent of 3D printing will undermine the advantages of low-cost labor in production and underscore the value of being physically close to primary consumer markets, having highly skilled and educated workers, innovators, and fostering specialized communities of practice.

However, others believe 3D printers will simply complement other manufacturing equipment—perhaps shortening the time for prototyping and negating the need to go outside of a firm for ordering some short-run, custom parts. Overall, they predict minimal disruptions to current businesses. Some place between these poles is the future. Economic developers and other public agencies cognizant of these technical changes and debates can update their approaches to booking speakers and plan informational networking events with technique experts.

Expensive laboratory equipment or 3D printers which are beyond the means of any individual entrepreneur or firm could be purchased with public support. Speakers, drawn from outside this area and who utilize these techniques could be arranged to come to networking events, give presentations at the community colleges, and talk Regional Accelerator and Innovation Network (RAIN) events.

Suitability and Support for Community Accessible "Maker Space"

A better funded, more professionally equipped, public supported, and community-accessible Maker Space could help improve the local government's image in industry circles. A tangible, visible investment in manufacturing workforce development, a sort of a "YMCA for tech," would send a positive message the region welcomes and actively seeks to boost manufacturing employment. Such a space could become an expression of the region's economic identity and creative brand. More importantly, it could also offer the kind of blended educational and workspace in demand by educators and employers.

The Maker Space grassroots movement of the past few years is a significant manifestation in response to several macro-level economic trends referenced in the report's introduction, including: automation, an increasing emphasis and demand for abilities only transferred by the act-of-doing on-the-job, and the creative, "artisan" manufacturing worker. The City must leverage recent state education investments in STEM and Career Technical Education and align its resources to these trends to help achieve its Prosperity goals of improving relations and investing in tomorrow's talent. If it chooses to do so, it is probable it will find community partners among the local school districts, Lane Community College, associates of the University of Oregon's STEM Center through Outreach, Research, and Education (STEM CORE), members of the Society of Manufacturing Engineers, and possibly the University of Oregon's undergraduate Product Design program.

Table 18: 2011 Oregon Metropolitan Productivity Ratio

Bend, OR:	0.694
Corvallis, OR:	1.389
Eugene-Springfield:	**0.634**
Portland, OR:	1.294
Salem, OR:	0.571

Source: US Bureau of Economic Analysis

(GDP output per person for metros divided by the gross domestic product (GDP) per person for the nation as a whole)

Beyond shared equipment, a Maker Space connects communities of practice and reduces lessens social distance between people from different fields or formal education backgrounds. An economically important by-product—innovation—comes from this mixing of various fields, disciplines, and ability levels in a free-form, community environment. The freedom of space, flexibility in hours, and emphasis on learning-by-doing over traditional instruction reflect present day realities confronting the schedules of many individuals, the market imperative to constantly re-train, and the emphasis employers place on abilities and kinds of tacit knowledge only attainable through practice. These qualities are among what distinguish the economic value of Maker Spaces from other community investments.

Blended education and workspace, supplemental to school

district offerings, can have greater appeal to young people as well as the programmatic flexibility to suit either employers or entrepreneurial interests. Its tool library and equipment are public goods which can encourage workers, young and old, to experiment with the latest techniques and gain new computer language. Among the equipment already available to Eugene Maker Space members are a CNC machine and a 3D printer, but in the future this group could be equipped with production equipment that accounts for the diversity of sectors and employment opportunities locally. National examples of maker spaces include Tech Shop in Pittsburgh, Artisan Asylum in Cambridge, and ADX Portland.

Conclusion

The greatest challenges for economic developers are not specific to a sector or cluster, but apply to all of the region's manufacturing. At the highest levels, regional agencies, legislators, and university officials can utilize an understanding of strength and weaknesses within the Eugene-Springfield area to inform location choices for sector specialized educational offerings, business recruitment, and marketing or outreach.

However, the choices available to young and prime working age individuals in their community—particularly in gaining direct experience with mentors and as apprentices—should be an area of primary concern.

