National Center for Higher Education Management Systems

Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin

Submitted to

University of Wisconsin System

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Introduction

The University of Wisconsin System contracted with the National Center for Higher Education Management Systems (NCHEMS) to determine "the extent and nature of shortages of engineers needed in the Wisconsin workforce, if any." Based on that information, NCHEMS was asked to "provide recommendations as to cost-effective approaches to responding to any identified shortages." This report has been prepared in response to that charge.

In this report we provide information about the supply and demand for engineers in various specialty areas, both statewide and in different regions within the state. In addition we analyzed data that provide a deeper understanding of the market, both current and potentially the future, for engineering talent in Wisconsin. These analyses include:

- A comparison of engineering employment in Wisconsin vis-à-vis employment nationally and in the states that border Wisconsin
- An assessment of migration of engineers into and out of Wisconsin
- A comparison of salaries paid to engineers in Wisconsin with salaries paid in Border States
- A determination of the age distribution of engineers in Wisconsin. Is there any evidence of a likely wave of retirements that would affect demand for engineers?

Major findings are noted in the report. At the end of the report we make recommendations concerning cost-effective ways of addressing identified needs.

Current Production of Employed Engineers Degrees in Wisconsin (Supply)

Almost 2.9 million people were engaged in non-farm employment in the state of Wisconsin in August 2013 and most of this employment occurred in the manufacturing, government, health care, and retail industries (Current Employment Statistics, Worknet, Wisconsin Department of Workforce Development). Estimates from the federal Bureau of Labor Statistics indicate that in May 2013 there were just over 30,500 engineers employed in Wisconsin.

In 2013 a total of 2,447 bachelor's and master's degrees in engineering were granted by public and private Wisconsin colleges and universities. (For-profit institutions have little effect on engineering education in Wisconsin and are not included in analyses.) Private Non-Profit institutions in Wisconsin provide a larger portion of baccalaureate engineering degrees (30.3%) compared to the percentage provided by this same type of institution in the rest of the country (22.1%). Public institutions grant a higher proportion of master's degrees in Wisconsin than is true in the rest of the country. Baccalaureate and master's data are treated separately except in those cases where data are only available for aggregated bachelors and graduate/professional degree levels.

Table 1. Total Degree Production by Institutional Control, Wisconsin and Nation, 2013

Institutional Type	Baccalaureate Degrees				Master's Degrees			
	Wisconsin		Nation		Wisconsin		Nation	
	N	% of Total	N	% of Total	N	% of Total	N	% of Total
Public	1306	69.7%	66724	77.6%	481	84.1%	85980	76.2%
Private Non-Profit	569	30.3%	18963	22.1%	91	15.9%	26569	23.6%
Private For-Profit	0	0.0%	293	0.3%	0	0.0%	247	0.2%
Total	1875	100.0%	85980	100.0%	572	100.0%	112796	100.0%

This level of engineering degree production in the state was compared to the current engineering employment in the state (see data in Table 2). These analyses were extended to the Border States. From these analyses it is clear that Border States contain institutions that have faculty expertise in different engineering areas. For instance, Wisconsin produces a large number of agricultural and biomedical engineers relative to the nation and to employment in the state of Wisconsin. States that border Wisconsin (Illinois, Iowa, Michigan, and Minnesota) produced substantially more agricultural engineers (Illinois), biomedical (Illinois, Iowa, Michigan), chemical (Iowa), computer hardware (Iowa), and materials engineers (Illinois, Iowa, Minnesota) than Wisconsin in 2013. Later we explore whether those are the types of engineers that might be needed within Wisconsin.

Table 2. Bachelor's and Master's Employed Engineers Degrees Awarded per 100 Employed Engineers, by Engineering Discipline by State, 2013

Type of Employed Engineers	Wisconsin	Border States				Nation
		Illinois	Iowa	Michigan	Minnesota	
Total	8.0	8.5	15.2	6.2	6.0	8.2
Aerospace	--	31.0	--	--	30.4	6.7
Agricultural	71.4	140.8	10.0	--	--	48.8
Biomedical	76.2	128.9	190.0	122.5	7.8	34.0
Chemical	30.8	24.3	90.6	44.2	26.9	27.0
Civil	8.4	8.2	13.7	8.1	7.0	7.1
Computer Hardware	15.5	11.7	67.1	34.8	5.6	8.3
Electrical and Electronic	5.7	12.4	15.0	9.8	8.2	7.4

Environmental	2.6	4.7	0	5.5	0	3.8
Industrial	2.2	2.7	4.6	1.5	0.3	2.2
Marine	0	--	--	--	--	6.9
Materials	9.4	24.1	44.4	11.4	26.3	8.2
Mechanical	8.5	6.6	13.9	4.4	7.0	10.8
Mining	--	6.5	--	31.4	4.3	7.6
Nuclear	30.0	6.5	--	15.8	0	5.8
Petroleum	--	--	--	0	--	4.4
Other	15.3	5.5	14.7	7.5	6.3	13.5

Finding 1. Relative to employment, production of engineering degrees in Wisconsin is greatest in the areas of agricultural and biomedical engineering. Border States have production capacity in areas in which Wisconsin produces few degrees in relation to employment.

Current Demand for Degreed Engineers in Wisconsin

In this section of the report, we investigate various factors that could affect decisions about taking steps to increase production of engineers in the state – migration of engineers, the age distribution of engineers, and wages paid to the engineers.

Migration of Engineers Into and Out of Wisconsin

The question of need for engineers is determined not just by supply and demand within Wisconsin, but by migration of engineers into and out of the state. Using the American Community Survey (ACS), an annual survey conducted by the U.S. Census Bureau to gauge activity between census dates, the migration of degreed engineers from one state to another was estimated. Because ACS data are estimates, only those which are within a reasonable margin of error were used. In terms of the average annual net migration of engineers by state between 2008 and 2012, we find that Wisconsin is an overall exporter of baccalaureate degrees; no conclusion can be drawn with regard to master's degrees. Compared to Border States, Minnesota was an importer of engineers with baccalaureate degrees in the same time frame and Michigan was an importer of engineers with master's degrees.

Table 3 below presents similar data by type of engineering for the same time frame. (Note that the type of engineering categories is slightly different in order to maximize statistical power of available data.) Wisconsin is an overall exporter of industrial and mechanical engineers and an importer of civil and electrical and electronic engineers. From the table we also see that Illinois exports civil engineers and both Michigan and Minnesota export electrical and electronic engineers. These data do not indicate destination so it is unknown exactly where exported engineers went.

Finding 2. Overall Wisconsin is a net exporter of engineers – more engineers leave the state than come in. Wisconsin is a net importer in two areas, civil engineers and electrical and electronic engineers. Border States are net exporters of these types of engineers meaning that shortages in Wisconsin can potentially be addressed by attracting engineers from neighboring states that have surpluses of such engineers.

Table 3. Estimates of Average Annual Net Migration of Engineers by Employed Engineers Type, 2008-2012

Type of Employed Engineers	Wisconsin	Border States			
		Illinois	Iowa	Michigan	Minnesota
Total	Exporter (~390)	--	--	--	Importer (~480)
Aerospace	--	--	--	Exporter (~60)	--
Biomedical	--	Importer (~90)	--	--	--
Chemical	--	--	Importer (~80)	--	--

Civil	Importer (~100)	Exporter (~190)	Importer (~230)	--	--
Computer Hardware	--	--	--	--	--
Electrical and Electronic	Importer (~190)	--	--	Exporter (~120)	Exporter (~440)
Environmental	--	Exporter (~40)	--	--	--
Industrial	Exporter (~380)	Importer (~240)	Importer (~110)	--	--
Marine	--	--	--	--	--
Materials	--	--	--	--	--
Mechanical	Exporter (~130)		Exporter (~180)	Importer (~710)	Importer (~220)
Mining and Petroleum	--	--	--	--	Importer (~140)
Nuclear and Misc	--	--	--	--	Importer (~250)

Age Distribution of Engineers

Another area which can signal a coming demand for engineers is those who are close to retirement age. The ACS survey also provides data which are useful for this analysis. See Table 4 below for the estimated percent of engineering jobs filled by individuals who are 50 years of age or older. Cells in green indicate a younger workforce (<25% are 50 and older) while cells in red indicate an aging population (>45% are 50 and older). Iowa has a younger engineering workforce overall. Wisconsin has younger workers in chemical and computer hardware engineering and older workers in environmental engineering.

Finding 3. Overall, mass retirement of engineers does not appear to be a looming problem in Wisconsin.

Table 4. Estimates of the Percent of the Annual Employed Engineers Employment of Individuals who are age 50 or Older, 2008-2012

Type of Employed Engineers	Wisconsin	Border States				Nation
		Illinois	Iowa	Michigan	Minnesota	
Total	30.8	32.6	24.6	28.9	30.5	32.9
Aerospace	38.0	36.5	18.0	41.2	35.5	39.9
Biomedical	29.7	42.5	28.9	20.1	32.4	25.4
Chemical	21.1	44.8	21.0	26.1	31.6	30.7
Civil	30.3	31.3	23.1	27.9	28.6	32.1
Computer Hardware	12.8	25.6	32.2	19.3	34.2	24.5
Electrical and Electronic	34.6	35.1	21.0	28.2	41.0	33.8

Environmental	48.7	26.5	56.7	37.8	20.2	34.3
Industrial	37.7	37.0	35.5	30.5	27.6	35.4
Marine	--	--	--	--	--	
Materials	27.2	30.6	24.8	37.2	33.6	34.3
Mechanical	25.6	28.9	17.7	27.5	28.5	29.3
Mining and Petroleum	--	--	--	--	--	
Nuclear and Misc	31.1	30.4	24.7	30.4	29.2	32.9

Compensation of Engineers

Level of compensation for engineering employment was hypothesized as another factor that could influence the match between supply and demand. Data from ACS show that median engineering salaries in Wisconsin for both baccalaureate and master's degree engineers are lower than national averages. In several fields, salaries in Wisconsin are not just lower, they are much lower. It might be argued that these differentials could be due to cost of living differences, but the 2010 cost of living index for several Wisconsin cities indicates that is not the case. If the index has the nation at 100, Appleton has an index of 93.3, Marshfield of 94.2, Milwaukee of 101.9 and Sheboygan of 101.4. Clearly the differential in pay cannot be explained by differences in cost of living.

Table 5. Estimated Average Median Income for Engineers by Type of Employed Engineers and Degree, 2008-2012

	Baccalaureate		Masters		Indicates Need For
	Wisconsin	Nation	Wisconsin	Nation	
All Employed Engineers	$72,735	$81,706	$83,829	$96,562	
Aerospace Engineer	$77,963	$93,379	$103,990	$106,072	Workplace Development
Chemical/Process Engineer	$65,161	$90,195	$93,398	$103,172	Workplace Development
Civil Engineer	$69,647	$78,194	$81,082	$91,226	Workforce Development
Electrical Engineer	$76,022	$85,868	$86,279	$103,951	Workforce Development
Electronic Engineer	$76,022	$85,868	$86,279	$103,951	Workforce Development
Environmental Engineer	$55,561	$76,022	$82,384	$84,200	Workplace Development
Health and Safety Engineer	$70,714	$75,766	$69,704	$69,704	Workplace Development
Industrial Engineer	$70,714	$75,766	$84,890	$84,890	Workplace Development
Materials Engineer	$60,612	$76,022	$64,195	$89,873	Workplace Development
Mechanical Engineer	$70,592	$77,108	$82,767	$90,943	Workplace Development
Nuclear Engineer*	$73,850	$83,847	$84,890	$99,914	Workplace Development

*as part of "Miscellaneous Employed Engineers"

Additional data from special estimates developed by the U.S. Bureau of Labor Statistics in May 2013 allow for comparison with Border States as well as the rest of the United States (Table 6). Based on these data, Wisconsin pays computer hardware and nuclear engineers more than Border States and the rest of the country. However, for every other type of engineering Wisconsin salaries are lower than Border States and the rest of the country.

Table 6. May 2013 Estimates of Absolute Number and Percent by Type of Engineer Employed in Wisconsin and Median Annual Wage from BLS data

Type of Employed Engineers	Estimated Employment		Est. Median Annual Wage		
	N	%	Wisconsin	Border State	Rest of U.S.
All Employed Engineers	30,570	100%	$76,291	$83,751	$87,693
Aerospace Engineers	--	--	--	$92,080	$98,311
Agricultural Engineers	70	0.2%	$72,080	$72,135	$75,300
Biomedical Engineers	210	0.7%	$78,320	$86,685	$82,678
Chemical Engineers	370	1.2%	$70,540	$88,990	$93,346
Civil Engineers	4,460	14.6%	$70,330	$77,103	$76,309
Computer Hardware Engineers	580	1.9%	$99,110	$91,183	$92,444
Electrical Engineers	3,830	12.5%	$76,040	$81,308	$85,682
Electronics Engineers, Except Computer	1,660	5.4%	$72,390	$77,903	$89,143
Environmental Engineers	740	2.4%	$75,650	$80,183	$79,778
Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	310	1.0%	$61,440	$77,020	$77,316
Industrial Engineers	7,400	24.2%	$71,530	$75,308	$80,986
Marine Engineers and Naval Architects	70	0.2%	$82,090	--	$88,529
Materials Engineers	540	1.8%	$70,970	$80,408	$84,332
Mechanical Engineers	7,420	24.3%	$68,620	$79,043	$80,207
Mining and Geological Engineers	--	--	--	$72,077	$81,480
Nuclear Engineers	180	0.6%	$106,850	$102,283	$108,792
Petroleum Engineers	--	--	--	$107,020	$113,776
Engineers, All Other	2,730	8.9%	$68,410	$83,045	$90,065

Finding 4. Compensation of engineers in Wisconsin is lower than that in Border States and the nation as a whole in most fields. It is particularly the case in those fields in which shortages were noted – civil, electrical, and electronics engineers.

Engineers Employed by Industry and Their Associated Wages

Tables 7, 8, and 9 show estimated numbers and percentages of individuals employed as engineers in all occupations in Wisconsin, the four Border States, and the rest of the United States. These are calculated from the Bureau of Labor Statistics estimates contained in the May 2013 database. These analyses were conducted to determine if the lower compensation in Wisconsin is being affected by a different industry mix of employers. Table 9 indicates that engineers in Wisconsin are primarily employed in the Manufacturing and Professional, Scientific, and Technical Services industries. These same trends are reflected in the employment of engineers in Wisconsin's Border States as well, but at lower levels for Manufacturing (43.3% in Border States compared to 56.5% in Wisconsin) and Professional Scientific and Technical Services (35.1% compared to 20.8%). Table 9 gives a slightly different interpretation showing the percent of all occupations that are engineers by industry. It is estimated that in Wisconsin engineers comprise 6% of those employed in the Professional, Scientific, and Technical Sector, 5.1% in Utilities, 2.7% in the Management of Companies and Enterprises, and 3.6% in Manufacturing. These percentages are mirrored in both the Border States and the rest of the country.

