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Workforce Baseline Assessment for Biobased Manufacturing in Maine

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Prepared for Biobased Maine

E·D·A
U.S. ECONOMIC DEVELOPMENT ADMINISTRATION

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I. Executive Summary

At the request of Biobased Maine, this report provides a baseline assessment of the current workforce that likely can support or transition to biobased manufacturing in Maine. This assessment will be used to inform Biobased Maine's Road Map to Advance Biobased Manufacturing in Maine, a project funded by the U.S. Economic Development Administration (EDA). The report considers industry and occupational employment and the role of the workforce training system specific to two sectors that are most closely related to biobased manufacturing; forest products and advanced manufacturing. The key findings from this analysis are as follows:

Regional disparity exists between where jobs are located and where job seekers are located, and to the some extent of where occupational programs are located verses where industry and jobs are located.

Forest Products. Across all regions the number of job openings, exceeded the number of educational completions suggesting the workforce system is not producing enough graduates to meet industry demand in the forest products sector. Most of the jobs in this industry are located in the Central Western region however it had the lowest number of completions.

Advanced Manufacturing. Based on the number of completions, the workforce system is graduating the highly knowledgeable and skilled workforce required for a portion of growing occupations in the sector, however the number of completions in both the Northeastern and Coastal Counties regions far exceeded the number of job openings, in 2015.

Most of the core occupations highlighted in this report required a two-year degree or less, for both Forest Products and Advanced Manufacturing sectors. While biobased manufacturing is known as an industry that requires a more knowledge intensive workforce, in Maine many of the core occupations that currently exist require a two-year degree or less. Given the nascent stage of biobased manufacturing new occupations will likely emerge that may require higher degrees of formal education and training.

- Employment in occupations such as biological technicians, biochemists and biophysicists or microbiologists has increased by 50% or more from 2006 and requires a higher degree of formal education and prior work experience.

- Occupations such as machinists and computer control programmers and operators, which make up the greatest share of employment in advance manufacturing, still pay a reasonable median wage ($22.02 and $22.45) and require less than two-years of formal education with medium to long-term training.

On average, labor costs in Maine are lower than the nation, this is also true for most of the subsectors related to biobased manufacturing, however for most subsectors at the regional level annual wages were either comparable or in some cases slightly higher than the nation average. One example is machinery manufacturing, workers in the Northeastern region received an annual wage roughly $3,500 more per year than their national counterparts. Whereas on average, annual wages in Maine's chemical manufacturing subsector were below the national average though, in the Coastal Counties region where the subsector is most concentrated, wages were comparable to the nation.

As labor market conditions continue to tighten lower wages across the state and region may create difficulties in attracting and retaining workers. The decline in forest products and other manufacturing industries has left a lot of people out of work who have foundational knowledge and skills relevant and transferable to biobased manufacturing. If retrained these people may be able to help meet industry demand, but with a tightening labor market wages will likely need to increase to incentive these workers to return to the workforce.

Workforce Baseline Assessment for Biobased Manufacturing in Maine

II.   Introduction

An abundant and high skilled workforce are critical and fundamental in establishing a competitive and prosperous biobased manufacturing industry in Maine. Connection to the forest and other natural resources are deeply entrenched in Maine's culture and workforce. Building off of the existing stocks of knowledge and skill sets that logically branch from established and transitioning industries will be a key factor in the emergence and competitiveness of new industries. A dense workforce development and higher education system provide solid institutional foundations to facilitate a workforce pivot to the production of new and emerging technologies in the biobased manufacturing field. Full engagement of the workforce system will be critical in both attracting and derisking private sector investment in biobased manufacturing.

At the request of Biobased Maine, the following report provides a baseline assessment of the current workforce that likely can support or transition to biobased manufacturing in Maine. This assessment will be used to help inform Biobased Maine's *Road Map to Advance Biobased Manufacturing in Maine*, a project funded by the U.S. Economic Development Administration (EDA). To this end, the report that follows will provide a snapshot of Maine's existing workforce based on two key industry sectors, forest products and advance manufacturing, which closely relate to biobased manufacturing and could potentially support the industry. The remaining report is structured as follows. Section III provides a general overview of workforce trends in Maine. Section IV provides a baseline of industry and occupational employment for the Forest Products and advance manufacturing sectors and subsectors highlighting regional differences. Section V provides a brief overview of the states workforce development system and is followed by section VI which highlights the occupational programs currently available in the state to meet industry needs. Section VII provides a case study about one company in the pulp mill industry that has survived by transitioning into manufacturing niche products and is followed by a conclusion.

III.   General workforce trends and overview

This section provides an overview of general workforce and employment trends in Maine. Over the last year Maine's economy added a little under 5,000 jobs bringing total employment to 692,182 and at last returning to pre-2009 recession employment levels almost eight years later. In general, most major industry sectors have added jobs with a majority added in education and health services, a major contributor to employment growth over the last decade, and a half, and leisure and hospitality. Growth in Maine's labor market is driven primarily by long-term demographic and economic trends, which influence labor force participation as well as the quality and quantity of Maine's workforce. While overall workforce conditions continue to improve, people of prime working age still struggle to succeed, employers continue to have difficulties finding qualified workers and the aging population and workforce present significant challenges and opportunities for the state's economic outlook.

Population demographic trends

Long-term population demographic trends, including low natural growth rates (births versus deaths), declining net out-migration patterns, and shifts in labor force participation, present challenges to Maine's labor market and have a strong influence on healthy economic growth. As the oldest state in the nation, measured by median age, Maine's aging workforce and population is one of the most significant challenges and

Figure 9: Age Cohort Demographics for Maine's Population, 2016

Age Cohort	2016 Population	2016 Percent
Under 20 years	287,448	21.6%
20 to 39 years	305,605	23.0%
40 to 59 years	377,469	28.4%
60 to 79 years	296,988	22.3%
80 years and over	62,879	4.7%

Source: EMSI 2017.1 data series report.

opportunities for the state's economy. In 2016, 55% of the population was 40 or older (Figure 1) and the natural rate of population growth has recently turned negative, meaning there are more deaths than live births in the state. Any population and workforce growth in the future will need to rely on in-migrants, both domestic and international.

In the next fifteen years the size of the labor force is expected to shrink as the tail end of the baby boomer generation surpasses age 65 and the working age population (ages 20-64) contracts. Based on the current trend, the labor force is projected to shrink by 16% or 129,200 between 2010 to 2032.[1] This will present significant challenges to employers who will struggle to find qualified workers under an increasingly tight labor market structure. This will be particularly true for employers in need of specialized skills. It is critical that Maine retain young people to work and live in that state and attracts others to relocate here.

Educational attainment of workforce

In 2016, a little over forty percent of Maine's working age population held a high school diploma or less, while 28% of the population had a bachelor's degree or higher, slightly less than the national average (Figure 2). Those these differences are most pronounced regionally within the state. The Greater Portland region has a much higher share of people with a Bachelor's degree or higher relative to other regions in the state.

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[1] Sneddon, J. (2016) Central Western Maine WIOA Strategic Plan PY 2016-2020; Maines 2016-2020 WIOA Unified Plan.

Figure 2: Educational Attainment for Maine, 2016

|	Education Level	2016 Population	2016 Percent	
●	Less Than 9th Grade	37,804	3.9%	▪
●	9th Grade to 12th Grade	48,651	5.0%	▪
●	High School Diploma	324,741	33.6%	▬▬
●	Some College	192,633	19.9%	▬
●	Associate's Degree	90,494	9.4%	▪
●	Bachelor's Degree	177,226	18.3%	▪
●	Graduate Degree and Higher	95,293	9.9%	▪
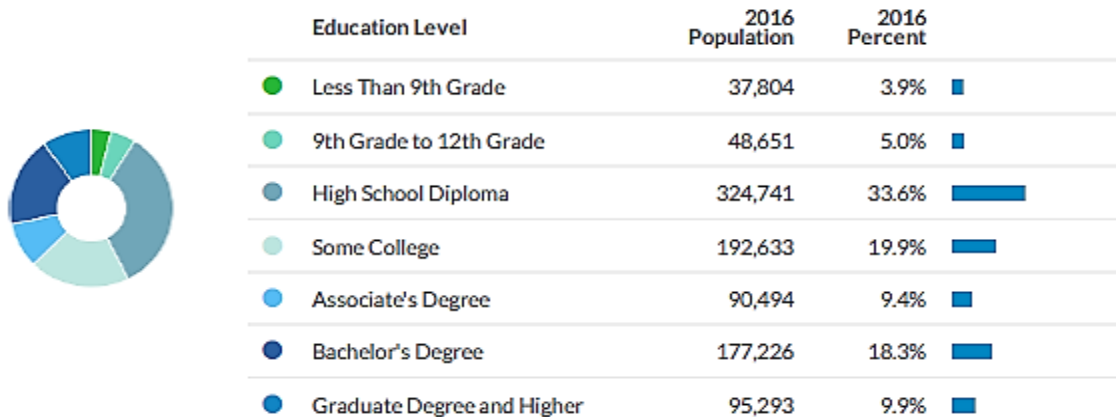
Source: EMSI 2017.1 data series report.

Following national trends, Maine's job growth since 2001 has been most pronounced in high skill and low skill jobs, while middle skill jobs (traditionally manufacturing) have seen steep declines. This has led to a polarization in the required skills demanded of the workforce (Figure 3). Growth has been in jobs requiring higher levels of formal education training that typically pay higher wages. At the same time, low skilled jobs that can be thought of as generally serving the local economy have grown. This

Figure 3: Change in Jobs in Maine, 2001-2016
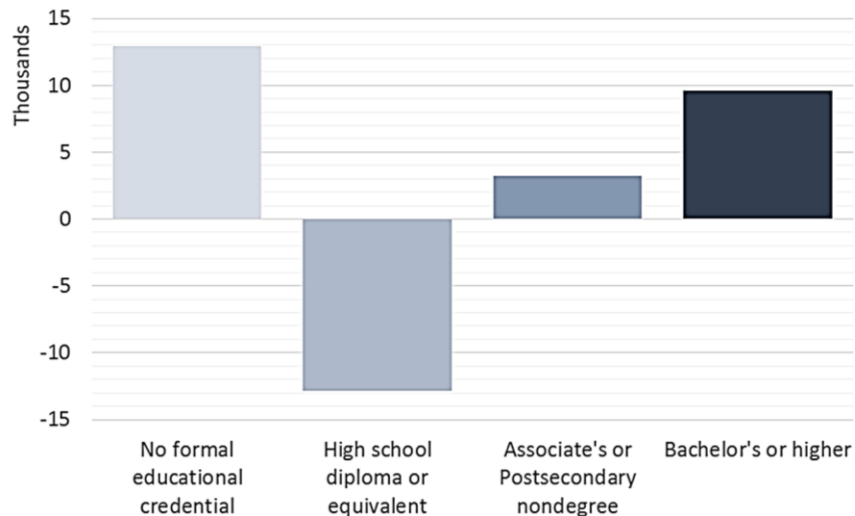
Labor costs

One key competitive advantage for industry in Maine are lower relative labor costs compared to other parts of the northeastern United States. On average, wage rates statewide in Maine are ($12,600) below the national average for all sectors and ($13,214) in the manufacturing sector.[2] These rates also differ across the state with wages tending to be higher in the southern region of the state and lower in the more rural areas. Currently, labor market conditions are tight for most parts of the state, particularly in southern Maine where unemployment rates are 3.2% (May 2017, seasonally adjusted) and essentially

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[2] These differences are not adjusted for cost of living differences. By some estimates, Maine cost of living is 22% higher than the national average (Council for Community and Economic Research, Cost of Living Index).

at full employment.. Tight labor market conditions will push wages higher, as firms will need to compete and attract talent by paying workers more. A declining workforce will also keep unemployment rates artificially low and further constrain labor. . This may pose a challenge when trying to attract specialized labor that may not be available in the region, such as engineers or scientists. Still, labor market conditions differ in parts of the state that have suffered most from the decline in traditional manufacturing industries such as in pulp and paper manufacturing. In Lincoln, Madison and Millinocket, unemployment rates (not seasonally adjusted) are currently at 7.8 %, 5.7% and 7.9%, respectively, as of May 2017, though they have fallen since peaking at 12.4% in 2014, 18.9% in 2011 and 12.6% in 2010.