Appendix

Sector Definitions from StatsAmerica.org

Machinery: Component **Sectors**

NAICS Code	Sector
333	Machinery manufacturing subcluster
333111	Farm machinery and equipment manufacturing
333112	Lawn and garden equipment manufacturing
333120	Construction machinery manufacturing
333131	Mining machinery and equipment manufacturing
333132	Oil and gas field machinery and equipment
333210	Sawmill and woodworking machinery
333220	Plastics and rubber industry machinery
333291	Paper industry machinery manufacturing
333292	Textile machinery manufacturing
333293	Printing machinery and equipment manufacturing
333294	Food product machinery manufacturing
333295	Semiconductor machinery manufacturing
333298	All other industrial machinery manufacturing
333311	Automatic vending machine manufacturing
333312	Commercial laundry and dry cleaning machinery
333313	Office machinery manufacturing
333314	Optical instrument and lens manufacturing
333315	Photographic and photocopying equipment manufacturing
333319	Other commercial and service machinery manufacturing
333411	Air purification equipment manufacturing
333412	Industrial and commercial fan and blower manufacturing
333414	Heating equipment, except warm air furnaces
333415	AC, refrigeration, and forced air heating
333511	Industrial mold manufacturing
333512	Metal cutting machine tool manufacturing
333513	Metal forming machine tool manufacturing
333514	Special tool, die, jig, and fixture manufacturing
333515	Cutting tool and machine tool accessory manufacturing
333516	Rolling mill machinery and equipment manufacturing
333518	Other metalworking machinery manufacturing
333611	Turbine and turbine generator set units manufacturing
333612	Speed changer, drive, and gear manufacturing
333613	Mechanical power transmission equipment manufacturing
333618	Other engine equipment manufacturing
333911	Pump and pumping equipment manufacturing
333912	Air and gas compressor manufacturing
333913	Measuring and dispensing pump manufacturing
333921	Elevator and moving stairway manufacturing
333922	Conveyor and conveying equipment manufacturing
333923	Overhead cranes, hoists, and monorail systems
333924	Industrial truck, trailer, and stacker manufacturing
333991	Power-driven handtool manufacturing
333992	Welding and soldering equipment manufacturing
333993	Packaging machinery manufacturing
333994	Industrial process furnace and oven manufacturing
333995	Fluid power cylinder and actuator manufacturing
333996	Fluid power pump and motor manufacturing
333997	Scale and balance, except laboratory, manufacturing
333999	Miscellaneous general purpose machinery manufacturing

Advanced Materials Cluster: Component Sectors

NAICS	Sector
212325	Clay and ceramic and refractory minerals mining
316211	Rubber and plastics footwear manufacturing
322221	Coated and laminated packaging paper and plastics film manufacturing
322299	All other converted paper product manufacturing
324191	Petroleum lubricating oil and grease manufacturing
325110	Petrochemical manufacturing
325120	Industrial gas manufacturing
325131	Inorganic dye and pigment manufacturing
325132	Synthetic organic dye and pigment manufacturing
325181	Alkalies and chlorine manufacturing
325182	Carbon black manufacturing
325188	All other basic inorganic chemical manufacturing
325191	Gum and wood chemical manufacturing
325192	Cyclic crude and intermediate manufacturing
325193	Ethyl alcohol manufacturing
325199	All other basic organic chemical manufacturing
325211	Plastics material and resin manufacturing
325212	Synthetic rubber manufacturing
325221	Cellulosic organic fiber manufacturing
325222	Noncellulosic organic fiber manufacturing
325320	Pesticide and other ag. chemical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological product manufacturing
325510	Paint and coating manufacturing
325520	Adhesive manufacturing
325611	Soap and other detergent manufacturing
325612	Polish and other sanitation good manufacturing
325613	Surface active agent manufacturing
325620	Toilet preparation manufacturing
325910	Printing ink manufacturing
325920	Explosives manufacturing
325991	Custom compounding of purchased resins
325992	Photographic film and chemical manufacturing
325998	Other miscellaneous chemical product manufacturing
326112	Plastics packaging film and sheet (including laminated) manufacturing
326113	Unlaminated plastics film and sheet (except packaging) manufacturing
326121	Unlaminated plastics profile shape manufacturing
326140	Polystyrene foam product manufacturing