Table 7. Estimated Employment by Industry Sector for Engineers and All Occupations by State Category, 2013

Industry Sector	Employed Engineers			All Occupations		
	WI	Border States	Rest of U.S.	WI	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	--	--	--	3420	12070	382530
Sector 21 - Mining	--	80	36650	3070	25190	778890
Sector 22 - Utilities	560	3460	20760	10910	61580	471860
Sector 23 - Construction	580	3240	36170	99540	497000	5206710
Sector 42 - Wholesale Trade	590	5360	26780	118870	660350	4924400
Sector 51 - Information	430	2350	28550	47770	234280	2419680
Sector 52 - Finance and Insurance	--	--	180	124270	643060	4821320
Sector 53 - Real Estate and Rental and Leasing	--	--	270	24240	173640	1769690
Sector 54 - Professional, Scientific, and Technical Services	5960	58730	416000	98520	807550	7115090
Sector 55 - Management of Companies and Enterprises	1500	5690	23790	54920	258050	1793700
Sector 56- Administrative and Support and Waste Management and Remediation Services	960	5220	24170	143380	906260	7239410
Sector 61 - Educational Services (including private, state, and local government schools)	40	500	5810	227210	1305780	11179730
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	110	370	4830	376620	1960960	15725050
Sector 71 - Arts, Entertainment, and Recreation	--	--	250	35130	184000	1773370
Sector 72 - Accommodation and Food Services	--	--	--	222870	1141720	10726740

Sector 81 - Other Services (except Federal, State, and Local Government)	60	100	1210	75770	428870	3362480
Sector 99 - Federal, State, and Local Government (OES Designation)	1670	9010	164910	178190	838720	8494050
Sectors 31, 32, and 33 - Manufacturing	16230	72440	441950	454560	1650320	9880000
Sectors 44 and 45 - Retail Trade	--	40	320	302110	1535980	13364400
Sectors 48 and 49 - Transportation and Warehousing	30	650	6670	103490	558320	4422370

Table 8. Percent Estimated Employment by Industry Sector for Engineers and All Occupations by State Category, 2013

Industry Sector	Employed Engineers			All Occupations		
	WI	Border States	Rest of U.S.	WI	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	0.0%	0.0%	0.0%	0.1%	0.1%	0.3%
Sector 21 - Mining	0.0%	0.0%	3.0%	0.1%	0.2%	0.7%
Sector 22 - Utilities	1.9%	2.1%	1.7%	0.4%	0.4%	0.4%
Sector 23 - Construction	2.0%	1.9%	2.9%	3.7%	3.6%	4.5%
Sector 42 - Wholesale Trade	2.1%	3.2%	2.2%	4.4%	4.8%	4.3%
Sector 51 - Information	1.5%	1.4%	2.3%	1.8%	1.7%	2.1%
Sector 52 - Finance and Insurance	0.0%	0.0%	0.0%	4.6%	4.6%	4.2%
Sector 53 - Real Estate and Rental and Leasing	0.0%	0.0%	0.0%	0.9%	1.3%	1.5%
Sector 54 - Professional, Scientific, and Technical Services	20.8%	35.1%	33.6%	3.6%	5.8%	6.1%
Sector 55 - Management of Companies and Enterprises	5.2%	3.4%	1.9%	2.0%	1.9%	1.5%
Sector 56- Administrative and Support and Waste Management and Remediation Services	3.3%	3.1%	2.0%	5.3%	6.5%	6.2%
Sector 61 - Educational Services (including private, state, and local government schools)	0.1%	0.3%	0.5%	8.4%	9.4%	9.7%
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	0.4%	0.2%	0.4%	13.9%	14.1%	13.6%
Sector 71 - Arts, Entertainment, and Recreation	0.0%	0.0%	0.0%	1.3%	1.3%	1.5%
Sector 72 - Accommodation and Food Services	0.0%	0.0%	0.0%	8.2%	8.2%	9.3%
Sector 81 - Other Services (except Federal, State, and Local Government)	0.2%	0.1%	0.1%	2.8%	3.1%	2.9%
Sector 99 - Federal, State, and Local Government (OES Designation)	5.8%	5.4%	13.3%	6.6%	6.0%	7.3%
Sectors 31, 32, and 33 - Manufacturing	56.5%	43.3%	35.7%	16.8%	11.9%	8.5%
Sectors 44 and 45 - Retail Trade	0.0%	0.0%	0.0%	11.2%	11.1%	11.5%
Sectors 48 and 49 - Transportation and Warehousing	0.1%	0.4%	0.5%	3.8%	4.0%	3.8%
Total	100%	100%	100%	100%	100%	100%

Data in subsequent tables dispel the notion that it is the mix of employment by industry that is affecting comparatively low salaries in Wisconsin; engineering salaries tend to be low in all industries in the state.

Table 9. Estimated Employed Engineers Employment as a Percent of All Occupations by Industry Sector by State Category, 2013

Industry Sector	% Employed Engineers Employment/All Occupations Employment		
	WI	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	0.0%	0.0%	0.0%
Sector 21 - Mining	0.0%	0.3%	4.7%
Sector 22 - Utilities	5.1%	5.6%	4.4%
Sector 23 - Construction	0.6%	0.7%	0.7%
Sector 42 - Wholesale Trade	0.5%	0.8%	0.5%
Sector 51 - Information	0.9%	1.0%	1.2%
Sector 52 - Finance and Insurance	0.0%	0.0%	0.0%
Sector 53 - Real Estate and Rental and Leasing	0.0%	0.0%	0.0%
Sector 54 - Professional, Scientific, and Technical Services	6.0%	7.3%	5.8%
Sector 55 - Management of Companies and Enterprises	2.7%	2.2%	1.3%
Sector 56- Administrative and Support and Waste Management and Remediation Services	0.7%	0.6%	0.3%
Sector 61 - Educational Services (including private, state, and local government schools)	0.0%	0.0%	0.1%
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	0.0%	0.0%	0.0%
Sector 71 - Arts, Entertainment, and Recreation	0.0%	0.0%	0.0%
Sector 72 - Accommodation and Food Services	0.0%	0.0%	0.0%
Sector 81 - Other Services (except Federal, State, and Local Government)	0.1%	0.0%	0.0%
Sector 99 - Federal, State, and Local Government (OES Designation)	0.9%	1.1%	1.9%
Sectors 31, 32, and 33 - Manufacturing	3.6%	4.4%	4.5%
Sectors 44 and 45 - Retail Trade	0.0%	0.0%	0.0%
Sectors 48 and 49 - Transportation and Warehousing	0.0%	0.1%	0.2%

Data are also available to compare estimated median annual wages of engineers and all occupations by industry sector. Tables 10, 11, and 12 contain these data. Table 11 presents comparison data of engineers' median annual wages in Wisconsin compared to the four Border States and the rest of the country. These data confirm that Wisconsin generally has lower wages than elsewhere. Compared to its Border States, Wisconsin pays engineers lower wages from only 80.6% for those in the Administration and Support and Waste Management and Remediation industry to an upper level of 96.7% in construction (indicated in red). The range when comparing engineer wages to the rest of the country is from 77.6% to 94.5%. When median annual wages for all occupations are compared, Wisconsin pays more than Border States and the rest of the country in a limited number of industries (lower median wages indicated in red, higher median wages indicated in green).

Table 10. Estimated Median Annual Wages by Industry Sector for Engineers and All Occupations by State Category, 2013

Industry Sector	Employed Engineers			All Occupations		
	WI	Border States	Rest of U.S.	WI	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	--	--	--	$32,670	$30,445	$28,040
Sector 21 - Mining	--	$87,560	$86,962	$37,660	$43,960	$44,923
Sector 22 - Utilities	$73,414	$81,271	$85,350	$67,200	$65,495	$64,869
Sector 23 - Construction	$72,276	$74,728	$76,468	$46,140	$46,940	$41,909
Sector 42 - Wholesale Trade	$73,130	$76,715	$84,121	$38,460	$40,578	$38,763
Sector 51 - Information	$70,153	$77,252	$83,515	$45,090	$44,900	$48,401
Sector 52 - Finance and Insurance	--	--	$108,850	$42,830	$45,925	$43,610
Sector 53 - Real Estate and Rental and Leasing	--	--	$70,185	$30,310	$32,055	$32,083
Sector 54 - Professional, Scientific, and Technical Services	$72,759	$80,912	$85,865	$50,280	$55,953	$54,923
Sector 55 - Management of Companies and Enterprises	$75,735	$81,589	$86,143	$54,500	$65,095	$56,215
Sector 56- Administrative and Support and Waste Management and Remediation Services	$65,685	$81,514	$84,668	$26,750	$26,783	$27,155
Sector 61 - Educational Services (including private, state, and local government schools)	$67,140	$83,150	$72,419	$44,590	$43,445	$42,977
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	$66,703	$74,031	$74,432	$33,220	$34,890	$34,808
Sector 71 - Arts, Entertainment, and Recreation	--	--	$89,660	$21,640	$22,090	$23,739
Sector 72 - Accommodation and Food Services	--	--		$18,620	$18,888	$19,731
Sector 81 - Other Services (except Federal, State, and Local Government)	$70,860	$81,520	$80,849	$25,800	$28,160	$29,027
Sector 99 - Federal, State, and Local Government (OES Designation)	$73,224	$81,735	$85,061	$42,020	$48,715	$45,019
Sectors 31, 32, and 33 - Manufacturing	$73,244	$79,528	$83,361	$37,480	$38,270	$37,331
Sectors 44 and 45 - Retail Trade	--	$74,140	$114,647	$22,410	$22,570	$23,015
Sectors 48 and 49 - Transportation and Warehousing	$64,570	$73,251	$83,238	$37,830	$41,158	$40,071

Table 11. Wisconsin Median Annual Wages as a Percent of Border States and Rest of U.S. by Industry Sector for Engineers and All Occupations, 2013

Industry Sector	Employed Engineers		All Occupations	
	Border States	Rest of U.S.	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	--	--	107.3%	116.5%
Sector 21 - Mining	0.0%	0.0%	85.7%	83.8%
Sector 22 - Utilities	90.3%	86.0%	102.6%	103.6%
Sector 23 - Construction	96.7%	94.5%	98.3%	110.1%
Sector 42 - Wholesale Trade	95.3%	86.9%	94.8%	99.2%
Sector 51 - Information	90.8%	84.0%	100.4%	93.2%
Sector 52 - Finance and Insurance	--	0.0%	93.3%	98.2%
Sector 53 - Real Estate and Rental and Leasing	--	0.0%	94.6%	94.5%
Sector 54 - Professional, Scientific, and Technical Services	89.9%	84.7%	89.9%	91.5%
Sector 55 - Management of Companies and Enterprises	92.8%	87.9%	83.7%	96.9%
Sector 56- Administrative and Support and Waste Management and Remediation Services	80.6%	77.6%	99.9%	98.5%
Sector 61 - Educational Services (including private, state, and local government schools)	80.7%	92.7%	102.6%	103.8%
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	90.1%	89.6%	95.2%	95.4%
Sector 71 - Arts, Entertainment, and Recreation	--	0.0%	98.0%	91.2%
Sector 72 - Accommodation and Food Services	--	--	98.6%	94.4%
Sector 81 - Other Services (except Federal, State, and Local Government)	86.9%	87.6%	91.6%	88.9%
Sector 99 - Federal, State, and Local Government (OES Designation)	89.6%	86.1%	86.3%	93.3%
Sectors 31, 32, and 33 - Manufacturing	92.1%	87.9%	97.9%	100.4%
Sectors 44 and 45 - Retail Trade	0.0%	0.0%	99.3%	97.4%
Sectors 48 and 49 - Transportation and Warehousing	88.1%	77.6%	91.9%	94.4%

Finally, a comparison is made between the estimated median annual wage paid to engineers and that paid to all occupations (see Table 12). Generally speaking, engineers can expect to garner a reasonably high wage. In Wisconsin, engineering wages compared to wages paid to all occupations ranged from a low of 109.2% in the Utilities industry (engineers paid only a 9.2% premium) to a high of 274.4% in the 'Other Services' industry. Employed Engineers wages paid in Border States are about the same as Wisconsin in three industries (Construction, Wholesale Trade, Professional, Scientific, and Technical Services) and are lower in Border States compared to Wisconsin in two industries (Management of Companies and Enterprises; Federal, State, and Local Government). In all other industries, engineers received a higher premium compared to all occupations in Border States. When Wisconsin is compared to the rest of the United States, it is only about equal for the 'Other Services" industry (274.7% compared to 278.5% for the rest of the U.S.).

Table 12. Percent of Estimated Median Annual Wages for Engineers divided by Estimated Median Annual Wages for All Occupations by Industry Sector by State Category, 2013

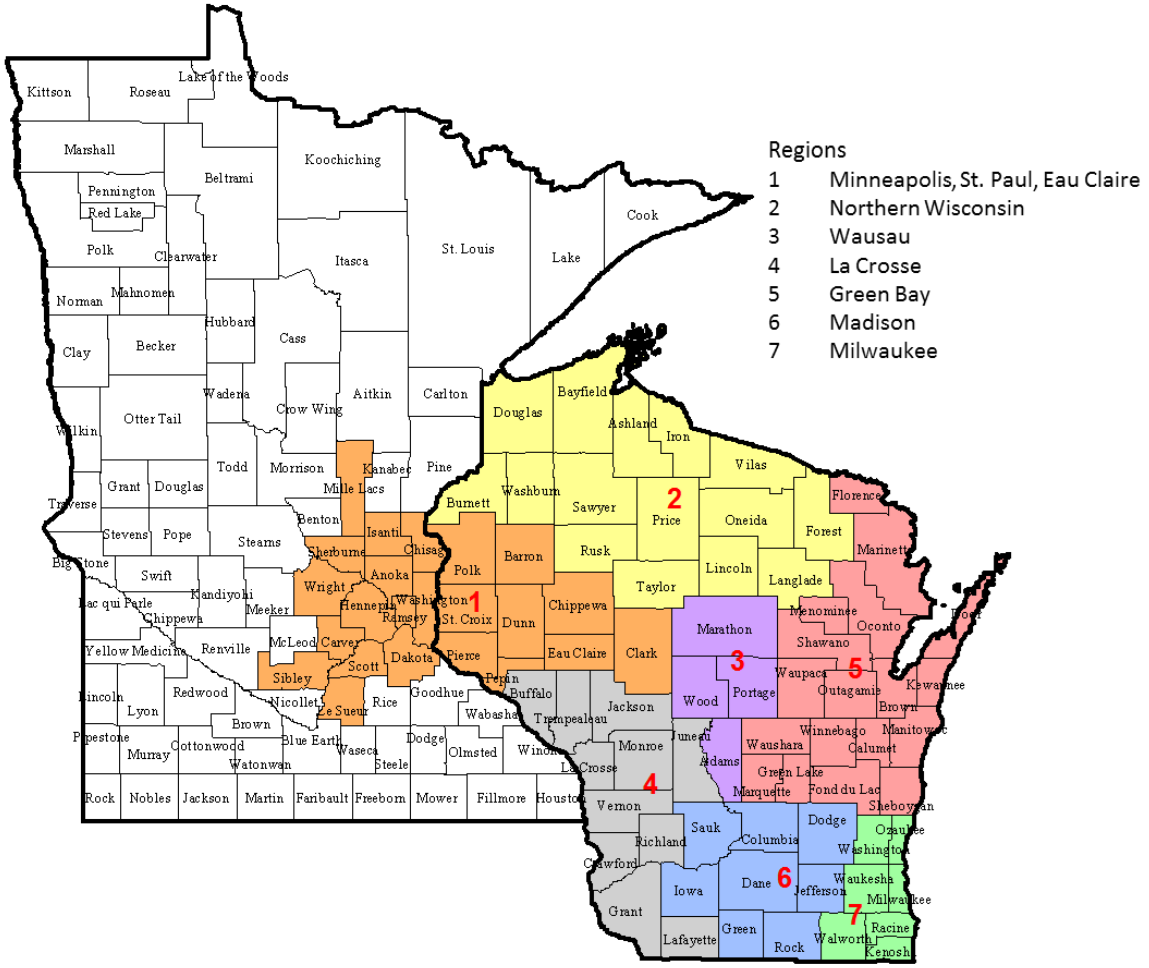
Industry Sector	Median Employed Engineers Wage/ Median All Occupation Wage		
	WI	Border States	Rest of U.S.
Sector 11 - Agriculture, Forestry, Fishing and Hunting	0.0%	0.0%	0.0%
Sector 21 - Mining	0.0%	199.2%	193.6%
Sector 22 - Utilities	109.2%	124.1%	131.6%
Sector 23 - Construction	156.6%	159.2%	182.5%
Sector 42 - Wholesale Trade	190.1%	189.1%	217.0%
Sector 51 - Information	155.6%	172.1%	172.5%
Sector 52 - Finance and Insurance	0.0%	0.0%	249.6%
Sector 53 - Real Estate and Rental and Leasing	0.0%	0.0%	218.8%
Sector 54 - Professional, Scientific, and Technical Services	144.7%	144.6%	156.3%
Sector 55 - Management of Companies and Enterprises	139.0%	125.3%	153.2%
Sector 56- Administrative and Support and Waste Management and Remediation Services	245.6%	304.4%	311.8%
Sector 61 - Educational Services (including private, state, and local government schools)	150.6%	191.4%	168.5%
Sector 62 - Health Care and Social Assistance (including private, state, and local government hospitals)	200.8%	212.2%	213.8%
Sector 71 - Arts, Entertainment, and Recreation	0.0%	0.0%	377.7%
Sector 72 - Accommodation and Food Services	0.0%	0.0%	0.0%
Sector 81 - Other Services (except Federal, State, and Local Government)	274.7%	289.5%	278.5%
Sector 99 - Federal, State, and Local Government (OES Designation)	174.3%	167.8%	188.9%
Sectors 31, 32, and 33 - Manufacturing	195.4%	207.8%	223.3%
Sectors 44 and 45 - Retail Trade	0.0%	328.5%	498.1%
Sectors 48 and 49 - Transportation and Warehousing	170.7%	178.0%	207.7%

Finding 5. The comparatively low salaries paid to Wisconsin engineers in different occupations are also found when the basis of comparison is industry of employment. Put simply, employers in Wisconsin do not pay engineers salaries competitive with those in Border States and the nation as a whole.