General manufacturing employment trends

Historically manufacturing jobs have been an essential economic driver in Maine and across the nation. The structure of Maine's economy has shifted over the last decade away from traditional manufacturing jobs to more service oriented jobs.

Decline in traditional manufacturing industries has left a void in demand for these types of workers and skills, and many modern manufacturing jobs require higher degrees of formal training and education. This is particularly true for many jobs in the advanced manufacturing sector where a highly skilled and knowledgeable labor pool is vital to its competitiveness. One response to address this issue is to encourage interstate mobility of workers and engage in job training opportunities and industries where skills are adaptable. Yet, it is still difficult to make a significant impact to the labor force participation rate in the short run, unless the jobs that are in demand match the types of skills traditionally carried by these workers.

IV.   Forest Products and Advanced Manufacturing Industry and Occupational Analysis

This section provides an industry and occupational overview of the existing workforce in the forest products and advance manufacturing sectors, which are most closely related to biobased manufacturing. We consider total industry employment, which includes all types of jobs in an industry, as well as occupations that are specific to the forest products and advance manufacturing sectors to gain a more specific understanding of the types of jobs and skills within these sectors.

Based on a review of past studies, biobased manufacturing is most likely to resemble industries such as chemical and plastics manufacturing, and other advance manufacturing industries, as well as more traditional forest product related industries, such as pulp and paper manufacturing. To form an operational definition, the forest products and advance manufacturing sectors are defined by a selection of three-digit North American Industry Classification System (NAICS) codes that fall within the two-digit 31-33 manufacturing NAICS.[3] NAICS codes are used to describe each industry, and along with staffing patterns by industry are used as a way to determine the core occupations that comprise of the industry. The first subsection provides an industry overview of the forest products sector for the state and by region followed by an overview of the core occupations within the sector. The second subsection follows the same structure focused on the advance manufacturing sector. Data is drawn from Economic

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[3] North American Industry Classification System (NAICS) is a coding standard used by Federal agencies to collect and disseminate data related to the U.S. business economy and employment. The full list of NAICS codes used in this study can be found in Appendix B.

Modeling Specialists Inc. (EMSI) which base industry and occupational estimates off of federal and state secondary economic data.[4]

The analysis considers industry and occupational employment for the entire State of Maine and by workforce investment area (WIAs), which allows us to look in more detail at differences in regional labor markets. Maine's WIAs are divided into three regions, Central/Western Maine, Northeastern Maine, and Coastal Counties (Figure 4).

Industry Overview

Forest Products Sector

Maine's forest products sector includes a mix of activities from businesses, organizations and individuals involved in forestry and logging, paper and related products manufacturing, sawmills and wood products manufacturing, and wood furniture manufacturing. The forest products sector is defined by four industries: paper manufacturing, wood product manufacturing, forestry & logging, and printing & related support activities. These industries form an operational definition for the forest products sector (Table 1) and are used to determine employment and the core occupations of the sector.

Industry Trends

Maine's forest products sector employed 15,293 people in 2016 making up roughly three percent of total state employment. Over the ten-year period (2006-2016) jobs have decreased by 31%, while the nation decreased by 26.5% (Table 1). Still, Maine has a strong competitive advantage in the sector relative to the nation as measured by location quotients (LQ), [5] despite

Figure 4: Workforce Investment Areas (WIAs)

the decline in employment. On average workers in the forest products sector earn slightly higher wages ($754) per year than their national counterparts ($60,000), on average.

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[4] Detailed descriptions included in Appendix A.

[5] Industry specialization is measured using location quotients (LQ) to gauge the presences of an industry in the region compared to the nation, in terms of employment. A ratio greater than 1.2 suggests an industry is specialized or concentrated, while a ratio of .80 suggests an underrepresented industry. A ratio at or close to 1 suggests a similar share of jobs in the regional workforce relative to the nation.

Table 1: Employment Summary for Forest Products Subsectors (Maine), 2016[6]

Subsector	Jobs	% Change from 2006	Industry Specialization
Paper Mfg.	5,061	(44%)	3.1
Wood Product Mfg.	4,900	(25%)	2.7
Forestry & Logging	3,858	(5%)	10.4
Printing & Related Support Activi	1,474	(41%)	0.7
State Total	**15,293**	**(31%)**	

Figure 5: Average Earnings per Worker by Subsector,

Over the last five years, 5 plants have closed in Bucksport, Old Town, East Millinocket, Lincoln and Madison. Since 2006, employment in pulp and paper mills have decreased by nearly 50% or 3,486 jobs. While this trend reflects seismic changes in the industry, including shifts in consumer demand and global competition, some paper mills have survived as they transition into making niche products and investing in innovation. On average, workers in this subsector earn between $4,000 to $8,000 more than their national counterparts at both the state and regional level (Figure 5). The next largest subsector is wood products manufacturing which represents thirty-two percent of total industry employment.

Regional Overview

Table 2 summarizes employment growth and industry specialization for the forest products industry and its subsectors by region. Similar to the state and nation, overall employment in the forest products industry has declined in each region since 2006. The Northeastern Region has been hit hardest by the closure of four pulp and paper mills over the last five years. Employment decreased by 59% or 1,854 from 2006. The Central Western region had one closure, employment decreased by 1,365 (40%) from 2006. The only subsector to experience employment growth from 2006 to 2016 is the forestry & logging subsector, which increased by 19% in the Coastal Counties region and by 2% in the Central Western region.

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[6]State industry totals are slightly higher than WIA industry totals because of "non-county" regions. "Non-county" jobs are included in the State total and represent small employers who have multiple establishments within the state, but report together to the BLS (QCEW), which serves as EMSI's primary source for industry data.

Almost half of all jobs in Maine's forest products sector are found in the Central Western region despite a decrease by 24%, albeit less than the state and nation. On average, annual wages were also highest in this region's ($65,336) forest products sector, workers made $4,097 more per year than the state average for the sector.

The Northeastern region makes up thirty-two percent of all jobs in Maine's forest products industry. However, this region has been hit hardest in terms of job loss; employment decreased by 39% from 2006. While average earnings per worker is ($6,030) less per year than the Central Western region, workers in this region earn a wage more comparable to their national counterparts. Forestry and logging is most concentrated within this region, nearly 23 times higher than the nation, though employment decreased by 12% from 2006. On average, workers in this subsector earn roughly $2,000 more per year than workers at the state and national level (Figure 5).

The Coastal Counties region employed 2,857 workers in 2016, nineteen percent of Maine's forest products industry. Similar to other regions overall jobs in this sector have decreased (34%) over the ten-year period. Despite overall decline in the industry in terms of employment, jobs in the Forestry and logging sector have increased by nineteen percent from 2006.

**Table 2:** Employment Summary for Forest Products Subsectors by WIA, 2016

Workforce Investment Area	Subsectors	Jobs	% Change from 2006	Industry Specialization
Central Western	Paper Mfg.	3,233	(32%)	7.9
	Wood Product Mfg.	2,110	(24%)	4.7
	Forestry & Logging	1,429	2%	15.4
	Printing & Related Support Activ.	712	(28%)	1.4
	Total	**7,484**	**(24%)**	
Northeastern	Forestry & Logging	1,929	(12%)	22.8
	Wood Product Mfg.	1,522	(30%)	3.7
	Paper Mfg.	1,315	(59%)	3.5
	Printing & Related Support Activ.	168	(45%)	0.4
	Total	**4,934**	**(37%)**	
Coastal Counties	Wood Product Mfg.	1,263	(21%)	1.4
	Printing & Related Support Activ.	593	(51%)	0.6
	Paper Mfg.	513	(53%)	0.6
	Forestry & Logging	488	19%	2.6
	Total	**2,857**	**(34%)**	

Source: EMSI 2017.1 data series.

Demographic breakdown

Statewide, the median age of the forest products labor force was 44.6 years, with about 60% of the workforce over the age of 45. There is little regional variation though the Coastal County region has a slightly younger workforce composition, 45% are between ages 19 - 44 (Figure 6).

Figure 6: Age Composition of Forest Products Workers by Region, 2016
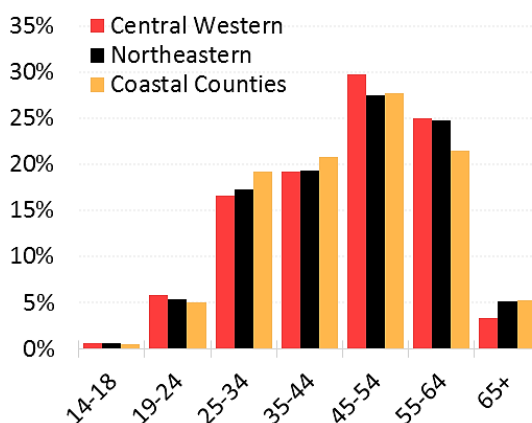
Source: EMSI 2017.1 data series.

Advanced Manufacturing Sector

The advanced manufacturing sector is defined by a four subsectors that are most closely related to biobased manufacturing: chemical manufacturing, fabricated metal product manufacturing, machinery manufacturing, and plastics & rubber products manufacturing. Maine's advance manufacturing sector employed 11,733 people in 2016, making up 1.7% of total state employment.[7] Over the ten-year period (2006 to 2016) employment increased by 4% or 454, out preforming the nation which decreased by 8.2%. Employment growth was concentrated in chemical manufacturing which increased by 41% from 2006 to 2016, and machinery manufacturing by 9% (Table 3). On average workers earned $7,665 less per year than their national counterparts ($80,373).

Table 3: Employment Summary for Advanced Manufacturing Subsectors, 2016

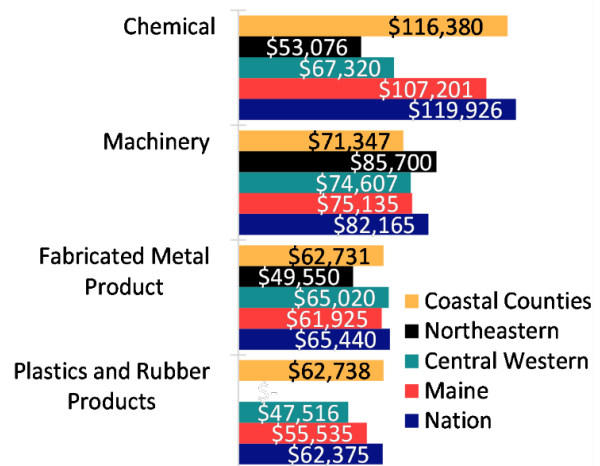| Subsectors	Jobs	% Change from 2006	Industry Specialization
Fabricated Metal Product Mfg.	4,832	(5%)	0.8
Chemical Mfg.	2,418	41%	0.7
Machinery Mfg.	2,332	9%	0.5
Plastics & Rubber Products Mfg.	2,152	(9%)	0.7
State Total	**11,733**	**4%**	

Source: EMSI 2017.1 data series

Fabricated metal product manufacturing was the largest subsector within the overall industry, employing 41% (4,832) of advance manufacturing workers (Table 3). On average, workers in this subsector earned $3,515 less than their national counterparts. This difference varies significantly at the regional level where average earnings ranged from $400 to $16,000 less per year (Figure 7, below). The second largest subsector, chemical manufacturing, represents 21% of total industry employment and increased by 41% from 2006. This subsector had the greatest regional disparity of average earnings per worker. Statewide, workers earned on average $12,725 less than their national counterparts while at the regional level workers earned from $3,546 to $66,850 less.