326150 Urethane and other foam product (except polystyrene) manufacturing
326199 All other plastics product manufacturing
326291 Rubber product manufacturing for mechanical use
326299 All other rubber product manufacturing
327112 Vitreous china, fine earthenware, and other pottery product manufacturing
327113 Porcelain electrical supply manufacturing
327124 Clay refractory manufacturing
327125 Nonclay refractory manufacturing
327420 Gypsum product manufacturing
327910 Abrasive product manufacturing
327992 Ground or treated mineral and earth manufacturing
327993 Mineral wool manufacturing
331111 Iron and steel mills
331210 Iron and steel pipe and tube manufacturing from purchased steel
331221 Rolled steel shape manufacturing
331222 Steel wire drawing
331311 Alumina refining
331314 Secondary smelting and alloying of aluminum
331315 Aluminum sheet, plate, and foil manufacturing
331316 Aluminum extruded product manufacturing
331319 Other aluminum rolling and drawing
331411 Primary smelting and refining of copper
331419 Primary nonferrous metal, except CU and AL
331421 Copper rolling, drawing, and extruding
331422 Copper wire, except mechanical, drawing
331423 Secondary processing of copper
331491 Nonferrous metal, except CU and AL, shaping
331492 Secondary processing of other nonferrous
331511 Iron foundries
331512 Steel investment foundries
331513 Steel foundries, except investment
331521 Aluminum die-casting foundries
331522 Nonferrous, except AL, die-casting foundries
331524 Aluminum foundries, except die-casting
331525 Copper foundries, except die-casting
331528 Other nonferrous foundries, exc. die-casting
332111 Iron and steel forging
332116 Metal stamping
332117 Powder metallurgy part manufacturing
332313 Plate work manufacturing
332322 Sheet metal work manufacturing
332618 Other fabricated wire product manufacturing
332710 Machine shops
332812 Metal coating, engraving (except jewelry and silverware), and allied services to manufacturers
332813 Electroplating, plating, polishing, anodizing, and coloring
332911 Industrial valve manufacturing
332991 Ball and roller bearing manufacturing
332995 Other ordnance and accessories manufacturing
332997 Industrial pattern manufacturing
332999 All other miscellaneous fabricated metal product manufacturing
333298 All other industrial machinery manufacturing
333313 Office machinery manufacturing
333319 Other commercial and service industry machinery manufacturing
333511 Industrial mold manufacturing
333513 Machine tool (metal forming types) manufacturing
333514 Special die and tool, die set, jig, and fixture manufacturing
333515 Cutting tool and machine tool accessory manufacturing
333518 Other metalworking machinery manufacturing
333912 Air and gas compressor manufacturing
334119 Other computer peripheral equipment manufacturing
334220 Radio and television broadcasting and wireless communications equipment manufacturing
334290 Other communications equipment manufacturing
334411 Electron tube manufacturing
334412 Bare printed circuit board manufacturing
334413 Semiconductors and related device manufacturing
334414 Electronic capacitor manufacturing
334415 Electronic resistor manufacturing
334416 Electronic coils, transformers, and inductors
334417 Electronic connector manufacturing
334418 Printed circuit assembly manufacturing
334419 Other electronic component manufacturing
334510 Electromedical and electrotherapeutic apparatus manufacturing
334511 Search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing
334512 Automatic environmental control manufacturing for residential, commercial, and appliance use
334513 Instruments and related products manufacturing for measuring, displaying, and controlling industrial process variables
334514 Totalizing fluid meter and counting device manufacturing
334515 Instrument manufacturing for measuring and testing electricity and electrical signals
334517 Irradiation apparatus manufacturing
334519 Other measuring and controlling device manufacturing
335110 Electric lamp bulb and part manufacturing
335314 Relay and industrial control manufacturing
335921 Fiber optic cable manufacturing
335931 Current-carrying wiring device manufacturing
336322 Other motor vehicle electrical and electronic equipment manufacturing
336399 All other motor vehicle parts manufacturing
336419 Other guided missile and space vehicle parts and auxiliary equipment manufacturing
339111 Laboratory apparatus and furniture manufacturing
339112 Surgical and medical instrument manufacturing
339113 Surgical appliance and supplies manufacturing
339991 Gasket, packing, and sealing device manufacturing
541380 Testing laboratories

541710	Research and development in the physical, engineering, and life sciences

NAICS Code	**Sectors Related to Chemicals and Chemical Based Products**
325920	Explosives manufacturing
325991	Custom compounding of purchased resins
325992	Photographic film and chemical manufacturing
325998	Other miscellaneous chemical product manufacturing
326111	Plastics bag manufacturing
326112	Plastics packaging film and sheet manufacturing
326113	Nonpackaging plastics film and sheet manufacturing
326121	Unlaminated plastics profile shape manufacturing
326122	Plastics pipe and pipe fitting manufacturing
326130	Laminated plastics plate, sheet, and shapes
326140	Polystyrene foam product manufacturing
326150	Urethane and other foam product manufacturing
326160	Plastics bottle manufacturing
326191	Plastics plumbing fixture manufacturing
326192	Resilient floor covering manufacturing
326199	All other plastics product manufacturing
326211	Tire manufacturing, except retreading
326212	Tire retreading
326220	Rubber and plastics hose and belting manufacturing
326291	Rubber product manufacturing for mechanical use
326299	All other rubber product manufacturing
327111	Vitreous china plumbing fixture manufacturing
327112	Vitreous china and earthenware articles manufacturing
327113	Porcelain electrical supply manufacturing
327121	Brick and structural clay tile manufacturing
327122	Ceramic wall and floor tile manufacturing
327123	Other structural clay product manufacturing
327124	Clay refractory manufacturing
327125	Nonclay refractory manufacturing
327211	Flat glass manufacturing
327212	Other pressed and blown glass and glassware
327213	Glass container manufacturing
327215	Glass product manufacturing made of purchased glass
327310	Cement manufacturing
327320	Ready-mix concrete manufacturing
327331	Concrete block and brick manufacturing
327332	Concrete pipe manufacturing
327390	Other concrete product manufacturing
327410	Lime manufacturing
327420	Gypsum product manufacturing
327910	Abrasive product manufacturing
327991	Cut stone and stone product manufacturing
327992	Ground or treated minerals and earths manufacturing
327993	Mineral wool manufacturing
327999	Miscellaneous nonmetallic mineral products
424610	Plastics materials merchant wholesalers
424690	Other chemicals merchant wholesalers
424710	Petroleum bulk stations and terminals
424720	Other petroleum merchant wholesalers