Supply and Demand Data by Region within Wisconsin

In addition to looking at engineering supply and demand on a statewide basis, NCHEMS also analyzed data for regions within Wisconsin. The regions are presented on the map below; they were defined in consultation with the University of Wisconsin System officials.

Chart 1. Wisconsin Regions for Burning Glass Job Postings Analysis with Region Names



Burning Glass data were used as the source of the demand statistics. Federal IPEDS data were used as the source of data about supply/production of engineers.

Demand = Burning Glass counts of number of "wanted ads" for engineers with a specified degree with two years or less experience in 2013

Supply = IPEDS completion data for engineering CIP codes for specified degrees between 2010 and 2012

Determining the Need Category. Because there can be quite a bit of noise in the demand data, the Demand: Supply Ratio (D:S Ratio) coupled with the absolute level of Demand was used to create a "Need" categorization using the following decision rules in order:

If Demand = 0, OR 0> D:S Ratio >3 and Demand < (Supply +2), then No Need.

If 0 > D:S Ratio >=3 and Supply <= Demand, then Balanced.

If D:S Ratio >3 OR D:S Ratio = NA, and Demand < 100, then Slight Need.

If D:S Ratio > 3 and Demand > 100 individuals, then Need.

Else, Slight Need.

In short, we identified areas of need only if the demand was high relative to supply (Demand:Supply ration >3) and the absolute size of the demand was greater than 100.

Overall results are summarized in Table 10 for both baccalaureate degrees and graduate and professional degrees. These data indicate that there is a need for baccalaureate engineers in Regions 1, 2, 3, 5, and 7. There is an oversupply of baccalaureate engineers in Region 4, and a relatively balanced demand and supply in Region 6.

In terms of graduate degrees, there are no "need" areas for engineers with graduate degrees in any Wisconsin region. There is a "slight need" for graduate degree engineers in three Wisconsin regions.

Table 13. Demand and Supply data for Engineers, 2013 using Burning Glass and IPEDS data

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand: Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	7819	1644	4.8	Need
1	Momentum West and Minneapolis	3598	596	6.0	Need
1a	Minnesota Portion	3404	516	5.7	Need
1b	Wisconsin Portion	194	82	2.4	Balanced
2	Visions Northwest and Grow North	58	0	NA	Slight Need
3	Centergy	107	1	79.5	Need
4	7 Rivers Alliance and Prosperity Southwest	95	168	0.6	No Need
5	New North	1110	8	134.0	Need
6	Madison Region	695	402	1.7	Balanced
7	Milwaukee 7	2155	463	4.6	Need
Region	**Economic Development Region (approx.)**	**Graduate/Professional Degree**			
		Demand	**Supply**	**Demand: Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	515	592	0.9	No Need
1	Momentum West and Minneapolis	231	213	1.1	Balanced
1a	Minnesota Portion	218	208	1.0	Balanced
1b	Wisconsin Portion	13	5	2.6	Balanced
2	Visions Northwest and Grow North	4	0	NA	Slight Need
3	Centergy	8	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	6	39	0.2	No Need
5	New North	77	0	NA	Slight Need
6	Madison Region	47	245	0.2	No Need
7	Milwaukee 7	142	88	1.6	Balanced

The data in Table 13 serve to both focus attention and remove certain issues from consideration. The data indicate that any substantial need is concentrated in Regions (served by UWI – Stout and the University of Minnesota), 5, 6 (Served by the University of Wisconsin-Madison) and 7 (served by the University of Wisconsin – Milwaukee, Marquette University, and the Milwaukee School of Engineering). The fact that three of the four regions exhibiting need are already home to existing engineering schools raises questions about the match between the capacity in those schools and demand. This question is addressed below. The more vexing question pertains to region 5 where there is demand but no in-region source of supply.

The data in this table also serves to eliminate graduate degrees from further consideration; there is no demonstrable need in any of the regions.

More detailed analysis of Burning Glass data provides information about unmet needs for different types of engineers. This information leads to the following conclusions.

There is no documented demand in Wisconsin for either baccalaureate or graduate degree holders in the following two types of engineering:

- Ergonomist - Designs workplace furniture and equipment or tools to make them safe, efficient and comfortable to use, and to minimize strain for workers. Incorporates occupational health criteria in design. Advises on design for products, such as computers, as they are being developed, or advises on the re-design of an office space or factory process to improve productivity and safety (Burning Glass definition).
- Solar Engineer - Designs and develops technologies that produce and store energy from solar power (Burning Glass definition).

Three types of baccalaureate engineers are “balanced” or exhibit “no need” across Wisconsin regions:

- Biomedical Engineer
- Optical/Laser Engineer
- Validation Engineer

Sixteen types of engineers are “slightly needed” in selected Wisconsin regions:

- Aerospace Engineer
- Electronics Engineer
- Energy Efficiency Engineer
- Energy Engineer
- Environmental Engineer
- Hardware Engineer
- Health and Safety Engineer
- Manufacturing Engineer
- Marine Engineer
- Materials Engineer

- Mining Engineer
- Nuclear Engineer
- Reservoir/ Petroleum Engineer
- RF Engineer
- Transportation Engineer
- Waste / Wastewater Engineer.

Five types of baccalaureate engineers have documented "need" as well as "slight need" in some Wisconsin regions (See Charts 1 – 5 below.):

- Chemical/Process Engineer
- Civil Engineer
- Electrical Engineer
- Industrial Engineer
- Mechanical Engineer

See the Appendix for supporting tables, associated data, and maps associated with each of these fields.

Table 14 provides more information about the five engineering fields in which there is need and the distribution of that need across regions of the state. Table 15 provides information about production of baccalaureate degrees, by field, by each institution having engineering programs in the state. The data provided in these two tables lead to the following observations:

- As noted previously, Region 5 has needs in multiple fields but no in-region programs that can respond to these needs. The largest need is in civil engineering followed by mechanical engineering.
- There are programs that align with all areas of need in both Region 1 and Region 6. The existing programs may be limited in capacity, but programs do exist in each area.
- In Region 7, there are two areas of need for which there are no in-region providers – chemical engineering and industrial engineering.

Table 14. Demand by Region for Needed Engineers

Region	Type of Engineer				
	Chemical / Process Engineer	Civil Engineer	Electrical Engineer	Industrial Engineer	Mechanical Engineer
Region 1	144	982	544	221	467
1a Minnesota	141	931	501	239	442
1b Wisconsin	4	50	43	-20	24
Region 2	1	43	6	0	6
Region 3	23	16	11	6	28
Region 4	0	-27	15	-1	-24
Region 5	68	323	145	109	254
Region 6	2	141	85	23	47
Region 7	90	475	316	176	337
WI and MSA	305	1958	1124	523	1108

Demand in this table is equal to Burning Glass demand minus IPEDS supply.

Table 15. Number of 2011-12 Baccalaureate Engineering Degrees Granted by Wisconsin Institutions

Type of Engineering	Region 1						Region 3	Region 4	Region 6	Region 7			Total
	Bethel University	DeVry University-Minnesota	Northwestern College	University of Minnesota-Twin Cities	University of St. Thomas	UW-Stout	UW-Stevens Point	UW-Platteville	UW-Madison	Marquette University	Milwaukee School of Engineering	UW-Milwaukee	
	N	N	N	N	N	N	N	N	N	N	N	N	
Aerospace, Aeronautical and Astronautical/Space Engineering	.	.	.	76	.	.	.	.	.	.	.	.	76
Agricultural Engineering	.	.	.	17	.	.	.	.	19	.	.	.	19
Architectural Engineering	.	.	.	.	.	.	.	.	.	.	71	.	71
Bioengineering and Biomedical Engineering	.	.	.	78	.	.	.	.	59	58	29	.	146
Chemical Engineering	.	.	.	120	.	.	.	.	79	.	.	.	79
Civil Engineering, General	.	.	.	117	.	.	.	81	109	36	.	52	278
Computer Engineering, General	.	.	.	27	.	<5	.	.	27	10	30	10	79
Computer Software Engineering	.	<5	.	.	.	.	.	15	.	.	26	.	41
Construction Engineering	.	.	.	.	.	.	.	.	.	7	.	.	7
Electrical and Electronics Engineering	.	.	.	124	22	.	.	33	56	14	59	45	207
Electrical, Electronics and Communications Engineering, Other	.	.	.	.	.	.	.	.	.	<5	.	.	<5
Engineering Mechanics	.	.	.	.	.	.	.	.	35	.	.	.	35
Engineering Physics/Applied Physics	.	.	.	.	.	.	.	10	<5	.	.	.	13
Engineering, General	.	.	<5	.	.	.	.	.	.	.	<5	.	<5
Engineering, Other	.	.	.	.	.	.	.	.	<5	.	.	.	<5
Engineering Science	<5	.	.	.	.	.	.	.	.	.	.	.	<5
Environmental/Environmental Health Engineering	.	.	.	.	.	.	.	16	.	7	.	.	23
Geological/Geophysical Engineering	.	.	.	5	.	.	.	.	<5	.	.	.	<5
Industrial Engineering	.	.	.	5	.	.	.	8	69	.	11	.	88
Manufacturing Engineering	.	.	.	.	.	39	.	.	.	.	.	16	55
Materials Engineering	.	.	.	29	.	.	.	.	19	.	.	<5	23
Mechanical Engineering	.	.	.	203	61	.	.	115	152	45	115	77	504
Nuclear Engineering	.	.	.	.	.	.	.	.	15	.	.	.	15
Paper Science and Engineering	.	.	.	.	.	.	9	.	.	.	.	.	9
Polymer/Plastics Engineering	.	.	.	.	.	9	.	.	.	.	.	.	9
Total	<5	<5	<5	801	83	50	9	278	647	181	342	204	1711

Recommendations

Based on the findings developed in this report, it is recommended that:

1. No action be taken to create new engineering programs in regions 1, 2, 3, and 4; in Regions 2, 3, and 4 because there is no demand that would justify such investment and in Region 1 because the majority of demand and almost all the capacity to respond to that demand is found in the Minnesota part of the region, not Wisconsin. Any Wisconsin investments are better directed elsewhere.
2. As an overarching strategy, priority be given to expanding existing capacity at Madison and Milwaukee rather than creating new capacity at other institutions.
3. A targeted study be undertaken to ascertain whether a program in chemical engineering should be added to the array of programs offered by the University of Wisconsin – Milwaukee. This study could be done as a joint activity of the University Wisconsin System Office and University of Wisconsin – Milwaukee or entrusted to an outside group. As part of this assessment, the question needs to be asked as to whether funding priority should be given to expansion of capacity in existing programs (Civil, Electrical, Industrial, Mechanical) or to creation of new programs.
4. Any creation of engineering program capacity in Region 5 be done as a joint activity between Madison and/or Milwaukee and Green Bay or Oshkosh. NCHEMS staff have not been "on the ground" in a way that would let us make an informed choice among the options presented above. However, the basic principles of such an arrangement would be that

    - The general education and pre-engineering courses would be taught by Oshkosh or Green Bay faculty
    - The courses in the program major would be taught
        - By Madison/Milwaukee faculty, either in person or on-line
        - By Oshkosh/Green Bay faculty if they were a) qualified, and b) classified as adjunct faculty by Madison/Milwaukee
    - Only baccalaureate degrees would be offered
    - All administrative and student support services would be provided by Oshkosh/Green Bay

    The foundation for such a collaborative effort has already been established through the efforts of the New Era for Higher Education Alliance. This is a consortium of technical colleges, UW Colleges, UW Extension, Oshkosh, and Green Bay working together to provide three baccalaureate-level engineering technology programs for students and employers in the region. This recommendation calls for adding Milwaukee and/or Madison to the mix to provide the additional courses that would lead to a full engineering degree.

    Evidence of the feasibility of such arrangements is found in Kentucky which has several such programs.

    - University of Kentucky and Western Kentucky in Mechanical Engineering
    - University of Kentucky and Western Kentucky in Civil Engineering

- University of Louisville and Western Kentucky in Electrical Engineering
- University of Louisville and Murray State University in Electrical & Telecommunications Engineering

By Kentucky Council for Postsecondary Education definition,

- a joint-degree program is "a program that is mutually sponsored by two or more institutions leading to a single credential or degree, which is conferred by both or all participating institutions. … All institutions share responsibility for all aspects of the program's delivery and quality."
- The curriculum of the joint engineering program is under the direction of a joint program faculty, with equal representation from each participating institution. Students who complete the program will receive a B.S. degree conferred jointly by the two institutions.

Such arrangements have the benefit of minimizing the costs (and risk) associated with starting an expensive program in the face of uncertain demand. If, at some point in the future, on-going demand has been proven and the participating institutions agree, the program could be made the sole responsibility of Oshkosh/Green Bay.

The shortcoming of all studies such as this is that they deal with conditions in the present, not the future. The fact that employment of engineers is so heavily concentrated in two industry sectors – manufacturing and professional, scientific, and technical services – helps in speculating what the future may hold; as go these two sectors, so goes the demand for engineers.

The distribution of the types of engineers employed in these two sectors is shown in Table 16. The heavy concentration of civil and mechanical engineers in the Technical Services sector suggests that much of the employment is in consulting firms that provide their expertise to contractors/architects and governments engaged in public works projects of various kinds. The concentration of industrial and mechanical engineers in the manufacturing sector would seem to indicate that the primary emphasis is on manufacturing processes rather than product design and development. If these deductions are reasonably accurate, the demand for engineers in these sectors will likely be quite stable. Our reasoning is certainly open to challenge, but given what we know and can reasonably infer we believe the data as presented paint a sound picture of the demand for engineers in Wisconsin.