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[7] Refer to Appendix B for detailed industry definitions. Refer to Appendix C for long-term industry trends.

Regional Overview

Table 4 summarizes employment growth and industry specialization for the advance manufacturing sector and its subsectors by WIA region. More than half (63%) of all jobs in Maine's advance manufacturing sector are found in the Coastal Counties region where employment increased by 11% from 2006. Employment declined in the Central Western (-5%) and Northeastern (-10%) regions. On average, annual wages were highest in the Coastal Counties region ($78,967) where workers made $6,260 more per year than the state average for the sector.

Figure 7: Average Earnings per Worker, 2016

Source: EMSI 2017.1 data series

Table 4: Employment Summary for Advanced Manufacturing Subsectors by WIA, 2016

Workforce Investment Area	Subsectors	Jobs	% Change from 2006	Industry Specialization
Coastal Counties	Fabricated Metal Product Mfg.	2,784	(1%)	0.9
	Chemical Mfg.	1,996	52%	1.1
	Machinery Mfg.	1,477	18%	0.6
	Plastics & Rubber Products Mfg.	1,123	(13%)	0.7
	Total	**7,380**	**11%**	
Central Western	Fabricated Metal Product Mfg.	1,452	(17%)	0.9
	Plastics & Rubber Products Mfg.	1,022	5%	1.3
	Machinery Mfg.	309	(1%)	0.3
	Chemical Mfg.	295	51%	0.3
	Total	**3,078**	**(5%)**	
Northeastern	Fabricated Metal Product Mfg.	588	16%	0.4
	Machinery Mfg.	545	(7%)	0.5
	Chemical Mfg.	117	(44%)	0.1
	Plastics & Rubber Products Mfg.	8	0%	0.0
	Total	**1,258**	**(10%)**	

Source: EMSI 2017.1 data series.

Fabricated metal product manufacturing is the largest subsector in each region. Employment decreased in both the Coastal Counties (-1%) and Central Western (-17%) regions since 2006 and grew in the Northeastern region (16%), where the industry is least concentrated.

The chemical manufacturing subsector is most concentrated in the Coastal Counties region, employing 1,996 workers. Employment increased by 52% since 2006. On average, workers in this region

earn roughly double per year compared to their counterparts in the Central Western and Northeastern region (Figure 7). Also notable, employment increased by 52% in the Northeastern region, though the region employed only a small share of workers.

The Central Western region made up 26% of employment in Maine's advance manufacturing sector. The plastics & rubber products manufacturing subsector is most concentrated in this region; and makes up roughly one-third of the regions employment in the advance manufacturing sector. On average, workers in this subsector earn $420 less per year than their national counterparts but fair better than the other WIA regions (Figure 7).

The Northeastern region made up the smallest share (9%) of employment in Maine's advance manufacturing sector. While the region employs a smaller share of workers in the fabricated metal product manufacturing subsector it was the only to experience positive job growth (16%) from 2006. Despite positive grow in terms of employment, on average, workers in this regions subsector earned from $13,000 to $16,000 less per year than their counterparts in Coastal Counties and Central Western regions.

Demographic breakdown

As the current advance manufacturing workforce nears retirement age, the need to replace these jobs will increase. According to a talent management study conducted by the Sloan Center on Aging & Work (2010), twenty percent of manufacturing companies nationwide had a mean age workforce composition of 55 years or older, almost 10 years ago. In Maine, a greater portion of the advance manufacturing workforce is 55 years or older relative to the nation. A quarter of advance manufacturing jobs statewide had a mean average age workforce composition of 55 years or older.[8] This trend is mirrored at the regional level and is illustrated in Figure 8 which shows the demographic breakdown, by age, of individuals working in the advance manufacturing sector by WIA.

Figure 8: Advanced Manufacturing Sector Age Breakdown by WIA, 2016
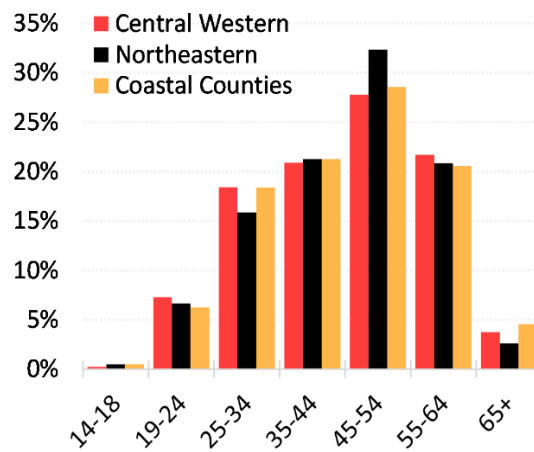
Source: EMSI 2017.1 data series

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[8] Sweet, S., Pitt-Catsouphes, M., et al. (2010) *Talent Pressures and the Aging Workforce: Responsive Action Steps for the Manufacturing Sector.* The Sloan Center on Aging & Work at Boston College.http://www.bc.edu/content/dam/files/research_sites/agingandwork/pdf/publications/TMISR01_Manufact uring.pdf.

A. Occupational Overview

Industry employment provides a sense of the overall health in an industry sectors but includes all workers in an industry regardless of the types of occupations they're employed in. Some occupations are ubiquitous across all industries, while others are specific and specialized to a certain industry. We use the Standard Occupational Classification (SOC) occupational data to identify occupations with the specific skills and knowledge required of workers in forest products and advance manufacturing sectors.[9] Occupational data measures the number of workers that perform similar jobs across all industries and are an important aspect in understanding the knowledge and skills of a workforce and how labor is shared across industries.

Forest Products Sector

The core occupations identified in this section represent only a portion of total employment within the forest products sector. However, these occupations are highlighted in Table 5 because of their level of employment, and concentration in the industry indicate that theses occupations represent the primary occupations that define employment in this industry. The core detailed occupations that are most commonly employed by this industry fall within four major occupational categories and are listed below:

- Forestry Occupations
  - First-Line Supervisors of Farming, Fishing, and Forestry Workers
  - Fallers
  - Logging Equipment Operators
- Installation, Maintenance, and Repair Occupations
  - Electrical and Electronics Repairers, Commercial and Industrial Equipment
  - Industrial Machinery Mechanics
- Production Occupations
  - Printing Press Operators
  - Sawing Machine Setters, Operators, and Tenders, Wood
  - Woodworking Machine Setters, Operators, and Tenders, Except Sawing
  - Stationary Engineers and Boiler Operators
  - Cutting and Slicing Machine Setters, Operators, and Tenders
  - Paper Goods Machine Setters, Operators, and Tenders
  - Production Workers, All Other
  - Helpers--Production Workers
- Transportation and Material Moving Occupations
  - Heavy and Tractor-Trailer Truck Drivers
  - Machine Feeders and Offbearers

A detailed look at these occupations allows us to identify skill level and educational requirements, while gaining an understanding of job growth and competitiveness in terms of median

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[9] The Standard Occupational Classification (SOC) is a system used by federal agencies to categorize occupations for data collection and dissemination purposes.

wage (Table 5).[10] A majority of workers in the forest products sector are employed in logging and equipment operator occupations (2,025) followed by heavy & tractor-trailer truck drivers (710). With the expectation of first line supervisors, employment in the fifteen core occupations in this industry group have decrease from 2006.

Overall, wages for the Forest Product sectors core labor pool of worker's pay above the national median wage. Stationary engineers & boiler operator workers earn notably less in Maine while fallers earn notably more, relative to the nation. Workers in the electrical & electronics repairs and fallers occupations receive the highest median hourly wage in the state, $29.06 and $27.89 respectively.

Education and Work Experience

Overall, eighty percent of existing occupations within Maine's forest products sector require a two-year degree or less while 19% require a Bachelor's degree or higher.[11] Nearly seventy percent of occupations require some degree of on-the-job training, ranging from short-term to more intensive training, while 32% of occupations require no prior training experience. The types of jobs that require two-year degrees or less are typically in production or forestry related occupations such as logging equipment operators or printing press operators whereas the degrees that require higher education are in management or engineering occupations.

Of the core occupations highlighted in Table 5, a majority require a high school diploma or less. Most occupations require no related work experience, with the exception of the First-Line Supervisors of Farming, Fishing, and Forestry Workers occupation, which typically need 5 years or less of related experience.

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[10] Refer to Appendix D for the top five occupations by WIA region.
[11] Entry education and work experience requirements are defined by the BLS and may differ by region, industry or firm but provides a general sense of requirements.

Table 5: Maine - Top Occupations Employed by the Forest Product Industries, 2016

Occupation Description	Jobs	% Change from 2006	Median Hourly Earnings	Difference in Median Hourly Earnings Relative to the Nation	Educational Requirement (Entry)	Work Experience	Training
Logging Equipment Operators	2,025	-6%	$19.38	$2.65	H.S diploma	None	Moderate
Heavy & Tractor-Trailer Truck Drivers	710	-11%	$18.40	($0.92)	Postsecondary nondegree	None	Short
Sawing Machine*	654	-25%	$13.74	$0.10	H.S diploma	None	Short
Paper Goods Machine*	647	-50%	$15.09	($2.25)	H.S diploma	None	Moderate
Woodworking Machine*	599	-26%	$13.91	$0.24	H.S diploma	None	Short
Helpers--Production Workers	482	-40%	$12.18	$0.26	None	None	Short
First-Line Supervisors of Farming, Fishing, and Forestry Workers	410	6%	$23.04	$1.22	H.S diploma	Less than 5 years	None
Industrial Machinery Mechanics	313	-37%	$25.23	$1.12	H.S diploma	None	Long
Production Workers, All Other	292	-29%	$13.39	($0.64)	H.S diploma	None	Moderate
Printing Press Operators	285	-46%	$14.71	($2.51)	H.S diploma	None	Moderate
Electrical & Electronics Repairers, Commercial & Industrial Equip.	283	-35%	$29.06	$2.10	Postsecondary nondegree	None	Long
Machine Feeders & Offbearers	271	-31%	$14.65	$0.26	None	None	Short
Cutting & Slicing Machine*	217	-41%	$17.53	$1.96	H.S diploma	None	Short
Fallers	191	-2%	$27.89	$8.37	H.S diploma	None	Moderate
Stationary Engineers & Boiler Operators	190	-39%	$20.26	($8.57)	H.S diploma	None	Long

Setters, operators and tenders
Source: EMSI 2017.1 data series; MCBER calculations.

Advanced Manufacturing Sector

Fifteen occupations that are most commonly employed by Maine's advance manufacturing industry fall within three major occupational categories, a majority are production related. The core occupations identified in this section represent only a portion of total employment within the advance manufacturing industry. The highlighted occupations were identified using the same criteria for the forest products industry and are included because of their level of employment and concentration in the industry.[12] The core occupations listed below offer a detailed look at skill level and educational requirements generally required of the current workforce, while gaining an understanding of job growth and competitiveness in terms of median wage (Table 6).[13]

- Production Occupations
    - Helpers--Production Workers
    - Packaging & Filling Machine Operators & Tenders
    - Team Assemblers
    - Machine Tool Cutting*
    - Molding, Coremaking, & Casting Machine*
    - Inspectors, Testers, Sorters, Samplers, & Weighers
    - Machinists
    - Computer Control Programmers & Operators
    - Welders, Cutters, Solderers, & Brazers
    - Coating, Painting, & Spraying Machine*
    - Structural Metal Fabricators & Fitters
    - First-Line Supervisors of Production & Operating Workers
    - Transportation and Material Moving Occupations
    - Heavy and Tractor-Trailer Truck Drivers
    - Machine Feeders and Offbearers
- Management Occupations
    - Industrial Production Mgmt.
- Architecture and Engineering Occupations
    - Mechanical Engineers
    - Industrial Engineers

In 2016, a majority of workers employed in the advance manufacturing sector worked as machinist (857) and computer control programmers & operator (590) which increased by 2% and 18% from 2006, respectively. While packing and filling machine operator and fillers occupations made up a smaller portion of total employment the number of jobs increased by 28% (Table 6). Overall, wages for

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[12] While a number of the identified core occupations are ubiquitous across each subsectors that comprise of Advanced Manufacturing sector they mostly reflect jobs specific to machinery and fabricated metal products manufacturing. Occupations more related to chemical and plastics manufacturing were not included in the top fifteen occupations simply due to the smaller number of jobs, though a detailed list of occupations specific to each subsector can be found in Appendix G.

[13] Refer to the Appendix D for top five occupations by WIA region.

the advance manufacturing sector's core labor pool of worker's is above the national median wage. Structural metal fabricators etc., and coating, painting, & spraying workers earned notably more in Maine while industrial production managers earn notably less, relative to the nation.

Education and Work Experience

On the whole, occupations in the advance manufacturing sector are generally more knowledge intensive. Of the occupations that currently exist in Maine, 32% require a Bachelor's degree or higher while 68% require a two-year degree or less. While sixty percent of occupations require some degree of on-the-job training, ranging from short-term to more intensive training, for the remaining portion of workers no prior training experience is required. Occupations that are more sector specific, such as machinists or industrial machinery mechanics require a two-year degree or less but typically have long-term on the job training requirements while many of the occupations that require a bachelor's degree or more such as managers, chemists or engineers typically require some previous work experience. Most of these occupations employ a far smaller share of workers (less than 100 statewide) yet in most cases employment has increased from 2006, in particular biological technicians, biochemists and biophysicists, microbiologists, natural sciences managers, compliance officers and biomedical engineers occupations all have increased by 50% or more since 2006.

Of the core occupations highlighted in this report, a majority require a high school degree or less (Table 6). While most of these top occupations require minimal formal education they do require some degree of on-the-job training, ranging from short-term to more intensive training, most require moderate on-the-job training.

Table 6: Maine - Top Occupations Employed by Advanced Manufacturing Industries, 2016

Occupation Description	Jobs	% Change from 2006	Median Hourly Earnings	Difference in Median Hourly Earnings Relative to the Nation	Educational Requirement (Entry)	Work Experience	Training
Machinists	857	2%	$22.02	$2.39	H.S diploma	None	Long
Computer Control Programmers & Operators	590	18%	$22.45	$3.45	H.S diploma	None	Moderate/Long
First-Line Supervisors of Production & Operating Workers	548	5%	$27.56	$0.41	H.S diploma	Less than 5 yrs	None
Team Assemblers	499	-2%	$14.88	$0.46	H.S diploma	None	Moderate
Welders, Cutters, Solderers, & Brazers	413	-2%	$23.34	$4.66	H.S diploma	None	Moderate
Machine Tool Cutting*	358	13%	$15.78	($0.26)	H.S diploma	None	Moderate
Packaging & Filling Machine**	279	28%	$14.66	$1.39	H.S diploma	None	Moderate
Helpers--Production Workers	262	2%	$12.18	$0.26	No formal edu.	None	Short
Inspectors, Testers, Sorters, Samplers, & Weighers	259	4%	$20.48	$2.73	H.S diploma	None	Moderate
Structural Metal Fabricators & Fitters	240	-2%	$27.21	$9.06	H.S diploma	None	Moderate
Molding, Coremaking, & Casting Machine*	186	-15%	$15.96	$1.69	H.S diploma	None	Moderate
Coating, Painting, & Spraying Machine*	183	5%	$25.60	$10.08	H.S diploma	None	Moderate
Industrial Production Mgmt.	169	6%	$41.21	($4.04)	Bachelor's	5 yrs or more	None
Mechanical Engineers	152	2%	$38.92	($1.72)	Bachelor's	None	None
Industrial Engineers	147	7%	$39.55	($1.08)	Bachelor's	None	None

* Setters, operators and tenders ** Operators & Tenders
Source: EMSI 2017.1 data series; MCBER calculations.

V.   The Workforce Development System In Maine

The workforce development system includes organizations and activities that prepare citizens for employment while helping to advance their careers, and ensure a skilled workforce is available to meet current and future demand. The following paragraphs provide a brief description of Maine's workforce system and the organizations involved including universities, community colleges, workforce investment boards (WIBs), and other workforce training programs that focus on delivering education and job training.

The University of Maine system (UMS), the Maine Community College System (MCCS), Maine's Career and Technical Education (CTE) and Maine Quality Centers (MQC), all publicly funded, provide educational programs designed to prepare the states workforce to meet current and future industry demands. As reported in *The State of Maine's 2016-2020 Unified Plan*, the UMS and MCCS each are comprised of seven campuses across the state with annual enrollment of more than 40,000 and 18,000 respectively (Figure 9). The UMS is one of the state's core delivery systems of the postsecondary education system, offering two and four year degrees as well as masters, doctoral, and specialized undergraduate/graduate certificates.[14] MCCS offers certificates, diplomas and two-year associate degrees in programs focused on educational, occupational and technical requirements.

Figure 9: MCCS (left) and UMS (right) campus locations
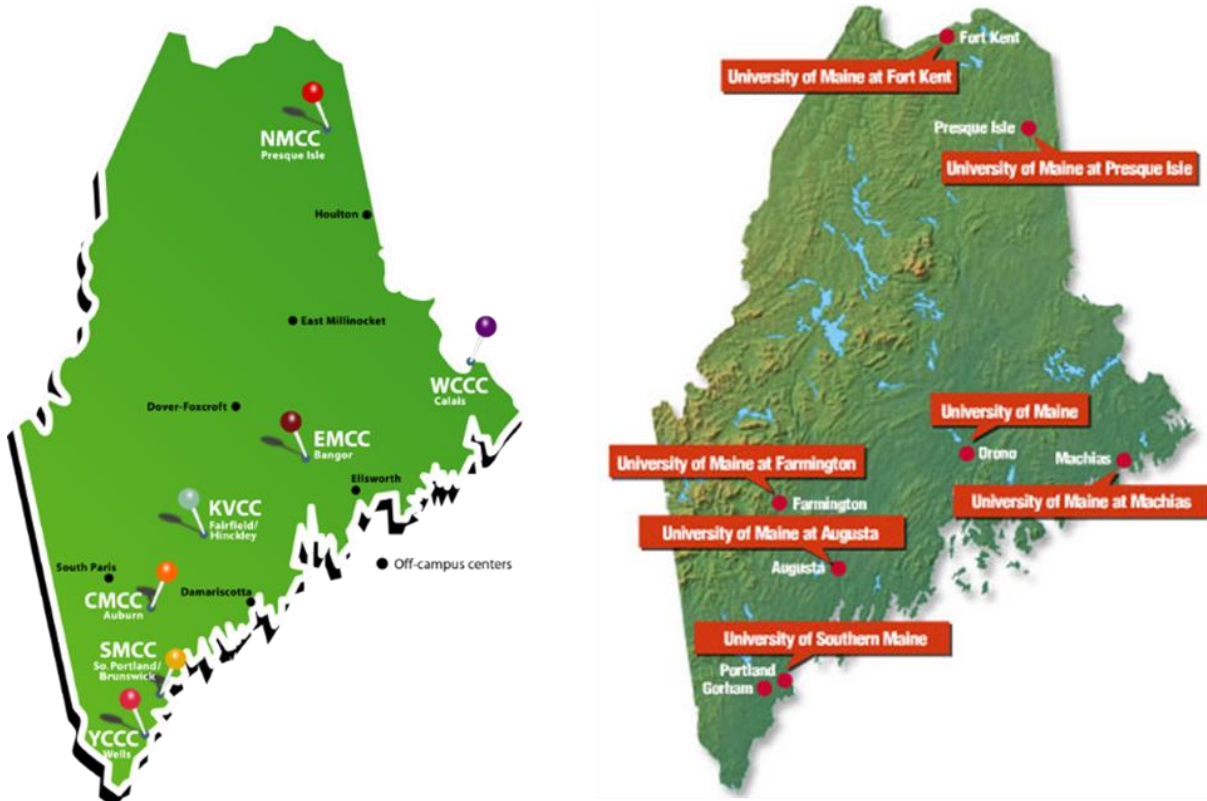
Credit: Maine Community College System and University of Maine System.

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[14] State of Maine. (2016). *State of Maine 2016-2020 WIOA Unified Plan.* Retrieved from http://www.maine.gov/swb/documents/wioa/plan/FINAL%20Maines%202016-2020%20WIOA%20Unified%20Plan.pdf.

The Career and Technical Education is program created to ensure access to high-quality technical skills and prepares high school students for postsecondary education. The Maine Quality Center provides focused workforce training grants to employers looking to relocate or expend operations in Maine or to provide training. Maine Adult Education also provides educational training with more than one hundred locations statewide.[15]

There are numerous job training programs and initiates, both public and private, focused on serving various populations. The Workforce Innovation and Opportunity Act (WIOA), enacted in 2014 is one example. WIOA replaced the Workforce Investment Act of 1998 (WIA) and reauthorized the federal workforce system to provide services and programs for unemployed and lower-skilled workers with improved access to relevant short-term training, credential attainment. WIOA is designed to encourage collaboration between the workforce and higher education through the WIOA-mandated state planning process and Workforce Investment Boards (WIBs) and by leverage funding, among other goals.[16]

For a more detailed analysis of Maine's workforce development system refer to the State of Maine's 2016-2020 Unified Plan and "Maine's Public Sector Investment in Workforce Development"

VI. General Overview of Occupational Programs

The connection between jobs and educational programs serves as an indicator of the demand that exists in the labor market for an occupation, and to what extent that demand is being met by the local workforce training programs.[17] These data are used to provide a general of sense of the occupational programs that are preparing the workforce and to describe the number of completions and degree types.

In 2015, 15,773 educational degrees and certificates were awarded in the state by forty-seven educational institutions, together offering 749 programs. Of the states total completions almost half were awarded by the twenty institutions within the Coastal Counties region; 29% by thirteen educational institutions in the Northeastern region; and 24% by fourteen institutions in the Central Western region. The top programs in the state in terms of completions include health professions and related programs (3,777), business, management, marketing, and related support services (1,754) and education (1,379), in 2015. The following sections provide an overview of occupational programs specific to the forest products and advance manufacturing sectors.