Table 16. Percent of type of engineers that make up Wisconsin's Professional and Manufacturing Industries, May 2013

This type of engineer…	Comprises this percentage of sector…	
Type of Engineer	**Sector 54 - Professional, Scientific, and Technical Services**	**Sectors 31, 32, and 33 - Manufacturing**
Agricultural Engineers	0.0%	0.2%
Biomedical Engineers	0.0%	0.3%
Chemical Engineers	1.5%	1.3%
Civil Engineers	42.3%	0.6%

Computer Hardware Engineers	0.8%	1.0%
Electrical Engineers	13.9%	13.2%
Electronics Engineers, Except Computer	6.0%	4.6%
Environmental Engineers	5.5%	0.5%
Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	0.0%	0.9%
Industrial Engineers	3.0%	34.1%
Materials Engineers	1.3%	2.3%
Mechanical Engineers	17.3%	34.3%
Nuclear Engineers	0.5%	0.0%
Engineers, All Other	7.7%	6.6%
Total	100.0%	100.0%

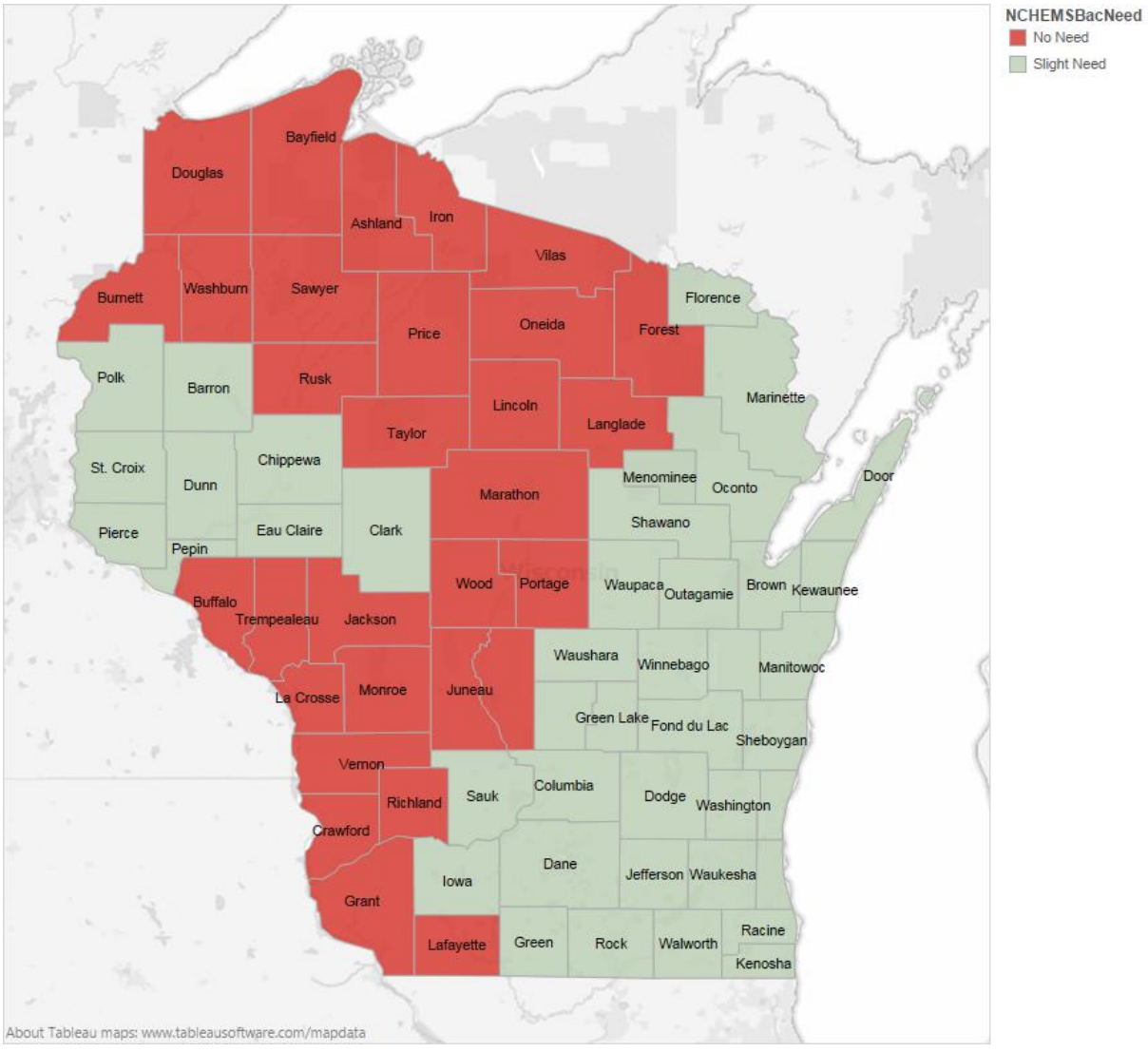
Appendix – Supporting Data, Tables, and Maps

Table A1. Aerospace Engineer Demand and Supply - Designs aircraft, missiles, and spacecraft using knowledge of engineering and physics, and tests prototypes to see if they work according to design. May specialize in aeronautical design and work with airplanes and helicopters, or specialize in astronautical design and work with vehicles used in outer space. May specialize in a particular area of design, such as aerodynamic flow or navigation.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	96	11	9.0	Slight Need
1	Momentum West and Minneapolis	53	12	4.5	Slight Need
2	Visions Northwest and Grow North	1	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	20	0	NA	Slight Need
6	Madison Region	7	0	NA	Slight Need
7	Milwaukee 7	13	0	NA	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	7	5	1.4	Balanced
1	Momentum West and Minneapolis	4	4	1.1	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	2	0	NA	No Need
6	Madison Region	1	1	1.0	Balanced
7	Milwaukee 7	1	0	2.3	No Need

Map A1 Baccalaureate Aerospace Engineering Need by Wisconsin Region, 2013

Aerospace engineers "design aircraft, missiles, and spacecraft using knowledge of engineering and physics, and test prototypes to see if they work according to design. May specialize in aeronautical design and work with airplanes and helicopters, or specialize in astronautical design and work with vehicles used in outer space. May specialize in a particular area of design, such as aerodynamic flow or navigation (Burning Glass definition)."



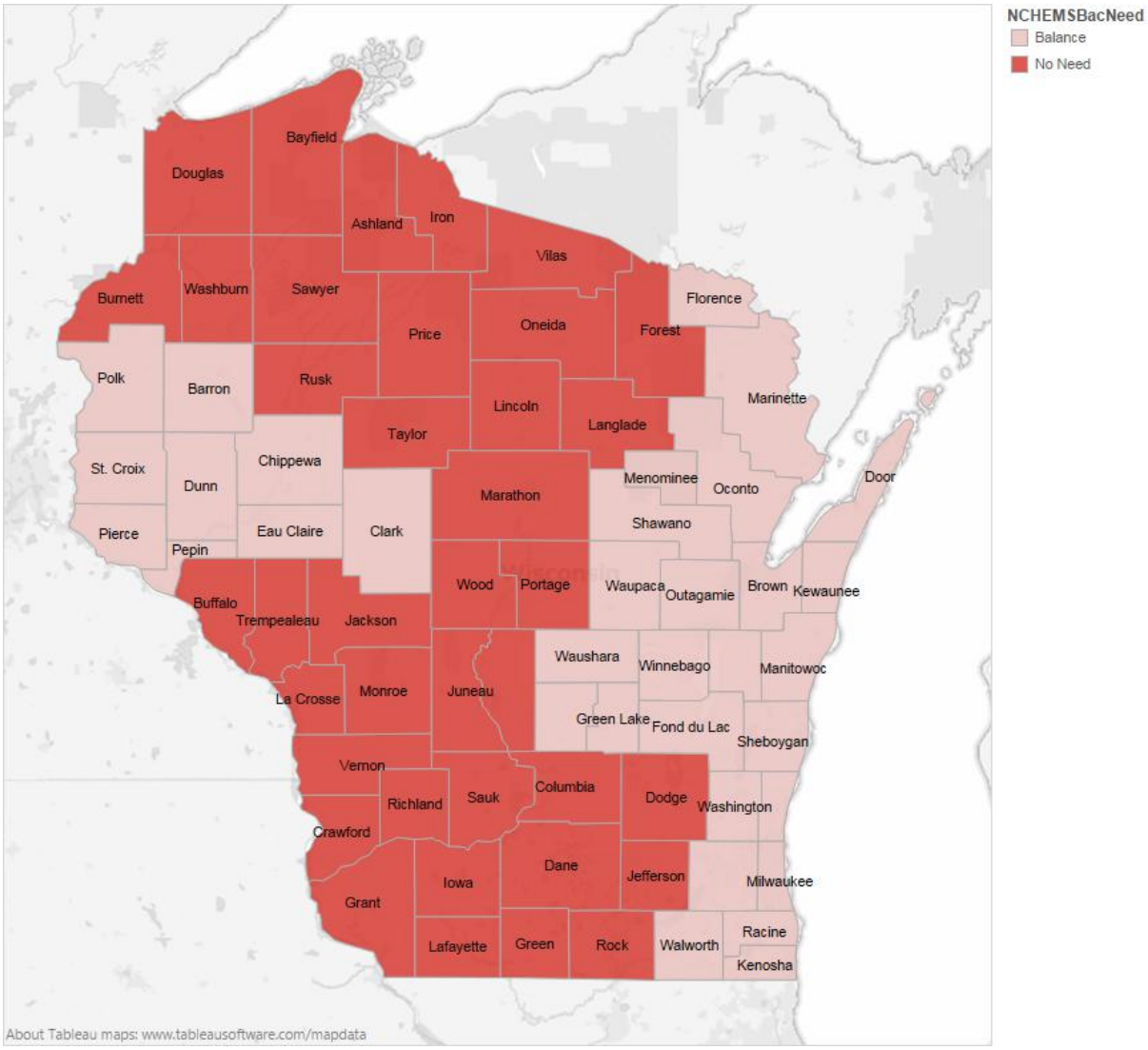
There is a slight need for aerospace engineers in Regions 1, 5, 6, and 7.

Table A2. Biomedical Engineer Demand and Supply - Designs solutions to problems in medicine and biology to improve patient care. Combines engineering with medical and biological knowledge. May develop medical products designed to replace biological functions, such as prosthetic limbs or artificial hearts, or design equipment such as X-rays and surgical tools.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	42	49	0.9	Balanced
1	Momentum West and Minneapolis	28	23	1.2	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	1	1	1.0	Balanced
6	Madison Region	9	17	0.5	No Need
7	Milwaukee 7	4	4	0.9	Balanced
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A2 Baccalaureate Biomedical Engineering Need by Wisconsin Region, 2013

Biomedical engineers "design solutions to problems in medicine and biology to improve patient care. Combine engineering with medical and biological knowledge. May develop medical products designed to replace biological functions, such as prosthetic limbs or artificial hearts, or design equipment such as X-rays and surgical tools.(Burning Glass definition)."



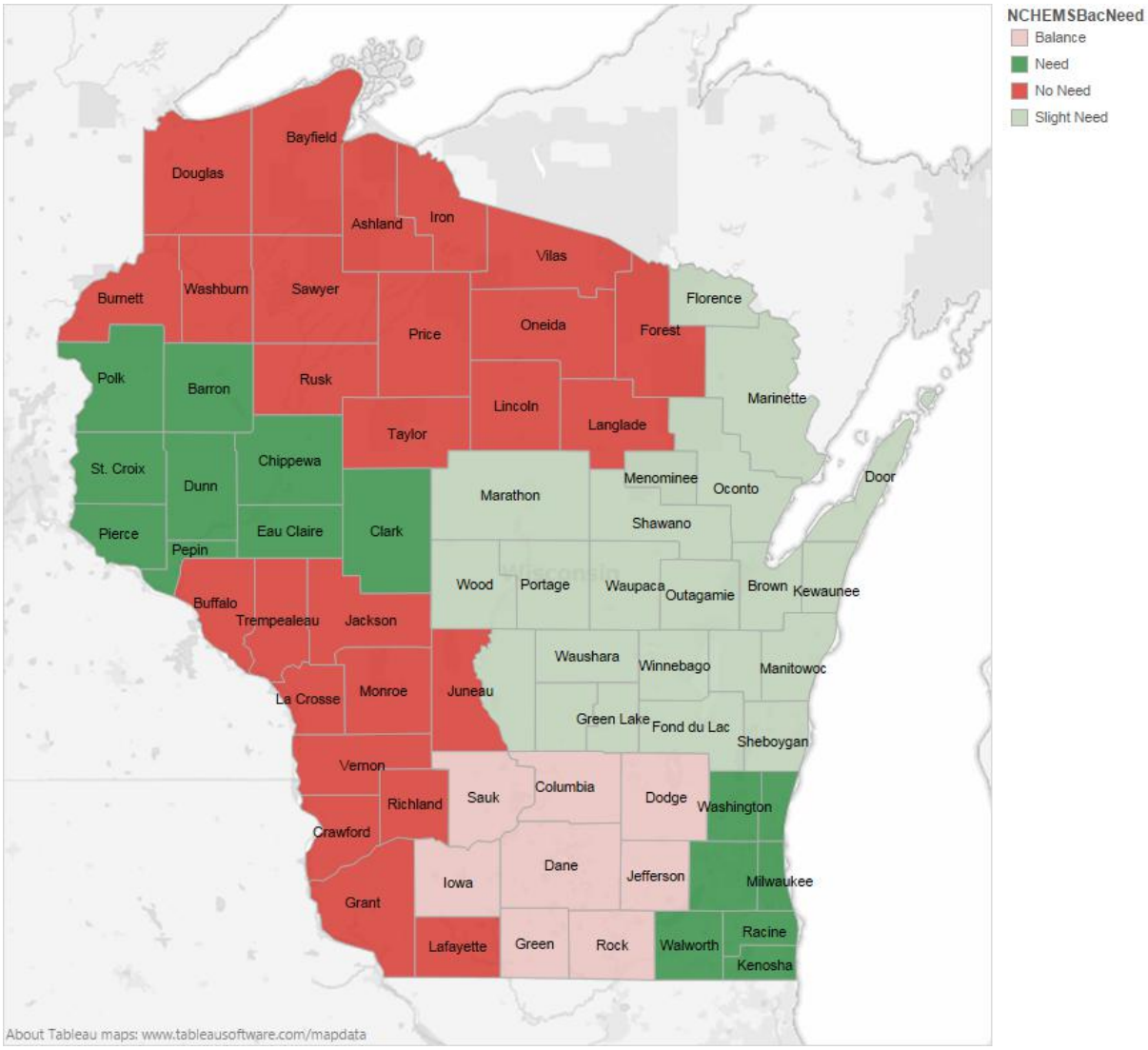
There is no need for Biomedical Engineers in Wisconsin at this time.

TableB3.Chemical/Process Engineer Demand and Supply - Solves problems related to the manufacturing and use of products, including chemicals, fuel, food, and clothing. Designs new products, improves existing ones, or develops new processes for better use of existing materials. May specialize in a chemical engineering process, such as making plastics, or in an industry such as health care.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	420	114	3.7	Need
1	Momentum West and Minneapolis	199	55	3.6	Need
2	Visions Northwest and Grow North	1	0	NA	No Need
3	Centergy	23	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	68	0	NA	Slight Need
6	Madison Region	25	22	1.1	Balanced
7	Milwaukee 7	104	14	7.3	Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	42	53	0.8	Balanced
1	Momentum West and Minneapolis	20	24	0.8	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	2	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	7	0	NA	Slight Need
6	Madison Region	2	20	0.1	No Need
7	Milwaukee 7	11	1	10.9	Slight Need

Map B3. Baccalaureate Chemical/Process Engineering Need by Wisconsin Region, 2013

Chemical/process engineers "solve problems related to the manufacturing and use of products, including chemicals, fuel, food, and clothing. Design new products, improve existing ones, or develop new processes for better use of existing materials. May specialize in a chemical engineering process, such as making plastics, or in an industry such as health care (Burning Glass definition)."