Forest Products

To provide anoverview of the educational system specific to the forest products sector, the number of programs, completions and openings described in this section reflect a more extensive selection of the sectors core occupations than highlighted in section III.B of this report. Refer to the Appendix H for a full list of occupations included in the occupational programs overview.

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[15] Maine State Workforce Investment Board and Maine Department of Labor, Maine's Workforce Development System: A Guide to Education and Training Programs" (2006). State Workforce Board Documents.2. http://digitalmaine.com/swib_docs/2/

[16] *WIOA Overview.* Last accessed on 7.05.2017 from https://www.doleta.gov/wioa/Overview.cfm.

[17] Occupational programs are based on Classification of Instructional Programs (CIP) data developed and defined by the U.S. Department of Education's National Center for Education Statistics (NCES) and is used to collect and disseminate information related to post-secondary course of study and program completions activity.

In 2015, 1,390 educational degrees and certificates were awarded for occupations relevant to Maine's forest products sector by twenty-four educational institutions which offered 35 programs (Table 7).[18] Across all regions the number of job openings, a conservative measure of demand

Table 7: Forest Product Occupational Programs Overview, 2015

Region	Programs	Completions	Openings
Central Western	11	264	778
Northeastern	16	574	644
Coastal Counties	8	552	1510
Total	**35**	**1,390**	**2,932**

Source: EMSI 2017.1 data series

developed by the Bureau of Labor Statistics which accounts for job growth and replacements needs, exceeded the number of completions suggesting the workforce system is not producing enough graduates to meet industry demand. Program completions by degree type are highlighted in Table 8 where a majority are bachelor degrees (581) followed by associates (380) and Master's degrees (264).[19]

Table 8: Completions by degree type for Forest Products, 2015.

Award Level	Central Western	Coastal Counties	Northeastern	Total
Associates degree	111	158	111	380
Award of at least 1 but less than 2 academic yrs	1	-	3	4
Award of less than 1 academic yrs	-	146	4	150
Bachelors degree	81	181	319	581
Doctors degree	-	-	4	4
Masters degree	71	61	132	264
Postbaccalaureate certificate	-	6	1	7
Region Total	264	552	574	

Source: EMSI 2017.1 data series

Of the fifteen core occupations highlighted in section III.B, two key programs in the state, located in the Coastal Counties region, provide training for truck and bus driver commercial vehicle operator and instructors (less than 1 academic year) and mechanical engineering (four year degree). The primary institutions that provided this education and training include the University of Southern Maine and Northeast Technical Institute. Together, 160 educational degrees and certificates were awarded in 2015.

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[18] Refer to Appendix E for a list of institutions by region.
[19] Refer to Appendix F for a full list of programs that train for occupations relevant in the Forest Products sector by region.

Advanced Manufacturing[20]

In 2015, 4,006 educational degrees and certificates were awarded for occupations relevant to Maine's advance manufacturing industry from thirty-one educational institutions, which offered 214 programs.[21] The regional breakdown for programs, completions and openings in 2015 is shown in Table 9, which illustrates Northeastern and Coastal Counties region had over 1,500 completions and the Central Western region had 845. In the Northeastern region, the number of completions was more than double the number of job openings suggesting graduates have a hard time finding employment and need to look outside the region to find a job.

Table 9: Advanced Manufacturing Occupational Programs Overview. 2015

Region	Programs	Completions	Openings
Central Western	54	845	979
Northeastern	89	1,635	837
Coastal Counties	71	1,526	2,570
Total	**214**	**4,006**	**4,386**

Source: EMSI 2017.1 data series

Overall, the number of completions for bachelor degrees (2,284) far exceeds any other degree type and is followed by associates (846) and master's degrees (428) (Table 10). This suggests the workforce system is graduating highly knowledgeable and skilled people, which is required for a portion of occupations in the advance manufacturing industry including biology/biological studies, information technology, mechanical engineering, food science and so on.

Table 10: Completions by degree type for Advanced Manufacturing, 2015

Award Level	Central Western	Coastal Counties	Northeastern	Total
Associates degree	305	288	253	846
Award of at least 1 but less than 2 academic yrs	18	74	100	192
Award of less than 1 academic yrs	-	175	7	182
Bachelors degree	451	805	1,028	2,284
Doctors degree	-	6	38	44
Masters degree	71	153	204	428
Postbaccalaureate certificate	-	25	5	30
Region Total	845	1,526	1,635	

Source: EMSI 2017.1 data series

Of the core occupations listed in section III.B, there were ten programs in the state that together produced 1,359 completions in business administration and management (989), machine tool technology/machinist (200), mechanical engineering (86), welding technology/welder (72), metal fabricator (7), and computer programming/programmer (5).

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[20] The number of programs, completions and openings described in this section reflect a more extensive selection of core occupations in this sector than highlighted in section III.B of this report. Refer to Appendix H for a full list of occupations included in the occupational programs overview.

[21] Refer to Appendix E for a list of institutions by region, and Appendix F for a full list of detailed programs that train for occupations in the Advanced Manufacturing sector by subsector.

VII.   Case Study: St Croix Tissue

St Croix Tissue Inc., an affiliate of Woodland Pulp, is one example of a company in the pulp mill industry that has transitioned into making niche products through investment and innovation. Nearly suffering the same fate as many pulp and fine paper mills across the State, the Woodland Pulp mill was purchased in 2010. Since then over $150 million dollars have been invested in new equipment and facilities to create St. Croix Tissue, which is located next to the pulp mill in the town of Baileyville along the St. Croix River in northeastern Maine. [22] Together St Croix Tissue and Woodland Pulp is one of the largest employer in Washington County, employing 325 workers in 2016.

St. Croix Tissue produces tissue products made from pulp provided by the Woodland Pulp mill and will supply national and international markets. The promising outlook for this company is made possible by investments to the mill and in new technologies that have allowed the company to expand beyond pulp production and into the value-add tissue market.

St. Croix and Woodland Pulp Employment[23]

Employment growth at St. Croix and Woodland Pulp greatly surpassed that of the nation. Pulp mills employed 325 workers in 2016, nearly a forty percent increase from 2011. The industry is expected to increase in terms of absolute growth with more than 160 jobs added to the region between 2016 and 2025. On average, workers annual earnings is $88,649 in this industry which is well above those in Maine, however workers earned $(12,899) less per year than their national counterparts.

For the top five occupations employed in the pulp mill industry, Table 11 highlights employment, absolute growth, median hourly earnings, and skill and educational requirements needed to supply this industries workforce. Of these occupations, minimal formal education is required, and prior work experience is not typically needed. These occupations require some degree of on-the-job

Table 105: Top 5 Occupations Employed in the Pulp Mill Industry, 2016

Occupation	Jobs	Change from 2011	Median Hourly Earnings	Educational Requirement*	Work Experience	Training
Paper Goods Machine Setters, Operators, & Tenders	39	8	$16.41	HS diploma	None	Moderate
Electrical & Electronics Repairers, Commercial & Industrial Equipt.	20	7	$25.82	Postsecondary nondegree	None	Long
Industrial Machinery Mechanics	18	5	$22.81	HS diploma	None	Long
Helpers-Production Workers	17	4	$11.13	No formal edu.	None	Short
Stationary Engineers & Boiler Ops.	13	4	$19.24	HS diploma	None	Long

Source: EMSI 2017.1 data series

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[22] Andritz Pulp & Paper. 2016. *Mill story: St. Croix Tissue*. http://www.stcroixtissue.com/newstcroix/wp-content/uploads/2017/04/MillStory_StCroix_english_lowres.pdf

[23] Using EMSI's zip code patterns we are able to isolate industry data in the town of Baileyville. Considering it is the only pulp mill in the town is it highly likely that the following industry summary is reflective of St. Croix Tissue and Woodland Pulp mill.

training, ranging from short-term to more intensive. Four of the five occupations require more intensive on-the-jobs training.

Median hourly wage for three of the five occupations is well above the state-wide median wage of $17.01 for all occupations. Figure 10 shows the median wage gap by occupation employed in the pulp mill industry for this region relative to Maine and the nation. Overall, workers from the top five occupations employed in this industry receive less than the state and nation. Most

Figure 10: Median Wage Differential for Pulp mill vs Nation and State, 2016

Source: EMSI 2017.1 data series

notably, Stationary Engineers & boiler operators receive $(9.59) less than their statewide counterparts.

Similar to other industries in Maine, as this industry continues to grow and the workforce ages lower wages in the area may create difficulties in attracting and retaining workers.

VIII. Conclusion

This report provides a baseline assessment of the current workforce available in Maine's forest products and advance manufacturing sectors, both likely to support or transition to biobased manufacturing. On average labor costs in Maine are lower than the nation across all industries. However at the regional level annual wages were either comparable or in some cases slightly higher than the national average. While biobased manufacturing is known as an industry that requires a more knowledge intensive workforce, in Maine many of the core occupations that currently exist in advanced manufacturing and forest products require a two-year degree or less. Given the nascent stage of biobased manufacturing new occupations will likely emerge that may require higher degrees of formal education and training. Furthermore, a regional disparity exists between where jobs are located and where job seekers are located, and to the some extent of where occupational programs are located verses where industry and jobs are located suggesting a greater need for engagement to align educational efforts. With a declining and aging population and workforce this illustrates the critical importance of a cohesive workforce development system that can properly prepare Maine's future workforce while also retraining workers with relevant skills and knowledge. A more comprehensive workforce study may be complete in the future that characterizes the workforce needs for a growing biobased manufacturing industry in Maine.

IX. Appendix A: Data Sources and Calculations

The following description is provided by EMSI data reports.

Industry Data:

Emsi industry data have various sources depending on the class of worker. (1) For QCEW Employees, Emsi primarily uses the QCEW (Quarterly Census of Employment and Wages), with supplemental estimates from County Business Patterns. (2) Non-QCEW employee's data are based on a number of sources including QCEW, Current Employment Statistics, County Business Patterns, BEA State and Local Personal Income reports, the National Industry-Occupation Employment Matrix (NIOEM), the American Community Survey, and Railroad Retirement Board statistics. (3) Self-Employed and Extended Proprietor classes of worker data are primarily based on the American Community Survey, Nonemployer Statistics, and BEA State and Local Personal Income Reports. Projections for QCEW and Non-QCEW Employees are informed by NIOEM and long-term industry projections published by individual states.

Staffing Patterns Data

The staffing pattern data in this report are compiled from several sources using a specialized process. For QCEW and Non-QCEW Employees classes of worker, sources include Occupational Employment Statistics, the National Industry-Occupation Employment Matrix, and the American Community Survey. For the Self-Employed and Extended Proprietors classes of worker, the primary source is the American Community Survey, with a small amount of information from Occupational Employment Statistics.

Infogroup Business-Level Data

Data for individual businesses is provided by Infogroup, which maintains a database of more than 16 million U.S. business entities. Note that in aggregate it will not be consistent with Emsi labor market data due to differences in definitions, methodology, coverage, and industry/geographic classification.

Completers Data

The completers data in this report is taken directly from the national IPEDS database published by the U.S. Department of Education's National Center for Education Statistics.

Demographic Data

The demographic data in this report is compiled from several sources using a specialized process. Sources include annual population estimates and population projections from the US Census Bureau, birth and mortality rates from the US Health Department, and projected regional job growth.

Institution Data

The institution data in this report is taken directly from the national IPEDS database published by the U.S. Department of Education's National Center for Education Statistics.

Occupation Data

Emsi occupation employment data are based on final Emsi industry data and final Emsi staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates also affected by county-level Emsi earnings by industry.

Educational Attainment Data

Emsi's educational attainment numbers are based on Emsi's demographic data and the American Community Survey. By combining these sources, Emsi interpolates for missing years and projects data at the county level. Educational attainment data cover only the population aged 25 years or more and indicate the highest level achieved.

X.   Appendix B: Industry Definitions

B- 1 : Industry Definitions: Forest Products Sector

NAICS Code	Description
113	**Forestry and Logging**
113110	*Timber Tract Operations*
113210	*Forest Nurseries and Gathering of Forest Products*
113310	*Logging*
321	**Wood Product Manufacturing**
321113	*Sawmills*
321114	*Wood Preservation*
321211	*Hardwood Veneer and Plywood Manufacturing*
321212	*Softwood Veneer and Plywood Manufacturing*
321213	*Engineered Wood Member (except Truss) Manufacturing*
321214	*Truss Manufacturing*
321219	*Reconstituted Wood Product Manufacturing*
321911	*Wood Window and Door Manufacturing*
321912	*Cut Stock, Resawing Lumber, and Planing*
321918	*Other Millwork (including Flooring)*
321920	*Wood Container and Pallet Manufacturing*
321991	*Manufactured Home (Mobile Home) Manufacturing*
321992	*Prefabricated Wood Building Manufacturing*
321999	*All Other Miscellaneous Wood Product Manufacturing*
322	**Paper Manufacturing**
322110	*Pulp Mills*
322121	*Paper (except Newsprint) Mills*
322122	*Newsprint Mills*
322130	*Paperboard Mills*
322211	*Corrugated and Solid Fiber Box Manufacturing*
322212	*Folding Paperboard Box Manufacturing*
322219	*Other Paperboard Container Manufacturing*
322220	*Paper Bag and Coated and Treated Paper Manufacturing*
322230	*Stationery Product Manufacturing*
322291	*Sanitary Paper Product Manufacturing*
322299	*All Other Converted Paper Product Manufacturing*
323	**Printing and Related Support Activities**
323111	*Commercial Printing (except Screen and Books)*
323113	*Commercial Screen Printing*
323117	*Books Printing*
323120	*Support Activities for Printing*

Bold = Subsector

Italics = Detailed industry

B- 2: Industry Definitions – Advanced Manufacturing Sector

NAICS	Description
332	**Fabricated Metal Product Manufacturing**
332111	Iron and Steel Forging
332112	Nonferrous Forging
332114	Custom Roll Forming
332117	Powder Metallurgy Part Manufacturing
332119	Metal Crown, Closure, and Other Metal Stamping (except Automotive)
332215	Metal Kitchen Cookware, Utensil, Cutlery, and Flatware (except Precious) Mfg.
332216	Saw Blade and Handtool Manufacturing
332311	Prefabricated Metal Building and Component Manufacturing
332312	Fabricated Structural Metal Manufacturing
332313	Plate Work Manufacturing
332321	Metal Window and Door Manufacturing
332322	Sheet Metal Work Manufacturing
332323	Ornamental and Architectural Metal Work Manufacturing
332410	Power Boiler and Heat Exchanger Manufacturing
332420	Metal Tank (Heavy Gauge) Manufacturing
332431	Metal Can Manufacturing
332439	Other Metal Container Manufacturing
332510	Hardware Manufacturing
332613	Spring Manufacturing
332618	Other Fabricated Wire Product Manufacturing
332710	Machine Shops
332721	Precision Turned Product Manufacturing
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing
332811	Metal Heat Treating
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
332911	Industrial Valve Manufacturing
332912	Fluid Power Valve and Hose Fitting Manufacturing
332913	Plumbing Fixture Fitting and Trim Manufacturing
332919	Other Metal Valve and Pipe Fitting Manufacturing
332991	Ball and Roller Bearing Manufacturing
332992	Small Arms Ammunition Manufacturing
332993	Ammunition (except Small Arms) Manufacturing
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing
332996	Fabricated Pipe and Pipe Fitting Manufacturing
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
333	**Machinery Manufacturing**
333111	Farm Machinery and Equipment Manufacturing
333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Mfg.
333120	Construction Machinery Manufacturing
333131	Mining Machinery and Equipment Manufacturing
333132	Oil and Gas Field Machinery and Equipment Manufacturing
333241	Food Product Machinery Manufacturing

NAICS	Description
332	**Machinery Manufacturing Continued …**
333243	Sawmill, Woodworking, and Paper Machinery Manufacturing
333242	Semiconductor Machinery Manufacturing
333244	Printing Machinery and Equipment Manufacturing
333249	Other Industrial Machinery Manufacturing
333314	Optical Instrument and Lens Manufacturing
333316	Photographic and Photocopying Equipment Manufacturing
333318	Other Commercial and Service Industry Machinery Manufacturing
333413	Industrial and Commercial Fan and Blower and Air Purification Equipment Mfg.
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing
333415	Air-Conditioning & Warm Air Heating & Commercial & Industrial Mfg.
333511	Industrial Mold Manufacturing
333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing
333515	Cutting Tool and Machine Tool Accessory Manufacturing
333517	Machine Tool Manufacturing
333519	Rolling Mill and Other Metalworking Machinery Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333612	Speed Changer, Industrial High-Speed 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 Traveling Crane, Hoist, and Monorail System Manufacturing
333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery 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 Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing
325	**Chemical Manufacturing**
325110	Petrochemical Manufacturing
325120	Industrial Gas Manufacturing
325130	Synthetic Dye and Pigment Manufacturing
325180	Other Basic Inorganic Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325194	Cyclic Crude, Intermediate, and Gum and Wood Chemical Mfg.
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325212	Synthetic Rubber Manufacturing
325220	Artificial and Synthetic Fibers and Filaments Manufacturing

NAICS	Description
335	**Chemical Manufacturing Continued …**
325311	*Nitrogenous Fertilizer Manufacturing*
325312	*Phosphatic Fertilizer Manufacturing*
325314	*Fertilizer (Mixing Only) Manufacturing*
325320	*Pesticide and Other Agricultural Chemical Manufacturing*
325411	*Medicinal and Botanical Manufacturing*
325412	*Pharmaceutical Preparation Manufacturing*
325413	*In-Vitro Diagnostic Substance Manufacturing*
325414	*Biological Product (except Diagnostic) 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, Paper, Plate, and Chemical Manufacturing*
325998	*All Other Miscellaneous Chemical Product and Preparation Manufacturing*
326	**Plastics and Rubber Products Manufacturing**
326111	*Plastics Bag and Pouch 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*
326122	*Plastics Pipe and Pipe Fitting Manufacturing*
326130	*Laminated Plastics Plate, Sheet (except Packaging), and Shape Mfg*
326140	*Polystyrene Foam Product Manufacturing*
326150	*Urethane and Other Foam Product (except Polystyrene) Manufacturing*
326160	*Plastics Bottle Manufacturing*
326191	*Plastics Plumbing Fixture Manufacturing*
326199	*All Other Plastics Product Manufacturing*
326211	*Tire Manufacturing (except Retreading)*
326212	*Tire Retreading*
326220	*Rubber and Plastics Hoses and Belting Manufacturing*
326291	*Rubber Product Manufacturing for Mechanical Use*
326299	*All Other Rubber Product Manufacturing*

Bold = Subsector

Italics = Detailed industry

XI.   Appendix C: Long-Term Regional Employment Trends (2001-2025)

C- 1. Regional Employment Trends for Forest Products Sector

	Region	2006 Jobs	2016 Jobs	Change	% Change
●	Region	22,153	15,293	-6,860	-31.0%
■	Coastal Counties, WIA	4,315	2,857	-1,458	-33.8%
▲	Central Western, WIA	9,874	7,484	-2,390	-24.2%
◆	Northeastern, WIA	7,878	4,933	-2,945	-37.4%
+	United States	1,810,371	1,330,279	-480,092	-26.5%

C- 2. Regional Employment Trends for Advanced Manufacturing
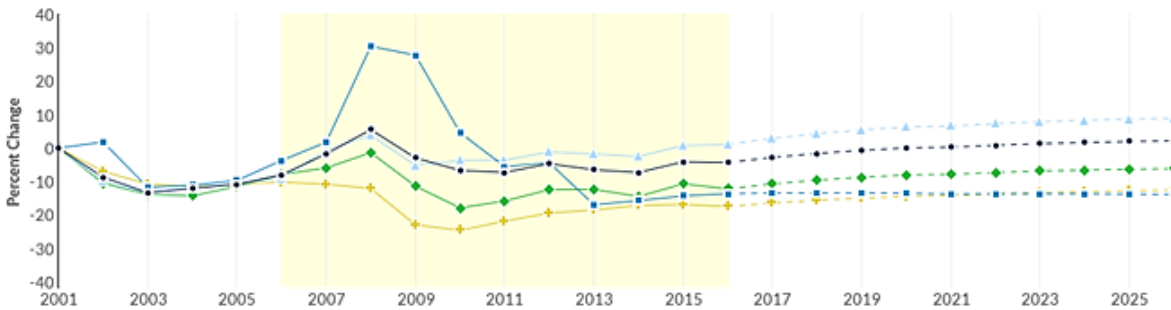
	Region	2006 Jobs	2016 Jobs	Change	% Change
●	Region	11,279	11,733	454	4.0%
●	Northeastern, WIA	1,403	1,258	-145	-10.3%
●	Coastal Counties, WIA	6,643	7,381	738	11.1%
●	Central Western, WIA	3,229	3,077	-152	-4.7%
●	United States	4,421,133	4,060,349	-360,784	-8.2%

Source: EMSI 2017.1 data series report. Region = State. Base year index = 2001.