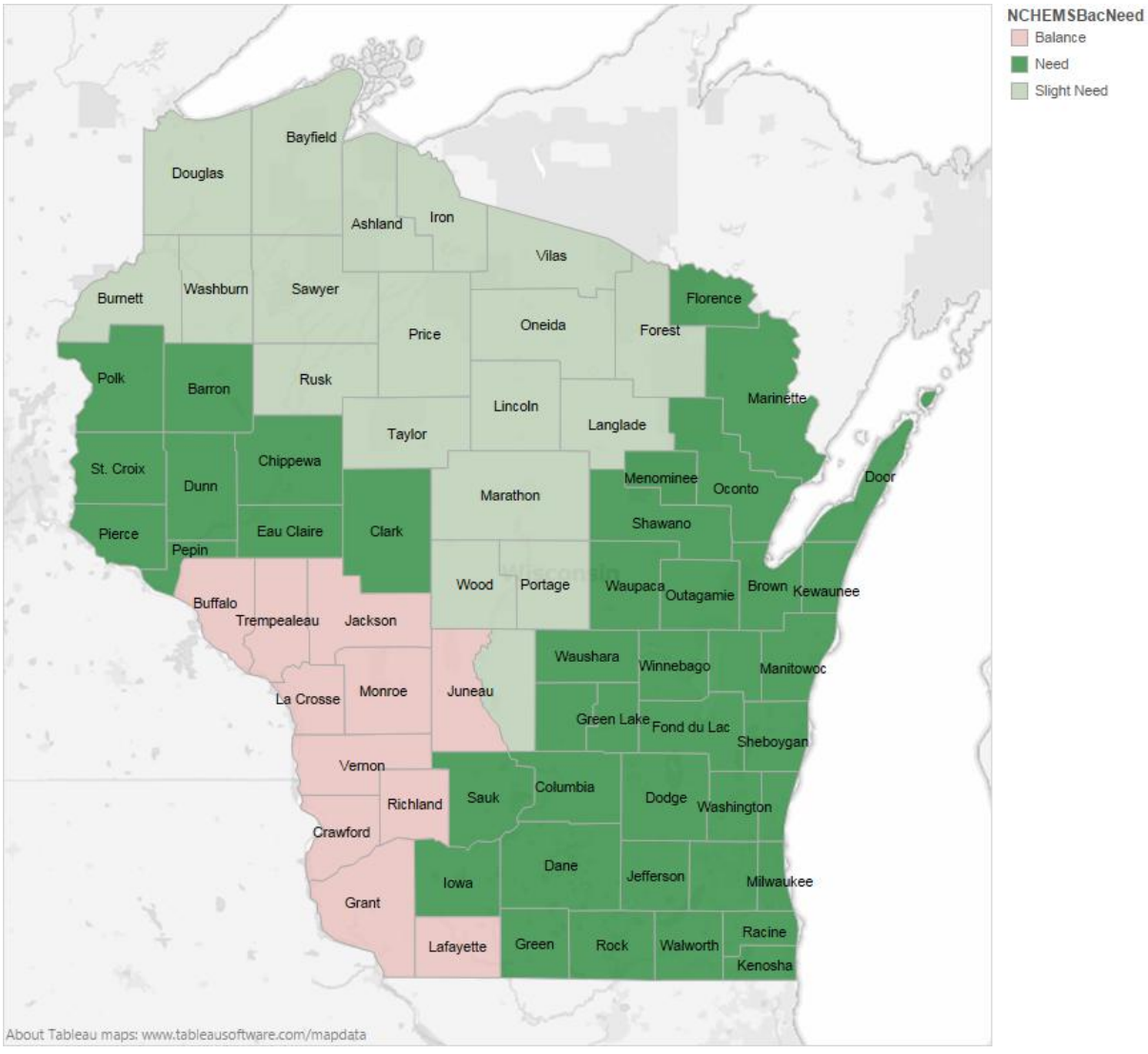
Chemical/process engineers are needed in Regions 1 and 7, with a slight need indicated in Regions 3 and 5.

Table A4. Civil Engineer Demand and Supply - Designs and supervises large construction projects such as public buildings, roads, and waterways. Designs projects that meet the needs of users and the public and are structurally sound. Addresses environmental and land use issues in project design. May specialize in a particular aspect of design and construction, or a particular type of construction, such as transportation systems.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	2,206	248	8.9	Need
1	Momentum West and Minneapolis	1,051	69	15.3	Need
2	Visions Northwest and Grow North	43	0	NA	Slight Need
3	Centergy	16	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	26	53	0.5	Balanced
5	New North	323	0	NA	Need
6	Madison Region	210	69	3.0	Need
7	Milwaukee 7	538	63	8.6	Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	116	105	1.1	Balanced
1	Momentum West and Minneapolis	55	30	1.8	Balanced
2	Visions Northwest and Grow North	2	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	9	0.2	No Need
5	New North	17	0	NA	Slight Need
6	Madison Region	11	41	0.3	No Need
7	Milwaukee 7	28	25	1.1	Balanced

Map A4 Baccalaureate Civil Engineering Need by Wisconsin Region, 2013

Civil engineers "design and supervise large construction projects such as public buildings, roads, and waterways. Design projects that meet the needs of users and the public and are structurally sound. Addresses environmental and land use issues in project design. May specialize in a particular aspect of design and construction, or a particular type of construction, such as transportation systems (Burning Glass definition)."



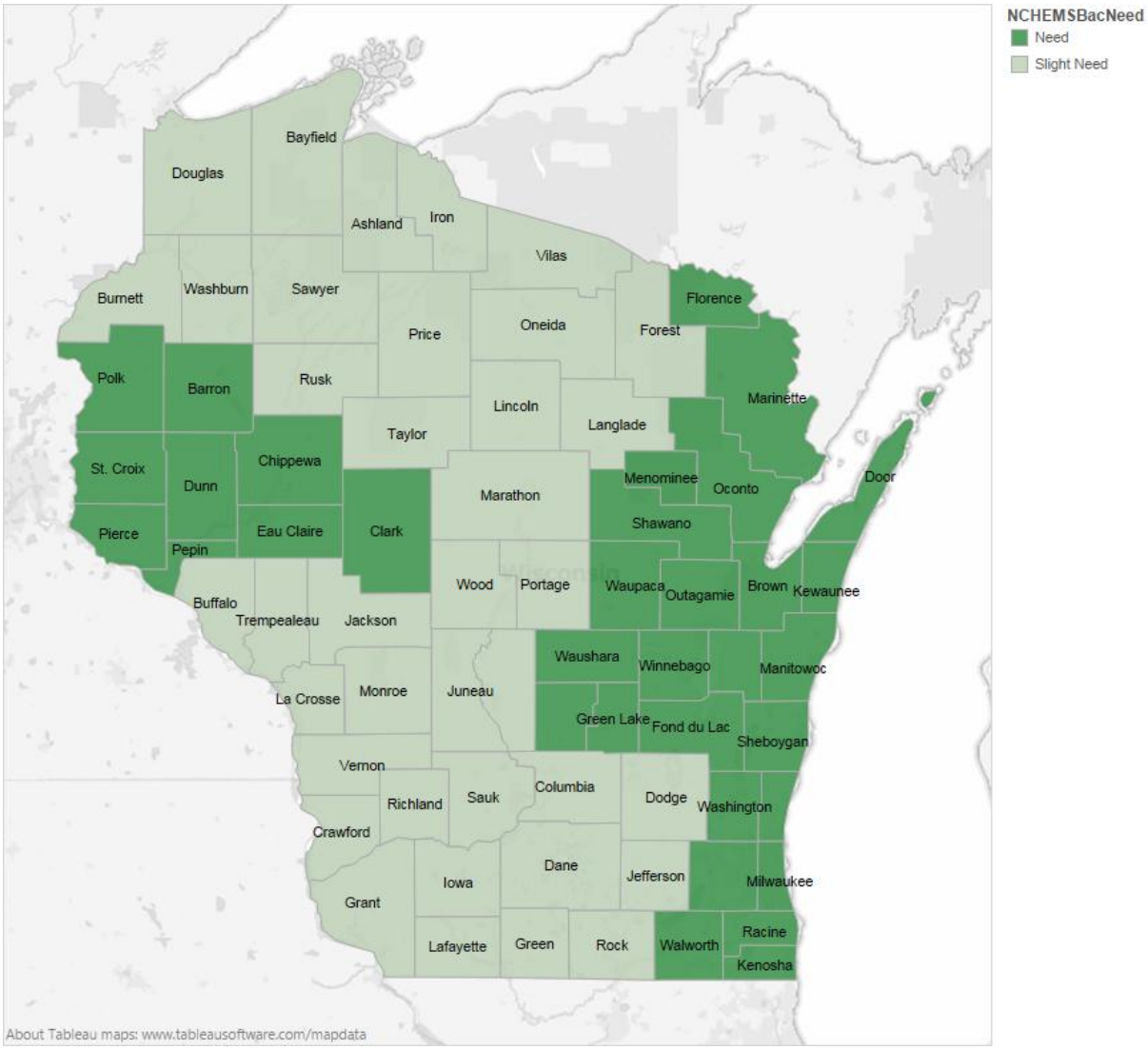
Civil engineers are needed in Regions 1, 5, 6, and 7. There is a slight need in Regions 2 and 3.

Table A5. Electrical Engineer Demand and Supply - Designs, develops, and tests products and systems that use or produce electricity, including power generators, electric motors, radar and navigation systems, and communication systems. Works on larger electrical systems rather than small electronic products or devices.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	1,165	41	28.4	Need
1	Momentum West and Minneapolis	558	13	41.3	Need
2	Visions Northwest and Grow North	6	0	NA	Slight Need
3	Centergy	11	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	20	5	3.7	Slight Need
5	New North	145	0	NA	Need
6	Madison Region	90	5	19.9	Slight Need
7	Milwaukee 7	335	19	17.7	Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	105	81	1.3	Balanced
1	Momentum West and Minneapolis	50	27	1.9	Balanced
2	Visions Northwest and Grow North	1	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	2	14	0.1	No Need
5	New North	13	0	NA	Slight Need
6	Madison Region	8	20	0.4	No Need
7	Milwaukee 7	30	16	1.8	Balanced

Map A5. Baccalaureate Electrical Engineering Need by Wisconsin Region, 2013

Electrical engineers "design, develop, and test products and systems that use or produce electricity, including power generators, electric motors, radar and navigation systems, and communication systems. Work on larger electrical systems rather than small electronic products or devices (Burning Glass definition)."



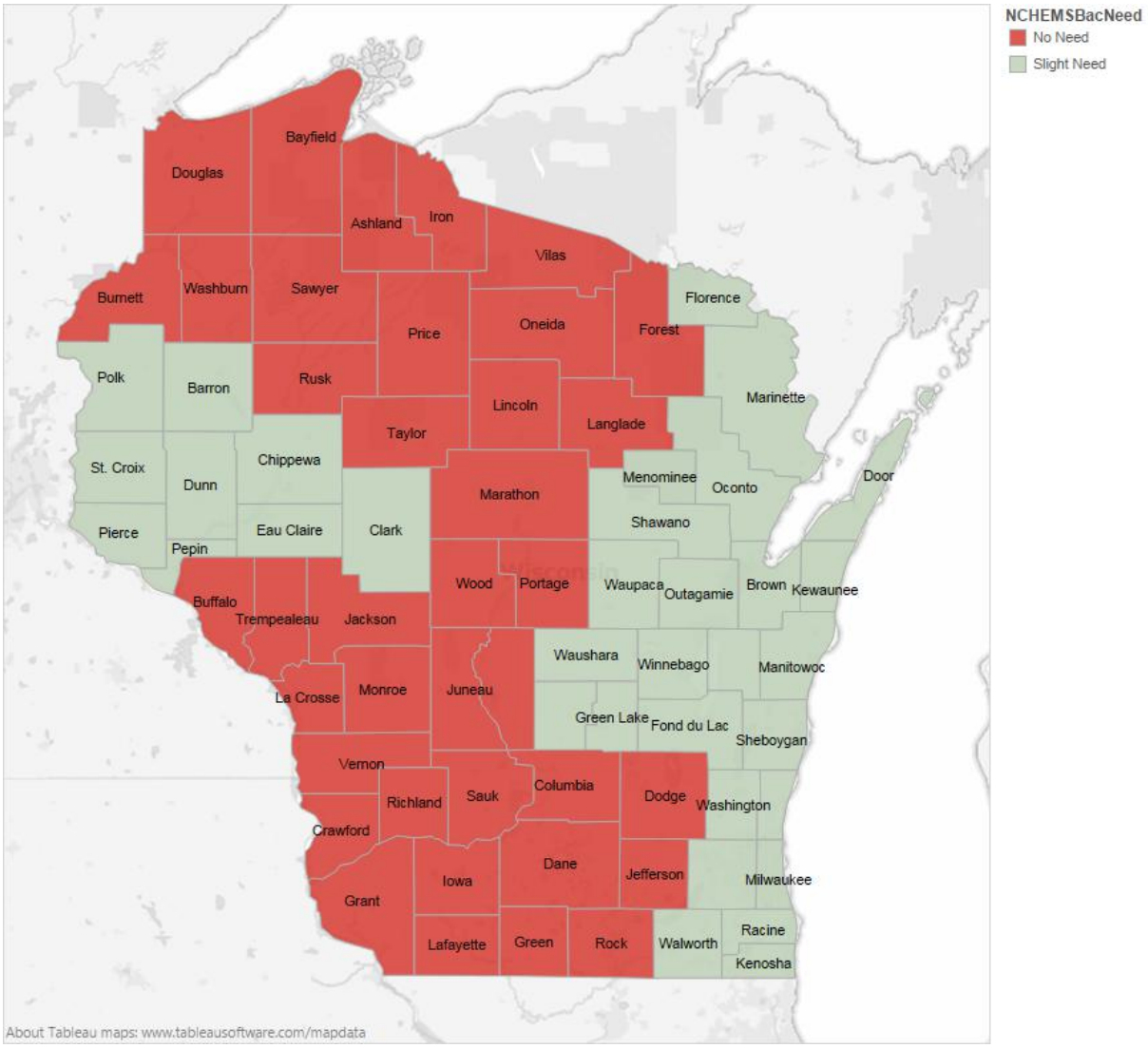
Electrical engineers are needed in Regions 1, 5, and 7 with a slight need in the rest of the state.

Table A6. Electronics Engineer Demand and Supply - Designs and develops electronic equipment, from iPods to global positioning systems (GPS). Works primarily with smaller electronic equipment that uses electricity as a means of storing information.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	48	2	25.0	Slight Need
1	Momentum West and Minneapolis	19	0	38.2	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	0	3.0	No Need
5	New North	8	0	NA	Slight Need
6	Madison Region	2	0	17.4	No Need
7	Milwaukee 7	19	1	15.0	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	16	13	1.2	Balanced
1	Momentum West and Minneapolis	6	3	1.8	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	2	0.1	No Need
5	New North	2	0	NA	No Need
6	Madison Region	1	2	0.4	No Need
7	Milwaukee 7	6	3	1.8	Balanced

Map A6. Baccalaureate Electronics Engineering Need by Wisconsin Region, 2013

Electronic engineers "design and develop electronic equipment, from iPods to global positioning systems (GPS). Work primarily with smaller electronic equipment that uses electricity as a means of storing information (Burning Glass definition)."