XII.   Appendix D: Top 5 Occupations employed by Region, 2016

D 1: Top 5 Occupations employed by Advanced Manufacturing industries by Region

Central Western

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Machinists	292	9.5%
Computer-Controlled Machine Tool Operators, Metal and Plastic	167	5.4%
First-Line Supervisors of Production and Operating Workers	153	5.0%
Team Assemblers	130	4.2%
Welders, Cutters, Solderers, and Brazers	121	3.9%

Coastal Counties

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Machinists	463	6.3%
First-Line Supervisors of Production and Operating Workers	339	4.6%
Computer-Controlled Machine Tool Operators, Metal and Plastic	298	4.0%
Team Assemblers	296	4.0%
General and Operations Managers	253	3.4%

Northeastern

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Machinists	103	8.2%
Team Assemblers	73	5.8%
First-Line Supervisors of Production and Operating Workers	54	4.3%
Computer-Controlled Machine Tool Operators, Metal and Plastic	54	4.3%
Welders, Cutters, Solderers, and Brazers	52	4.2%

D 2: Top Occupations employed by Forest Products industries by Region

Central Western

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Logging Equipment Operators	762	10.2%
Paper Goods Machine Setters, Operators, and Tenders	419	5.6%
Sawing Machine Setters, Operators, and Tenders, Wood	302	4.0%
Heavy and Tractor-Trailer Truck Drivers	282	3.8%
Helpers--Production Workers	269	3.6%

Coastal Counties

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Logging Equipment Operators	265	9.3%
Sawing Machine Setters, Operators, and Tenders, Wood	155	5.4%
Woodworking Machine Setters, Operators, and Tenders, Except Sawing	147	5.1%
Printing Press Operators	99	3.5%
First-Line Supervisors of Production and Operating Workers	96	3.4%

Northeastern

Description	Employed in Industry Group (2016)	% of Total Jobs in Industry Group (2016)
Logging Equipment Operators	992	20.1%
Heavy and Tractor-Trailer Truck Drivers	333	6.7%
Woodworking Machine Setters, Operators, and Tenders, Except Sawing	198	4.0%
Sawing Machine Setters, Operators, and Tenders, Wood	196	4.0%
First-Line Supervisors of Farming, Fishing, and Forestry Workers	185	3.7%

XIII.   Appendix E: Primary Educational Intuitions by Region

E 1: Primary intuitions in the Forest Product industry

Region	Institution
Central Western	Central Maine Community College
	Kaplan University-Augusta Campus
	Kennebec Valley Community College
	Thomas College
	University of Maine at Augusta
	University of Maine at Farmington
Coast Counties	Kaplan University-Maine Campus
	Northeast Technical Institute
	Saint Joseph's College of Maine
	Seacoast Career Schools-Sanford Campus
	Southern Maine Community College
	University of New England
	University of Southern Maine
	York County Community College
Northeastern	Beal College
	Eastern Maine Community College
	Husson University
	Maine Maritime Academy
	Northern Maine Community College
	University of Maine
	University of Maine at Fort Kent
	University of Maine at Machias
	University of Maine at Presque Isle
	Washington County Community College

E 2: Primary intuitions in the Advanced Manufacturing industry

Region	Institution
Central Western	Bates College
	Central Maine Community College
	Colby College
	Kennebec Valley Community College
	University of Maine at Augusta
	University of Maine at Farmington
	Thomas College
	Kaplan University-Augusta Campus
Coast Counties	Bowdoin College
	InterCoast Career Institute-South Portland
	Kaplan University-Maine Campus
	Maine College of Art
	Northeast Technical Institute
	Saint Joseph's College of Maine
	Seacoast Career Schools-Sanford Campus
	Southern Maine Community College
	The Landing School
	Unity College
	University of New England
	University of Southern Maine
	York County Community College
Northeastern	Eastern Maine Community College
	Husson University
	University of Maine at Fort Kent
	University of Maine at Machias
	University of Maine
	Maine Maritime Academy
	University of Maine at Presque Isle
	Northern Maine Community College
	Washington County Community College
	Beal College

XIV. Appendix F: Regional Program Completions by Sector and Region

F 1: Regional Program Completions for Forest Products Sector

Region	Program	Completions
Central Western	Business Administration and Management, General	246
	Public Administration	7
	Accounting Technology/Technician and Bookkeeping	5
	Administrative Assistant and Secretarial Science, General	3
	International Business/Trade/Commerce	2
	Business/Commerce, General	1
Northeastern	Business Administration and Management, General	374
	Mechanical Engineering	72
	Business/Commerce, General	45
	International Business/Trade/Commerce	30
	Entrepreneurship/Entrepreneurial Studies	18
	Business, Management, Marketing, and Related Support Services, Other	9
	Cabinetmaking and Millwork	6
	Accounting Technology/Technician and Bookkeeping	6
	Administrative Assistant and Secretarial Science, General	6
	General Office Occupations and Clerical Services	4
	Heavy/Industrial Equipment Maintenance Technologies, Other	2
Coast Counties	Business Administration and Management, General	369
	Truck and Bus Driver/Commercial Vehicle Operator and Instructor	146
	Accounting Technology/Technician and Bookkeeping	15
	Mechanical Engineering	14
	Public Administration	5
	International Business/Trade/Commerce	3

F 2: Regional Program Completions for Advanced Manufacturing - Central Western Region

54	845	979
Programs (2015)	Completions (2015)	Openings (2015)

CIP Code	Program	Completions (2011)	Completions (2012)	Completions (2013)	Completions (2014)	Completions (2015)
52.0201	🎓 Business Administration and Management, General	189	230	204	205	246
26.0101	🎓 Biology/Biological Sciences, General	88	77	89	95	87
27.0101	🎓 Mathematics, General	44	48	67	52	53
48.0501	🎓 Machine Tool Technology/Machinist	26	24	17	32	45
11.0103	🎓 Information Technology	0	21	15	29	39
40.0801	🎓 Physics, General	21	21	23	29	36
40.0501	🎓 Chemistry, General	32	20	27	21	35
26.1501	🎓 Neuroscience	15	18	29	35	34
52.1401	🎓 Marketing/Marketing Management, General	26	28	29	25	33
11.1001	🎓 Network and System Administration/Administrator	0	0	0	25	30
15.0403	🎓 Electromechanical Technology/Electromechanical Engineering Technology	14	29	17	30	24
11.0701	🎓 Computer Science	9	15	18	24	21
40.0601	🎓 Geology/Earth Science, General	16	20	21	29	20
26.0202	🎓 Biochemistry	21	21	22	20	19
46.0302	🎓 Electrician	19	23	26	14	17
11.0101	🎓 Computer and Information Sciences, General	32	4	0	15	14
41.0101	🎓 Biology Technician/Biotechnology Laboratory Technician	6	7	5	10	13
27.0503	🎓 Mathematics and Statistics	5	2	10	2	10
14.4001	🎓 Paper Science and Engineering	0	0	0	9	9
15.0303	🎓 Electrical, Electronic and Communications Engineering Technology/Technician	13	10	8	9	9

F- 3: Regional Program Completions for Advanced Manufacturing - Coastal Counties Region

71	1,526	2,570
Programs (2015)	Completions (2015)	Openings (2015)

CIP Code	Program	Completions (2011)	Completions (2012)	Completions (2013)	Completions (2014)	Completions (2015)
52.0201	🎓 Business Administration and Management, General	398	320	349	416	369
49.0205	🎓 Truck and Bus Driver/Commercial Vehicle Operator and Instructor	0	0	0	0	146
26.0101	🎓 Biology/Biological Sciences, General	119	106	87	104	117
44.0501	🎓 Public Policy Analysis, General	22	40	26	38	75
51.0000	🎓 Health Services/Allied Health/Health Sciences, General	60	29	21	26	70
27.0101	🎓 Mathematics, General	42	36	58	54	62
26.0102	🎓 Biomedical Sciences, General	49	54	59	85	59
26.1302	🎓 Marine Biology and Biological Oceanography	40	71	55	40	56
11.0701	🎓 Computer Science	13	16	27	53	49
52.1401	🎓 Marketing/Marketing Management, General	35	55	36	43	46
48.0501	🎓 Machine Tool Technology/Machinist	19	9	20	36	43
40.0601	🎓 Geology/Earth Science, General	8	11	15	26	40
11.1001	🎓 Network and System Administration/Administrator	0	0	0	21	34
15.0612	🎓 Industrial Technology/Technician	38	38	44	40	32
26.0202	🎓 Biochemistry	21	34	43	44	30
47.0616	🎓 Marine Maintenance/Fitter and Ship Repair Technology/Technician	4	8	34	36	26
26.1501	🎓 Neuroscience	24	32	30	24	25
15.0303	🎓 Electrical, Electronic and Communications Engineering Technology/Technician	27	31	31	25	23
11.0103	🎓 Information Technology	0	0	3	15	20
14.1001	🎓 Electrical and Electronics Engineering	7	9	7	12	20

F- 4: Regional Program Completions for Advanced Manufacturing – Northeastern Region

89	1,635	837
Programs (2015)	Completions (2015)	Openings (2015)

CIP Code	Program	Completions (2011)	Completions (2012)	Completions (2013)	Completions (2014)	Completions (2015)
52.0201	🎓 Business Administration and Management, General	328	345	365	396	374
26.0101	🎓 Biology/Biological Sciences, General	104	87	82	82	89
14.2201	🎓 Naval Architecture and Marine Engineering	67	45	66	59	86
14.1901	🎓 Mechanical Engineering	49	54	74	62	72
01.1001	🎓 Food Science	58	47	52	42	67
48.0508	🎓 Welding Technology/Welder	58	51	49	33	67
14.0801	🎓 Civil Engineering, General	86	62	68	76	57
52.1401	🎓 Marketing/Marketing Management, General	47	49	51	42	51
30.3201	🎓 Marine Sciences	31	34	37	39	50
15.0805	🎓 Mechanical Engineering/Mechanical Technology/Technician	26	42	31	29	47
52.1101	🎓 International Business/Trade/Commerce	30	23	21	11	30
14.0501	🎓 Bioengineering and Biomedical Engineering	0	0	4	16	28
15.9999	🎓 Engineering Technologies and Engineering-Related Fields, Other	8	18	20	28	22
47.0302	🎓 Heavy Equipment Maintenance Technology/Technician	23	26	27	21	21
26.0701	🎓 Zoology/Animal Biology	12	10	13	14	20

XV. Appendix G: Top 20 Detailed Occupations by 3-digit NAICS Industry in Advanced Manufacturing

Machinery (333)

SOC	Description	Employed in Industry	% Change from 2006	Median Hourly Earnings	Education	Work Experience	Training
51-4041	Machinists	202	16%	$ 22.02	HS or equivalent	None	Long
51-2092	Team Assemblers	157	8%	$ 14.88	HS or equivalent	None	Moderate
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	116	33%	$ 22.13	HS or equivalent	None	Moderate
51-4121	Welders, Cutters, Solderers, and Brazers	103	7%	$ 23.34	HS or equivalent	None	Moderate
51-1011	First-Line Supervisors of Production and Operating Workers	91	12%	$ 27.56	HS or equivalent	> 5 yrs	None
17-2141	Mechanical Engineers	84	6%	$ 38.92	Bachelor's degree	None	None
11-1021	General and Operations Managers	76	15%	$ 36.92	Bachelor's degree	5 yrs +	None
17-3013	Mechanical Drafters	50	6%	$ 28.03	Associate's degree	None	None
17-2112	Industrial Engineers	45	5%	$ 39.55	Bachelor's degree	None	None
51-4111	Tool and Die Makers	44	13%	$ 23.41	HS or equivalent	None	Long
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	40	8%	$ 20.48	HS or equivalent	None	Moderate
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	39	5%	$ 26.38	HS or equivalent	None	Moderate
49-9041	Industrial Machinery Mechanics	35	13%	$ 25.23	HS or equivalent	None	Long
51-9198	Helpers--Production Workers	34	10%	$ 12.18	No formal educational credential	None	Short
51-2041	Structural Metal Fabricators and Fitters	34	6%	$ 27.21	HS or equivalent	None	Moderate
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	32	10%	$ 25.60	HS or equivalent	None	Moderate
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	32	7%	$ 29.06	Postsecondary nondegree award	None	Long
17-2112	Industrial Production Managers	29	4%	$ 41.21	Bachelor's degree	5 yrs +	None
51-9199	Production Workers, All Other	27	8%	$ 13.39	HS or equivalent	None	Moderate
51-9200	Architectural and Engineering Managers	26	4%	$ 58.36	Bachelor's degree	5 yrs +	None