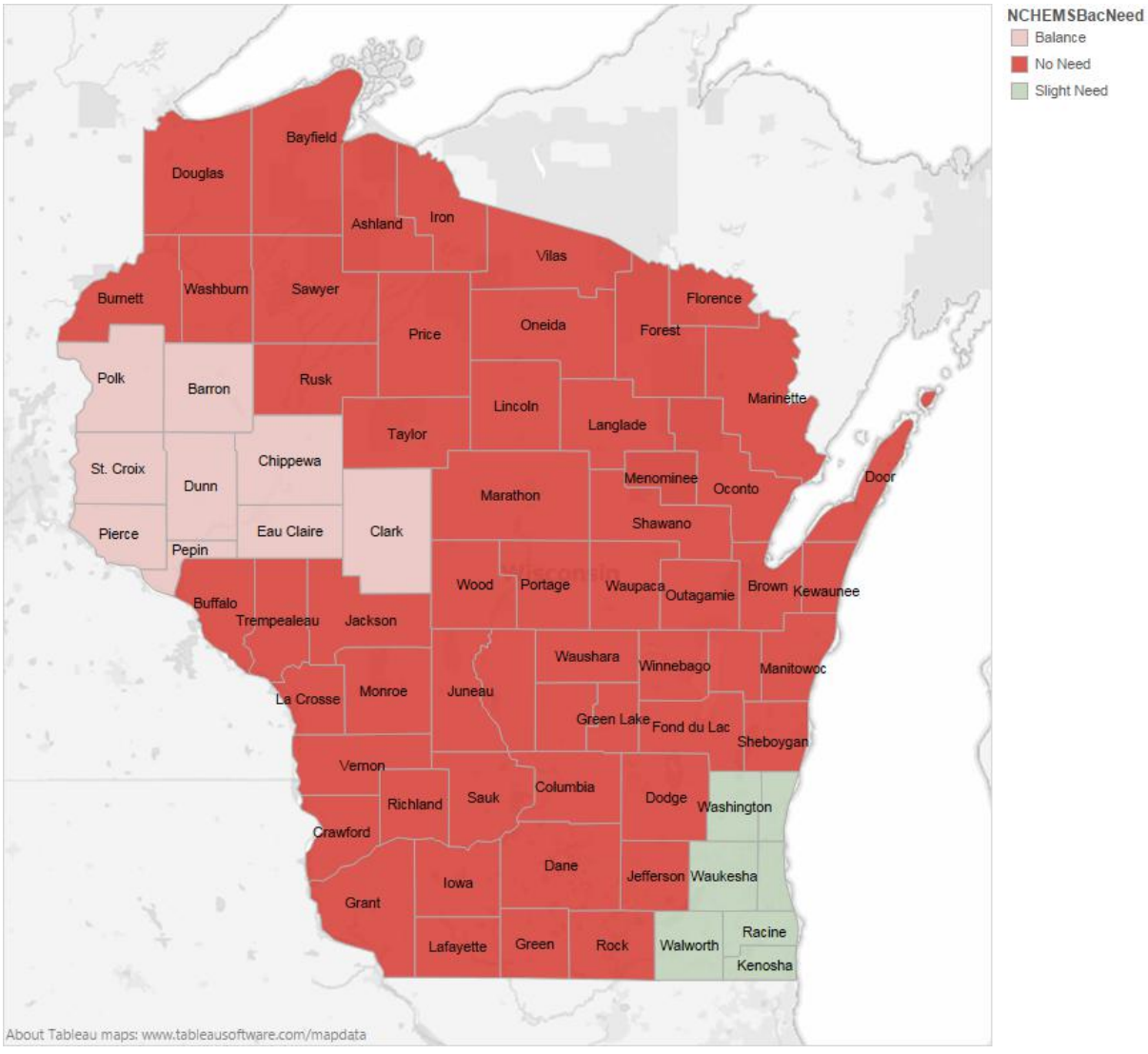
Regions 1, 5, and 7 show a slight need for electronic engineers.

Table A7. Energy Efficiency Engineer Demand and Supply - Analyzes data from energy audits and assessments and develops recommendations for saving energy and reducing electricity, gas or water usage. May work with public sector agencies and utilities, advise community residents or businesses and commercial organizations, or assist with implementing projects or programs aimed at improving energy efficiency and realizing energy cost savings.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	6	3	2.1	Balanced
1	Momentum West and Minneapolis	1	0	2.1	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.0	No Need
5	New North	0	0	NA	No Need
6	Madison Region	1	1	1.6	No Need
7	Milwaukee 7	4	1	3.4	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A7. Baccalaureate Energy Efficiency Engineering Need by Wisconsin Region, 2013

Energy efficiency engineers "analyze data from energy audits and assessments and develop recommendations for saving energy and reducing electricity, gas or water usage. May work with public sector agencies and utilities, advise community residents or businesses and commercial organizations, or assist with implementing projects or programs aimed at improving energy efficiency and realizing energy cost savings (Burning Glass definition)."



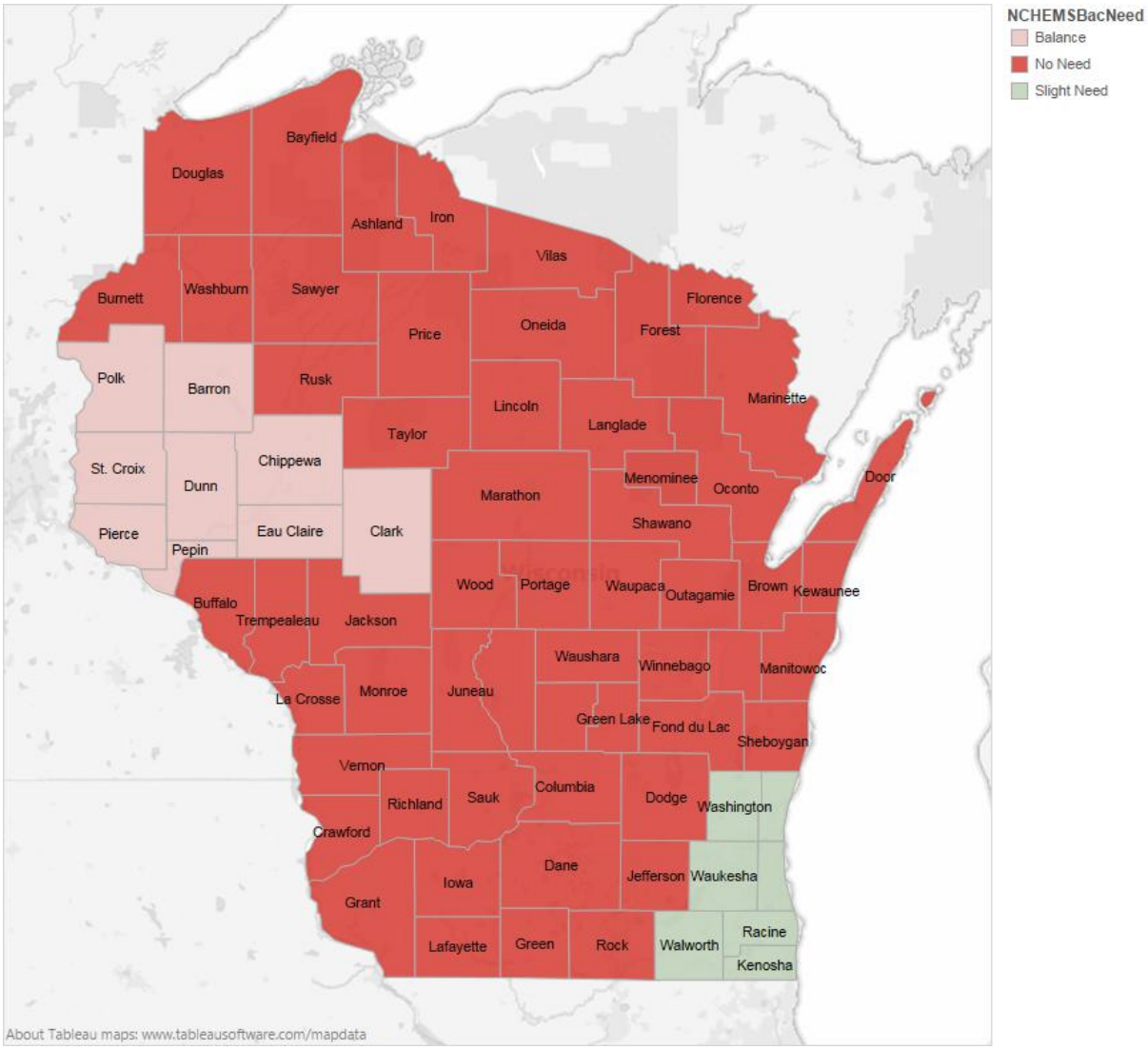
Energy efficiency engineers are slightly needed in Region 7.

Table A8. Energy Engineer Demand and Supply - Design and develop technologies that produce and store energy, particularly energy from sustainable sources such as wind and solar power. Develop ways for existing buildings and systems to become more energy efficient. May specialize in one type or field of energy production.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	14	7	2.0	Balanced
1	Momentum West and Minneapolis	5	2	2.0	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	2	1	1.4	Balanced
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.0	Balanced
5	New North	1	0	2.8	No Need
6	Madison Region	3	2	1.4	Balanced
7	Milwaukee 7	3	1	3.3	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	14	7	2.0	Balanced
1	Momentum West and Minneapolis	5	2	2.0	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	2	1	1.4	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.0	No Need
5	New North	1	0	2.8	No Need
6	Madison Region	3	2	1.4	Balanced
7	Milwaukee 7	3	1	3.3	Balanced

Map A8. Baccalaureate Energy Engineering Need by Wisconsin Region, 2013

Energy engineers "design and develop technologies that produce and store energy, particularly energy from sustainable sources such as wind and solar power. Develop ways for existing buildings and systems to become more energy efficient. May specialize in one type or field of energy production (Burning Glass definition)."



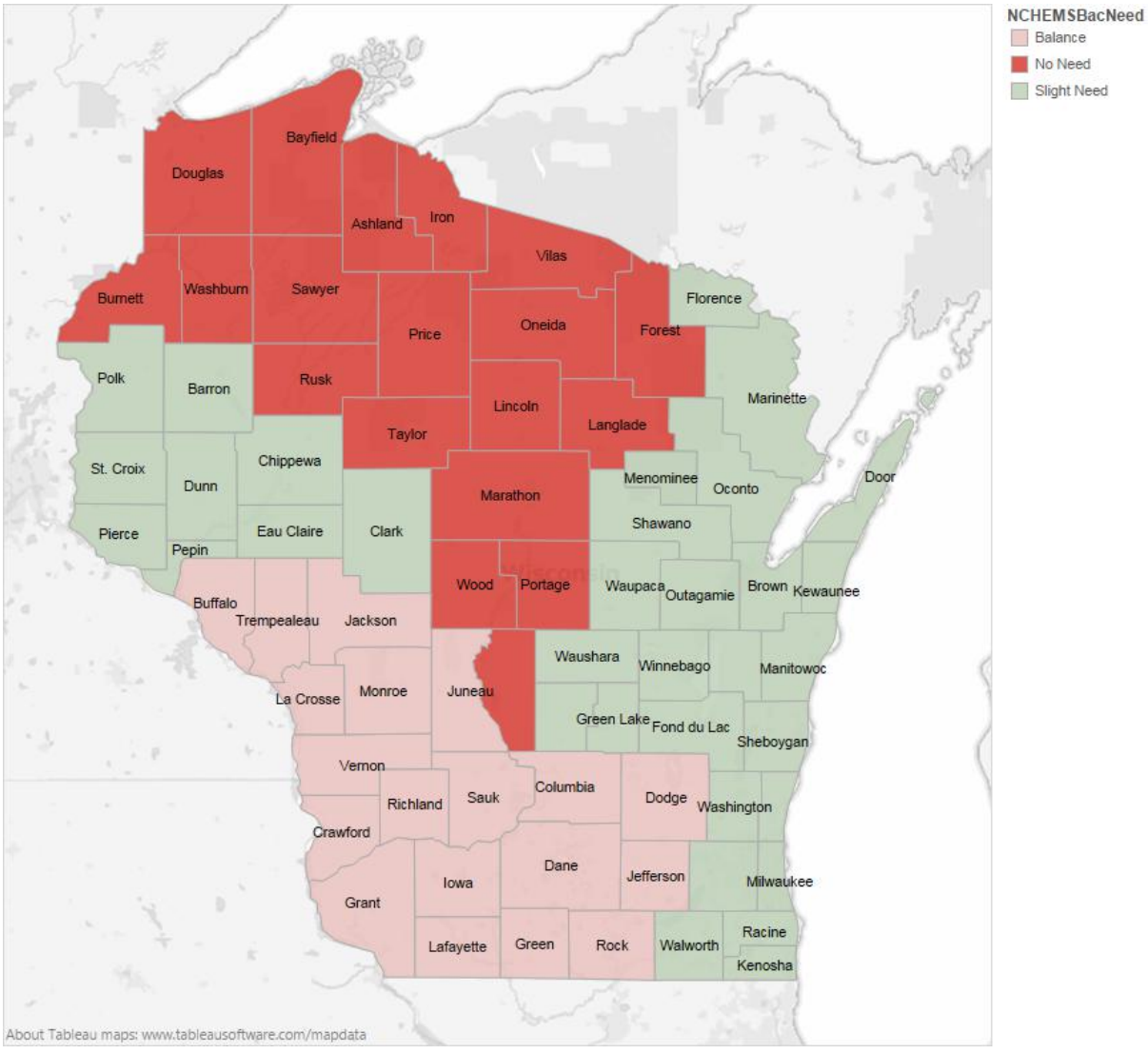
Energy engineers are slightly needed in Region 7.

Table A9. Environmental Engineer Demand and Supply - Develops solutions to environmental problems using engineering, biology, chemistry, and geology. Addresses pollution control, waste disposal, recycling, or public health issues. Works on local environmental issues, such as polluted groundwater, or global or regional issues, such as acid rain. Works with environmental scientists and public policymakers to identify problems and develop technologies that benefit people and protect the environment.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	150	25	6.1	Need
1	Momentum West and Minneapolis	83	12	7.2	Slight Need
2	Visions Northwest and Grow North	1	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	2	0.5	Balanced
5	New North	14	0	NA	Slight Need
6	Madison Region	18	9	2.0	Balanced
7	Milwaukee 7	33	4	9.1	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	10	10	1.0	Balanced
1	Momentum West and Minneapolis	5	4	1.5	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	1	0	NA	No Need
6	Madison Region	1	5	0.2	Balanced
7	Milwaukee 7	2	2	1.1	Balanced

Map A9. Baccalaureate Environmental Engineering Need by Wisconsin Region, 2013

Environmental engineers "develop solutions to environmental problems using engineering, biology, chemistry, and geology. Address pollution control, waste disposal, recycling, or public health issues. Work on local environmental issues, such as polluted groundwater, or global or regional issues, such as acid rain. Work with environmental scientists and public policymakers to identify problems and develop technologies that benefit people and protect the environment (Burning Glass definition)."



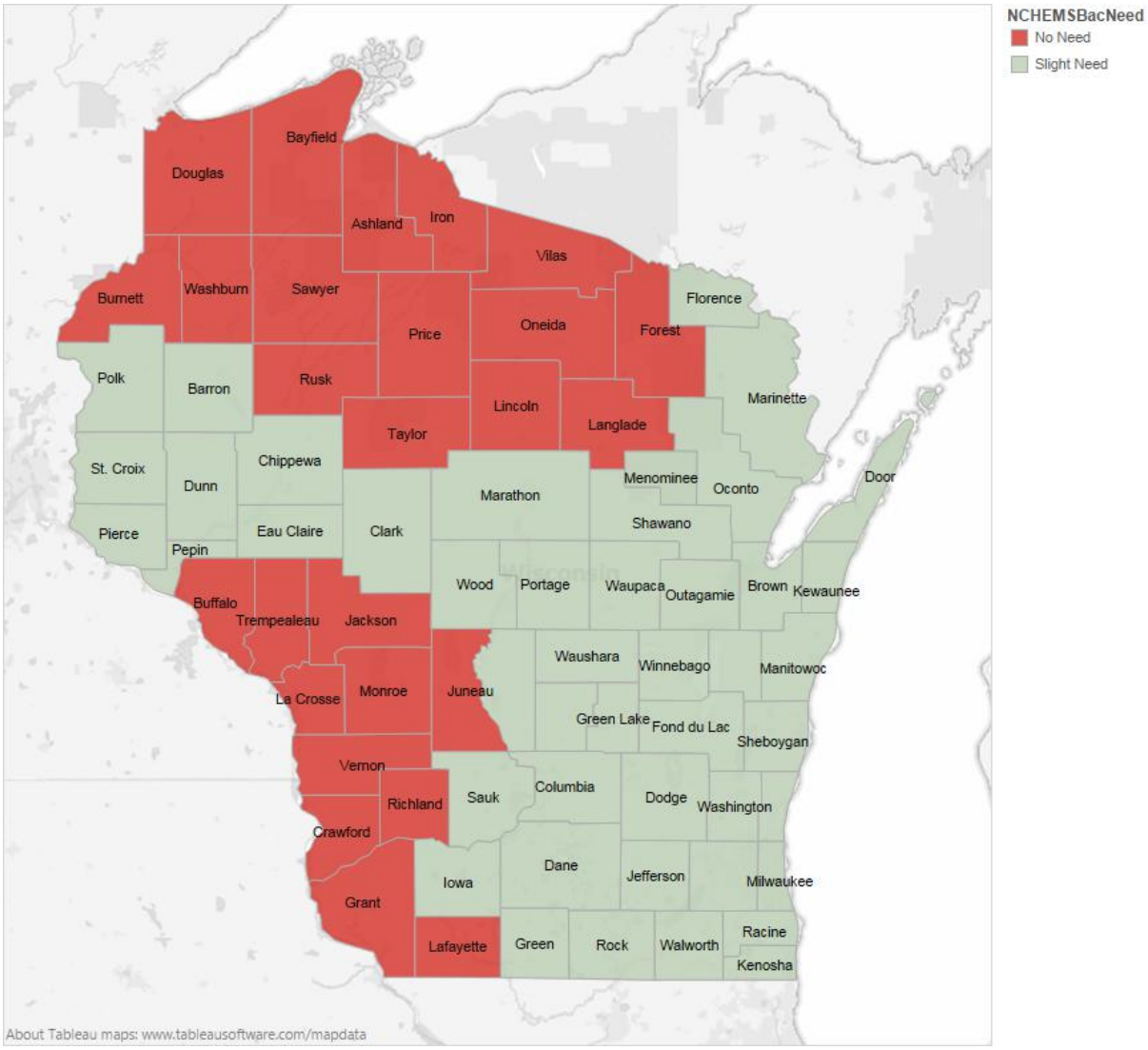
Regions 1, 5 and 7 show a slight need for environmental engineers.

Table A10. Hardware Engineer Demand and Supply - Designs and develops computer hardware such as circuit boards, chips, modems, and keyboards. Works with computer software engineers and developers to improve technology.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	88	3	30.9	Slight Need
1	Momentum West and Minneapolis	32	1	41.0	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	3	0	18.6	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	8	0	NA	Slight Need
6	Madison Region	6	0	NA	Slight Need
7	Milwaukee 7	39	1	27.4	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A10. Baccalaureate Hardware Engineering Need by Wisconsin Region, 2013

Hardware engineers "design and develop computer hardware such as circuit boards, chips, modems, and keyboards. Work with computer software engineers and developers to improve technology (Burning Glass definition)."



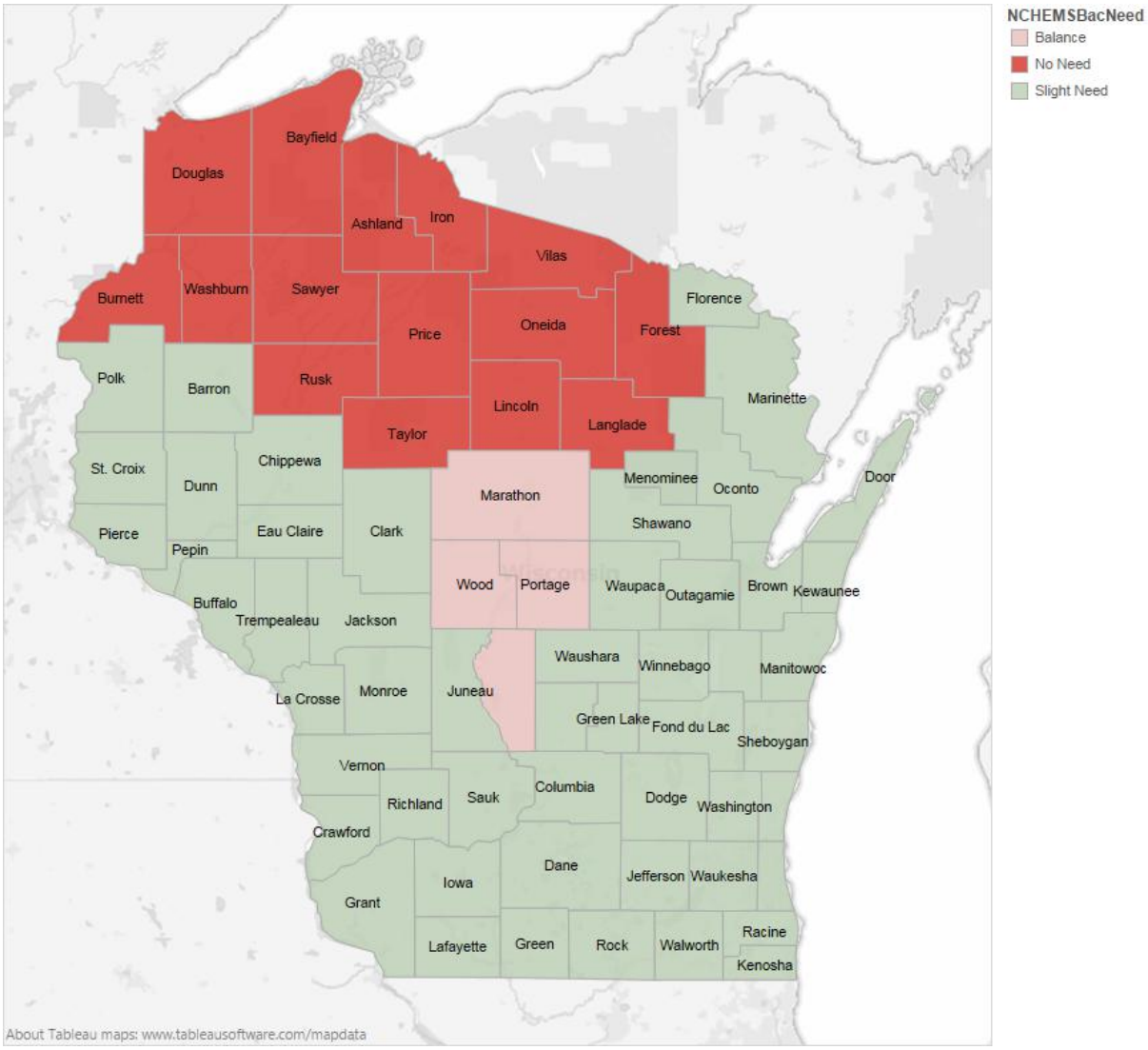
There is a slight need for Hardware engineers in Regions 1, 3, 5, 6, and 7.

Table A11. Health and Safety Engineer Demand and Supply - Develops workplace processes and procedures that help prevent people from getting injured or sick on the job, and also prevent property from being damaged. Works in industrial and manufacturing settings. Evaluates systems for health risks and designs solutions to minimize risks.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	195	24	8.1	Need
1	Momentum West and Minneapolis	77	2	39.5	Slight Need
2	Visions Northwest and Grow North	1	0	NA	No Need
3	Centergy	3	0	NA	Balanced
4	7 Rivers Alliance and Prosperity Southwest	4	1	3.1	Slight Need
5	New North	21	1	34.2	Slight Need
6	Madison Region	33	6	5.6	Slight Need
7	Milwaukee 7	55	19	3.0	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	45	29	1.5	Balanced
1	Momentum West and Minneapolis	18	23	0.8	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	0	NA	No Need
5	New North	5	0	NA	No Need
6	Madison Region	8	10	0.8	Balanced
7	Milwaukee 7	13	0	NA	No Need

Map A11. Baccalaureate Health and Safety Engineering Need by Wisconsin Region, 2013

Health and safety engineers "develop workplace processes and procedures that help prevent people from getting injured or sick on the job, and also prevent property from being damaged. Work in industrial and manufacturing settings. Evaluate systems for health risks and designs solutions to minimize risks (Burning Glass definition)."



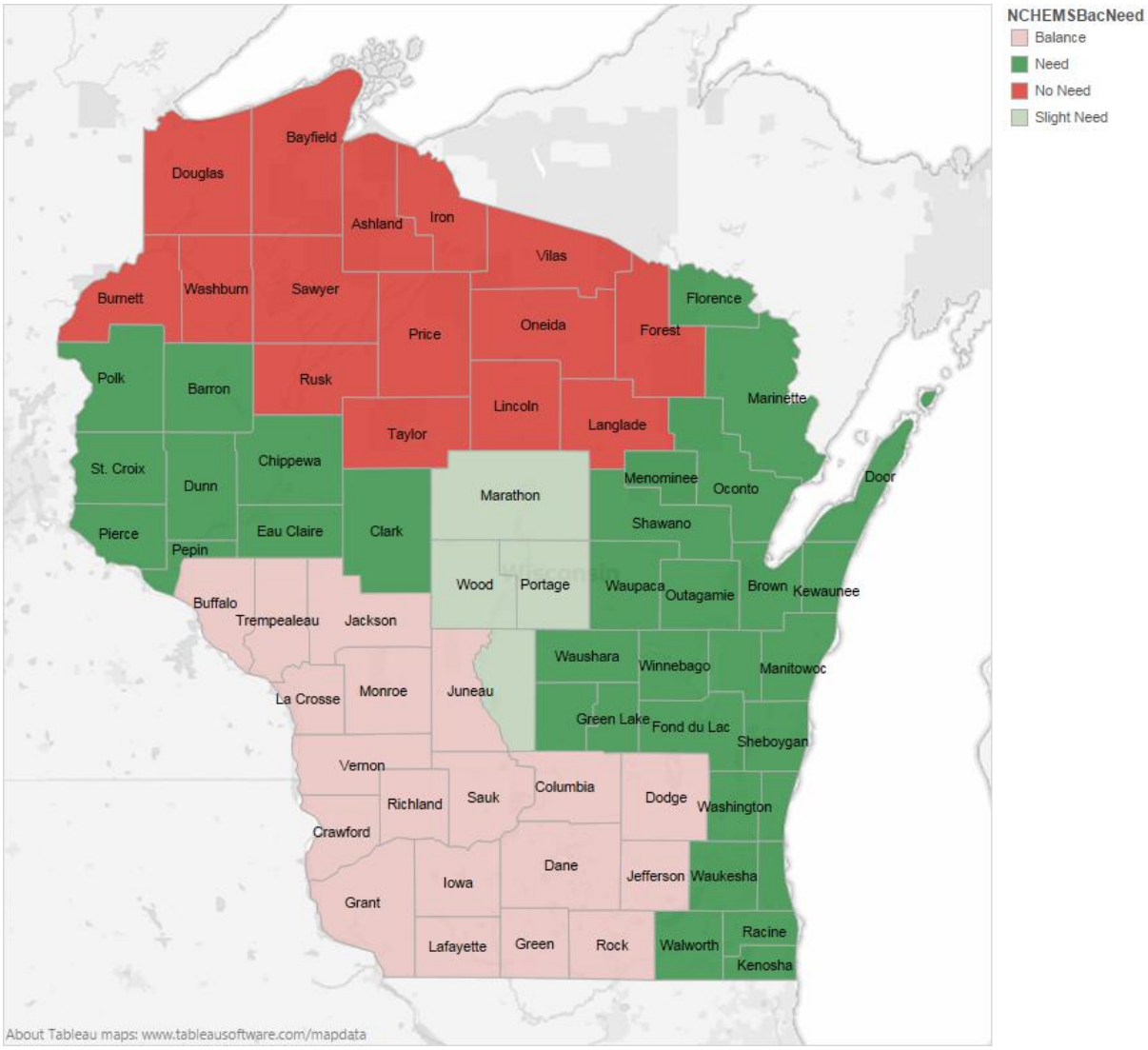
Most of the state of Wisconsin (Regions 1, 3, 4, 5, 6, and 7) has a slight need for health and safety engineers.

Table A12. Industrial Engineer Demand and Supply - Devises ways to make production processes more efficient and less wasteful. Uses technology and engineering to help companies and organizations produce products with efficient use of time, resources, and energy.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	643	120	5.4	Need
1	Momentum West and Minneapolis	280	59	4.8	Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	6	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	3	4	0.7	Balanced
5	New North	109	0	NA	No Need
6	Madison Region	43	20	2.2	Balanced
7	Milwaukee 7	202	26	7.8	No Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	41	44	0.9	Balanced
1	Momentum West and Minneapolis	18	15	1.2	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.2	Balanced
5	New North	7	0	NA	Slight Need
6	Madison Region	3	16	0.2	Balanced
7	Milwaukee 7	13	7	1.9	Balanced

Map A12. Baccalaureate Industrial Engineering Need by Wisconsin Region, 2013

Industrial engineers "devise ways to make production processes more efficient and less wasteful. Use technology and engineering to help companies and organizations produce products with efficient use of time, resources, and energy" (Burning Glass definition).



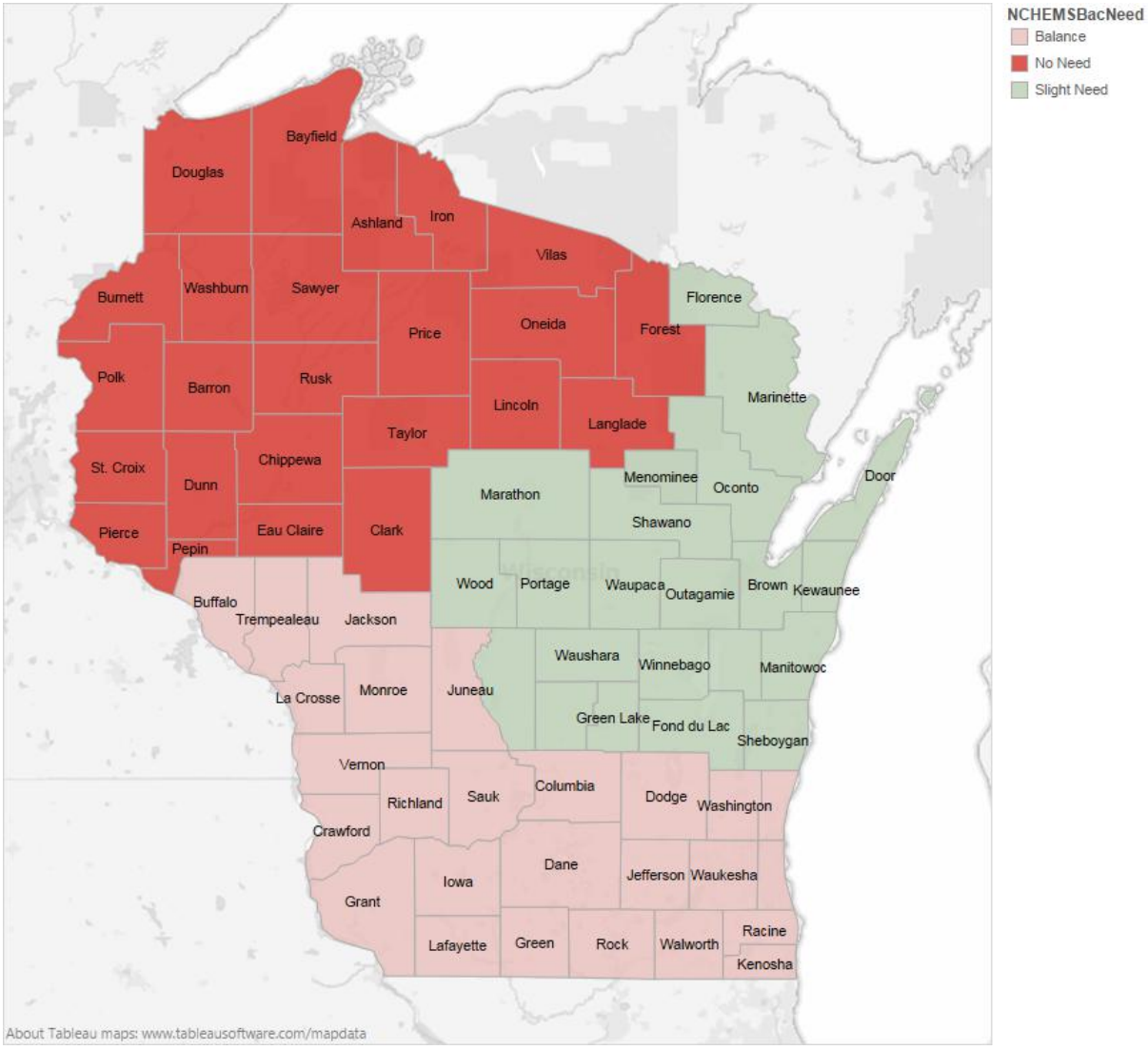
Industrial engineers are needed in Regions 1, 5, and 7 with a slight need in Region 3.