Fabaricated

SOC	Description	Employed in Industry	% Change from 2006	Median Hourly Earnings	Education	Work Experience	Training
51-4041	Machinists	625	-2%	$ 22.02	HS or equivalent	None	Long
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	353	16%	$ 22.13	HS or equivalent	None	Moderate
51-4121	Welders, Cutters, Solderers, and Brazers	306	-5%	$ 23.34	HS or equivalent	None	Moderate
51-1011	First-Line Supervisors of Production and Operating Workers	228	-3%	$ 27.56	HS or equivalent	> 5 yrs	None
51-2041	Structural Metal Fabricators and Fitters	205	-3%	$ 27.21	HS or equivalent	None	Moderate
51-2092	Team Assemblers	177	-9%	$ 14.88	HS or equivalent	None	Moderate
51-9198	Helpers--Production Workers	131	-2%	$ 12.18	No formal educational credential	None	Short
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	115	3%	$ 25.60	HS or equivalent	None	Moderate
47-2211	Sheet Metal Workers	104	2%	$ 23.54	HS or equivalent	None	Apprenticeship
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	93	-6%	$ 20.48	HS or equivalent	None	Moderate
51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	85	-10%	$ 14.07	HS or equivalent	None	Moderate
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	85	-9%	$ 16.07	HS or equivalent	None	Short
51-4193	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	80	-7%	$ 17.04	HS or equivalent	None	Moderate
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	70	-10%	$ 26.38	HS or equivalent	None	Moderate
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	70	-19%	$ 14.14	HS or equivalent	None	Moderate
43-5071	Shipping, Receiving, and Traffic Clerks	69	-4%	$ 16.12	HS or equivalent	None	Short
17-3013	Mechanical Drafters	64	-6%	$ 28.03	Associate's degree	None	None
17-2112	Industrial Production Managers	61	-3%	$ 41.21	Bachelor's degree	5 yrs +	None
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	60	-6%	$ 16.71	HS or equivalent	None	Moderate
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	53	15%	$ 24.83	HS or equivalent	None	Long

Plastics

SOC	Description	Employed in Industry	% Change from 2006	Median Hourly Earnings	Education	Work Experience	Training
51-4072	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	155	-16%	$ 15.96	HS or equivalent	None	Moderate
51-2092	Team Assemblers	135	-8%	$ 14.88	HS or equivalent	None	Moderate
51-1011	First-Line Supervisors of Production and Operating Workers	124	-5%	$ 27.56	HS or equivalent	> 5 yrs	None
51-9198	Helpers--Production Workers	65	-7%	$ 12.18	No formal educational credential	None	Short
11-1021	General and Operations Managers	61	-3%	$ 36.92	Bachelor's degree	5 yrs +	None
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	60	-8%	$ 20.48	HS or equivalent	None	Moderate
51-4021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	59	-17%	$ 15.23	HS or equivalent	None	Moderate
51-9111	Packaging and Filling Machine Operators and Tenders	55	-5%	$ 14.66	HS or equivalent	None	Moderate
49-9041	Industrial Machinery Mechanics	52	4%	$ 25.23	HS or equivalent	None	Long
53-7064	Packers and Packagers, Hand	52	-5%	$ 10.55	rmal educational cred	None	Short
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	50	-14%	$ 14.78	HS or equivalent	None	Moderate
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	50	9%	$ 22.13	HS or equivalent	None	Moderate
49-9071	Maintenance and Repair Workers, General	50	-6%	$ 17.69	HS or equivalent	None	Long
43-5071	Shipping, Receiving, and Traffic Clerks	41	-9%	$ 16.12	HS or equivalent	None	Short
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	39	-7%	$ 12.68	rmal educational cred	None	Short
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	36	-5%	$ 16.71	HS or equivalent	None	Moderate
53-7051	Industrial Truck and Tractor Operators	35	-5%	$ 15.33	No formal educational credential	None	Short
17-2112	Industrial Production Managers	34	-6%	$ 41.21	Bachelor's degree	5 yrs +	None
51-9197	Tire Builders	33	-34%	$ 14.81	HS or equivalent	None	Moderate

SOC	Description	Employed in Industry	% Change from 2006	Median Hourly Earnings	Education	Work Experience	Training
51-9111	Packaging and Filling Machine Operators and Tenders	212	44%	$ 14.66	HS or equivalent	None	Moderate
51-1011	First-Line Supervisors of Production and Operating Workers	106	43%	$ 27.56	HS or equivalent	> 5 yrs	None
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	96	22%	$ 21.71	HS or equivalent	None	Moderate
19-4021	Biological Technicians	80	74%	$ 20.10	Bachelor's degree	None	None
11-1021	General and Operations Managers	75	47%	$ 36.92	Bachelor's degree	5 yrs +	None
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	66	35%	$ 20.48	HS or equivalent	None	Moderate
19-1021	Biochemists and Biophysicists	61	69%	$ 32.06	toral/professional deg	None	None
19-2031	Chemists	59	20%	$ 28.45	Bachelor's degree	None	None
49-9041	Industrial Machinery Mechanics	56	56%	$ 25.23	HS or equivalent	None	Long
51-9199	Production Workers, All Other	50	47%	$ 13.39	HS or equivalent	None	Moderate
49-9071	Maintenance and Repair Workers, General	49	40%	$ 17.69	HS or equivalent	None	Long
17-2112	Industrial Production Managers	46	39%	$ 41.21	Bachelor's degree	5 yrs +	None
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	45	50%	$ 24.20	HS or equivalent	None	Moderate
19-4031	Chemical Technicians	43	34%	$ 20.03	Associate's degree	None	Moderate
17-2112	Industrial Engineers	43	54%	$ 39.55	Bachelor's degree	None	None
51-9011	Chemical Equipment Operators and Tenders	43	16%	$ 20.12	HS or equivalent	None	Moderate
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	40	54%	$ 14.78	HS or equivalent	None	Moderate
17-2041	Chemical Engineers	35	52%	$ 48.14	Bachelor's degree	None	None
19-1022	Microbiologists	34	70%	$ 26.22	Bachelor's degree	None	None
13-1199	Business Operations Specialists, All Other	34	55%	$ 29.26	Bachelor's degree	None	None

XVI. Appendix H – OCC Definitions Included in Occupational Program Overview

Table H-1: Forest Products Sector

SOC Code	Occupation Description
51-7011	Cabinetmakers and Bench Carpenters
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders
43-4051	Customer Service Representatives
51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment
45-4021	Fallers
45-1011	First-Line Supervisors of Farming, Fishing, and Forestry Workers
51-1011	First-Line Supervisors of Production and Operating Workers
11-1021	General and Operations Managers
53-3032	Heavy and Tractor-Trailer Truck Drivers
51-9198	Helpers--Production Workers
49-9041	Industrial Machinery Mechanics
53-7051	Industrial Truck and Tractor Operators
53-7062	Laborers and Freight, Stock, and Material Movers, Hand
45-4022	Logging Equipment Operators
53-7063	Machine Feeders and Offbearers
49-9071	Maintenance and Repair Workers, General
49-9044	Millwrights
51-9196	Paper Goods Machine Setters, Operators, and Tenders
51-5112	Printing Press Operators
51-9199	Production Workers, All Other
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products
51-7041	Sawing Machine Setters, Operators, and Tenders, Wood
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive
51-8021	Stationary Engineers and Boiler Operators
51-2092	Team Assemblers
51-7042	Woodworking Machine Setters, Operators, and Tenders, Except Sawing

Table H-2: Advanced Manufacturing Sector

Code	Description
51-4041	Machinists
51-1011	First-Line Supervisors of Production and Operating Workers
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic
51-2092	Team Assemblers
51-4121	Welders, Cutters, Solderers, and Brazers
11-1021	General and Operations Managers
51-9111	Packaging and Filling Machine Operators and Tenders
51-9198	Helpers--Production Workers
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers
51-2041	Structural Metal Fabricators and Fitters
49-9041	Industrial Machinery Mechanics
51-4072	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders
49-9071	Maintenance and Repair Workers, General
51-9199	Production Workers, All Other
11-3051	Industrial Production Managers
43-5071	Shipping, Receiving, and Traffic Clerks
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products
17-2141	Mechanical Engineers
17-2112	Industrial Engineers
53-7062	Laborers and Freight, Stock, and Material Movers, Hand
43-3031	Bookkeeping, Accounting, and Auditing Clerks
51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic
17-3013	Mechanical Drafters
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic
47-2211	Sheet Metal Workers
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders
43-5061	Production, Planning, and Expediting Clerks
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders
53-7064	Packers and Packagers, Hand
51-4193	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic
51-4111	Tool and Die Makers
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products
53-7051	Industrial Truck and Tractor Operators
51-2099	Assemblers and Fabricators, All Other
19-4021	Biological Technicians
51-4021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic
51-2031	Engine and Other Machine Assemblers
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic
17-3026	Industrial Engineering Technicians
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment
11-9041	Architectural and Engineering Managers
53-3032	Heavy and Tractor-Trailer Truck Drivers
19-2031	Chemists
19-1021	Biochemists and Biophysicists

51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers
53-7063	Machine Feeders and Offbearers
13-1199	Business Operations Specialists, All Other
43-1011	First-Line Supervisors of Office and Administrative Support Workers
49-9043	Maintenance Workers, Machinery
53-3033	Light Truck or Delivery Services Drivers
51-9011	Chemical Equipment Operators and Tenders
17-3027	Mechanical Engineering Technicians
19-4031	Chemical Technicians
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders
17-3029	Engineering Technicians, Except Drafters, All Other
17-2041	Chemical Engineers
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders
13-1051	Cost Estimators
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
17-2199	Engineers, All Other
19-1022	Microbiologists
15-1142	Network and Computer Systems Administrators
43-6011	Executive Secretaries and Executive Administrative Assistants
11-9121	Natural Sciences Managers
47-2111	Electricians
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
51-2091	Fiberglass Laminators and Fabricators
51-9197	Tire Builders
51-8091	Chemical Plant and System Operators
51-9022	Grinding and Polishing Workers, Hand
51-4191	Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic
13-1041	Compliance Officers
51-6091	Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers
11-3021	Computer and Information Systems Managers
51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders
11-3061	Purchasing Managers
43-5111	Weighers, Measurers, Checkers, and Samplers, Recordkeeping
13-1161	Market Research Analysts and Marketing Specialists
15-1121	Computer Systems Analysts
51-4194	Tool Grinders, Filers, and Sharpeners
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic
51-2022	Electrical and Electronic Equipment Assemblers
51-4199	Metal Workers and Plastic Workers, All Other
17-2071	Electrical Engineers
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
15-1151	Computer User Support Specialists
51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic
51-4192	Layout Workers, Metal and Plastic
15-1131	Computer Programmers
13-1081	Logisticians
19-1042	Medical Scientists, Except Epidemiologists
13-1111	Management Analysts
15-1132	Software Developers, Applications

51-2023	Electromechanical Equipment Assemblers
53-1021	First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand
49-9099	Installation, Maintenance, and Repair Workers, All Other
13-1151	Training and Development Specialists
17-3023	Electrical and Electronics Engineering Technicians
11-3071	Transportation, Storage, and Distribution Managers
41-9031	Sales Engineers
41-1012	First-Line Supervisors of Non-Retail Sales Workers
29-9011	Occupational Health and Safety Specialists
17-2031	Biomedical Engineers
47-2152	Plumbers, Pipefitters, and Steamfitters
51-9021	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders
17-2131	Materials Engineers
27-1021	Commercial and Industrial Designers
51-9192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders
51-9195	Molders, Shapers, and Casters, Except Metal and Plastic