Table A13. Manufacturing Engineer Demand and Supply - Uses technology and engineering to help companies and organizations manufacture products with efficient use of time, resources, and energy.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	789	332	2.4	Balanced
1	Momentum West and Minneapolis	402	121	3.3	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	5	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	20	55	0.4	Balanced
5	New North	56	0	NA	Slight Need
6	Madison Region	65	69	0.9	Balanced
7	Milwaukee 7	241	122	2.0	Balanced
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	21	66	0.3	Balanced
1	Momentum West and Minneapolis	11	31	0.3	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	3	0.2	Balanced
5	New North	1	0	NA	No Need
6	Madison Region	2	23	0.1	Balanced
7	Milwaukee 7	6	11	0.6	Balanced

Map A13. Baccalaureate Manufacturing Engineering Need by Wisconsin Region, 2013

Manufacturing engineers "use technology and engineering to help companies and organizations manufacture products with efficient use of time, resources, and energy (Burning Glass definition)."



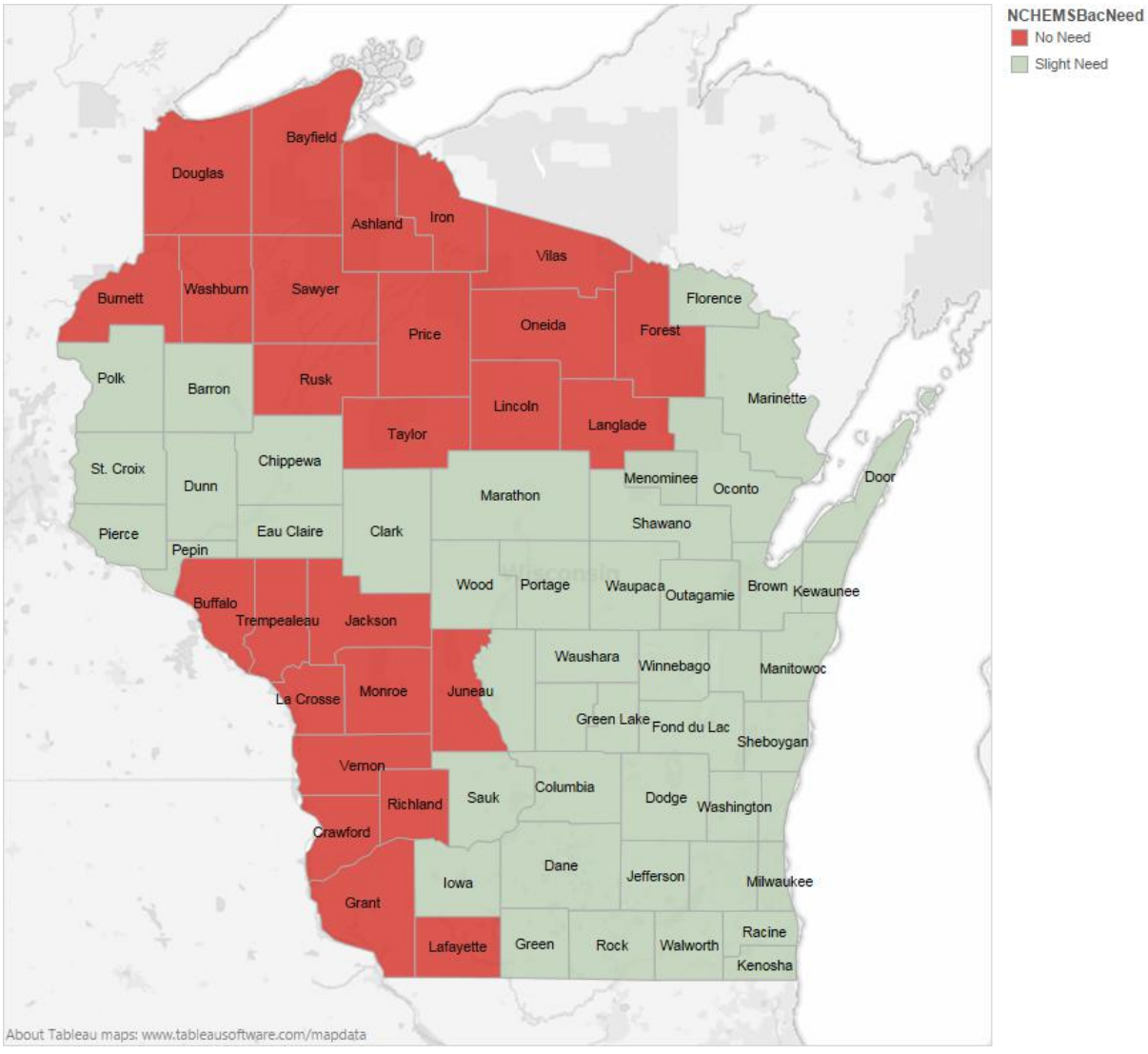
Manufacturing engineers are slightly needed in Regions 3 and 5.

Table A14. Marine Engineer Demand and Supply - Designs, constructs, tests, and maintains ships and other water-going vessels. May specialize in marine engineering and work on the mechanical systems that propel vehicles. May specialize in marine or naval architecture and focus on the basic structure and design of a ship. May specialize in a particular type of vessel, or a system or process involved in ship design.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	21	0	NA	Slight Need
1	Momentum West and Minneapolis	5	0	NA	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	2	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	3	0	NA	Slight Need
6	Madison Region	1	0	NA	Slight Need
7	Milwaukee 7	10	0	NA	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A14. Baccalaureate Marine Engineering Need by Wisconsin Region, 2013

Marine Engineers" design, construct, test, and maintain ships and other water-going vessels. May specialize in marine engineering and work on the mechanical systems that propel vehicles. May specialize in marine or naval architecture and focus on the basic structure and design of a ship. May specialize in a particular type of vessel, or a system or process involved in ship design (Burning Glass definition)."



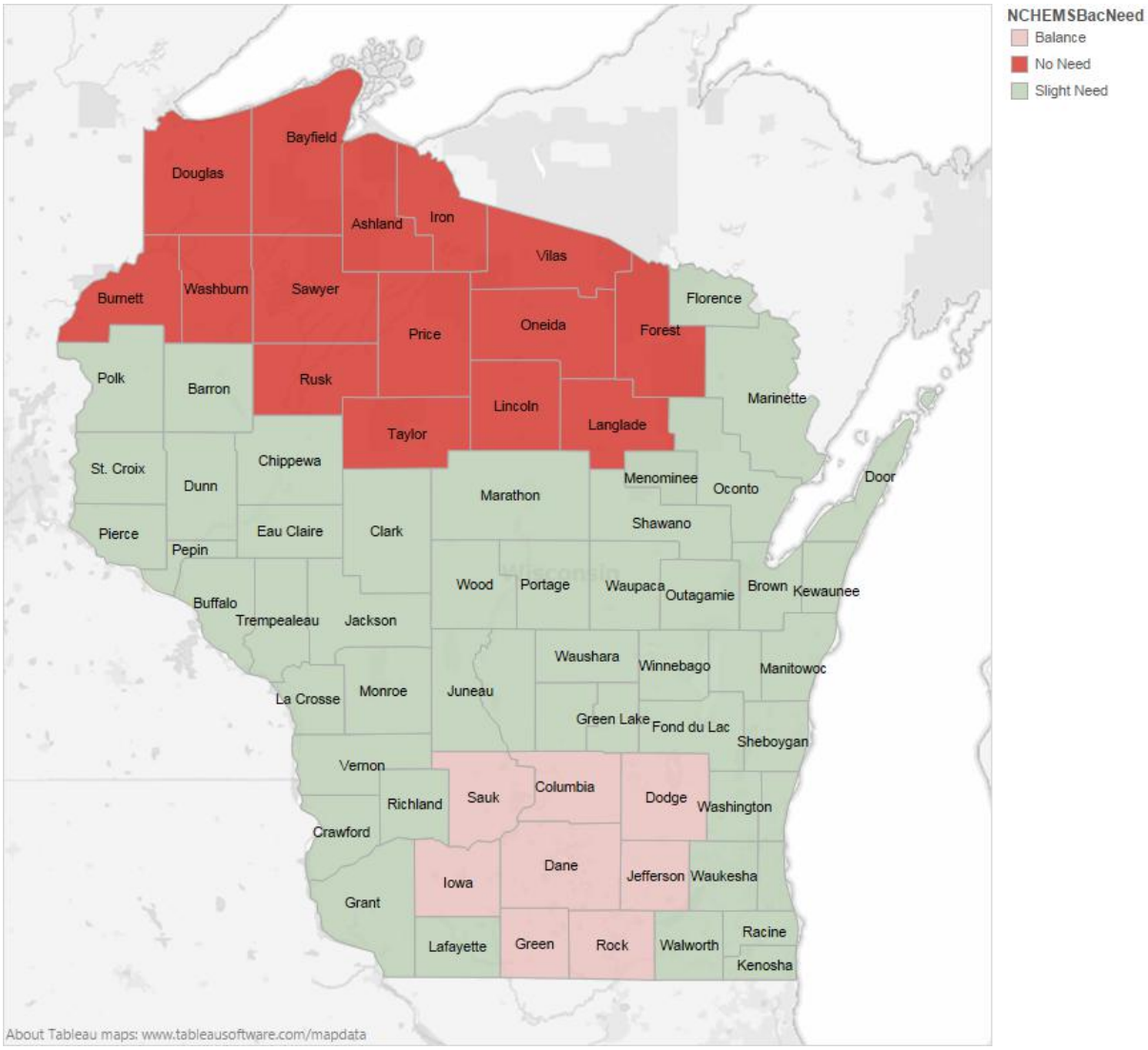
There is a slight need for Marine Engineers in Regions 1, 3, 5, 6, and 7.

Table A15.Materials Engineer Demand and Supply - Researches and tests the materials used to make a wide range of products. Develops new substances that have the properties needed for a particular use, or finds new ways to use existing substances. Uses knowledge of the chemical properties of materials, and specializes in one type of material, such as ceramics, metals, or plastics.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	113	15	7.4	Need
1	Momentum West and Minneapolis	27	4	6.6	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	4	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	4	1	3.1	Slight Need
5	New North	47	0	NA	Slight Need
6	Madison Region	5	3	1.8	Balanced
7	Milwaukee 7	26	1	28.8	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	12	15	0.8	Balanced
1	Momentum West and Minneapolis	3	2	1.2	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	2	0.2	Balanced
5	New North	5	0	NA	No Need
6	Madison Region	1	5	0.1	Balanced
7	Milwaukee 7	3	1	2.3	Balanced

Map A15. Baccalaureate Materials Engineering Need by Wisconsin Region, 2013

Materials engineers "research and test the materials used to make a wide range of products. Develop new substances that have the properties needed for a particular use, or find new ways to use existing substances. Use knowledge of the chemical properties of materials, and specialize in one type of material, such as ceramics, metals, or plastics (Burning Glass definition)."



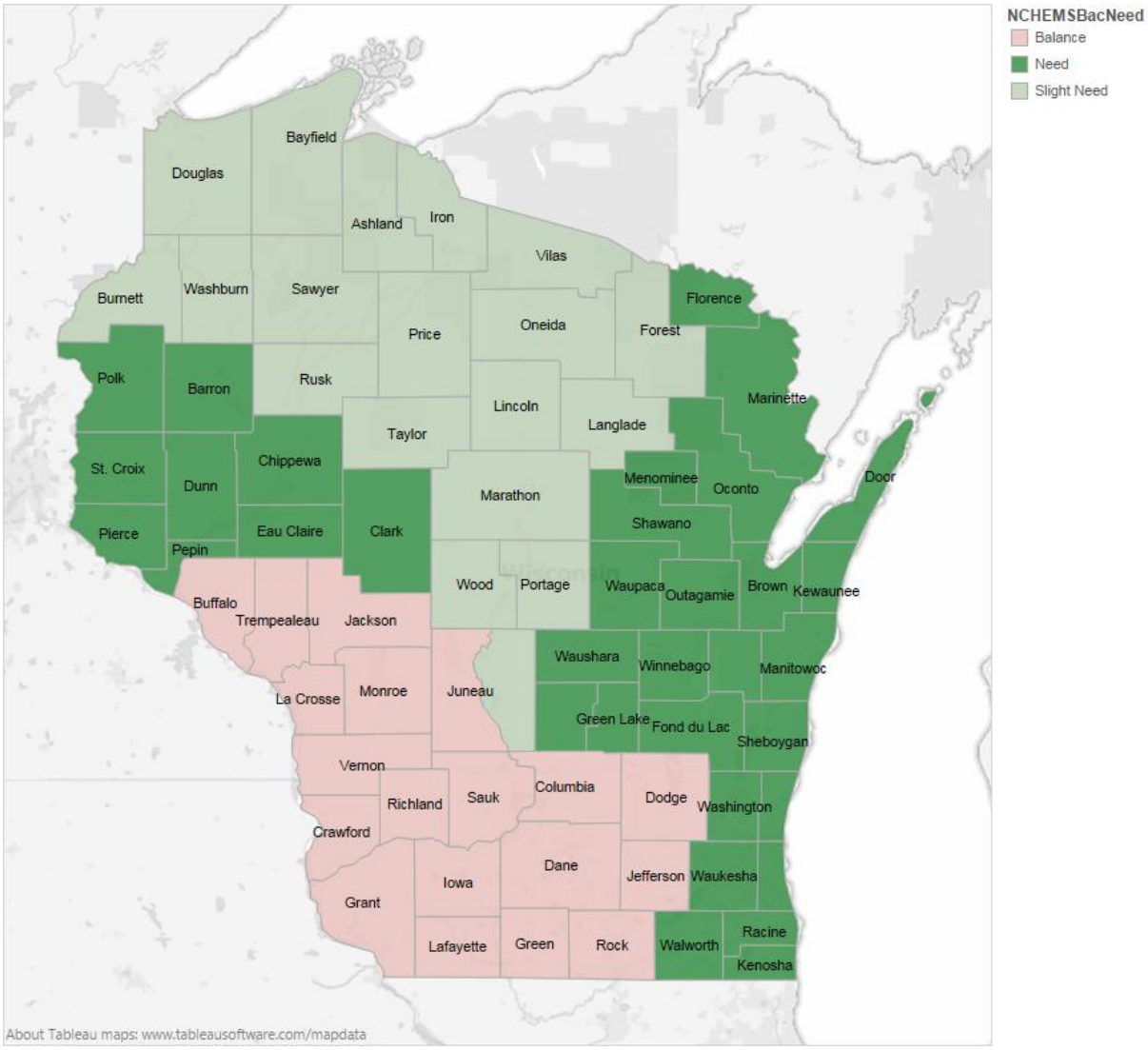
Regions 1, 3, 4, 5, and 7 show a slight need for materials engineers.

Table A16. Mechanical Engineer Demand and Supply - Researches, designs, develops, constructs, and tests mechanical devices including machines, engines and tools. Works on devices ranging from power generators to household dishwashers to surgical equipment. May specialize in a particular type of machine or tool. May develop new devices or improve existing ones to run more efficiently.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	1,440	332	4.3	Need
1	Momentum West and Minneapolis	563	97	5.8	Need
2	Visions Northwest and Grow North	6	0	NA	Slight Need
3	Centergy	28	0	NA	Slight Need
4	7 Rivers Alliance and Prosperity Southwest	16	40	0.4	Balanced
5	New North	254	0	NA	Need
6	Madison Region	135	88	1.5	Balanced
7	Milwaukee 7	438	101	4.4	Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	86	111	0.8	Balanced
1	Momentum West and Minneapolis	34	36	0.9	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	2	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	1	6	0.2	Balanced
5	New North	15	0	NA	No Need
6	Madison Region	8	54	0.1	Balanced
7	Milwaukee 7	26	16	1.6	Balanced

Map A16. Baccalaureate Mechanical Engineering Need by Wisconsin Region, 2013

Mechanical engineers "research, design, develop, construct, and test mechanical devices including machines, engines and tools. Work on devices ranging from power generators to household dishwashers to surgical equipment. May specialize in a particular type of machine or tool. May develop new devices or improve existing ones to run more efficiently (Burning Glass definition)."



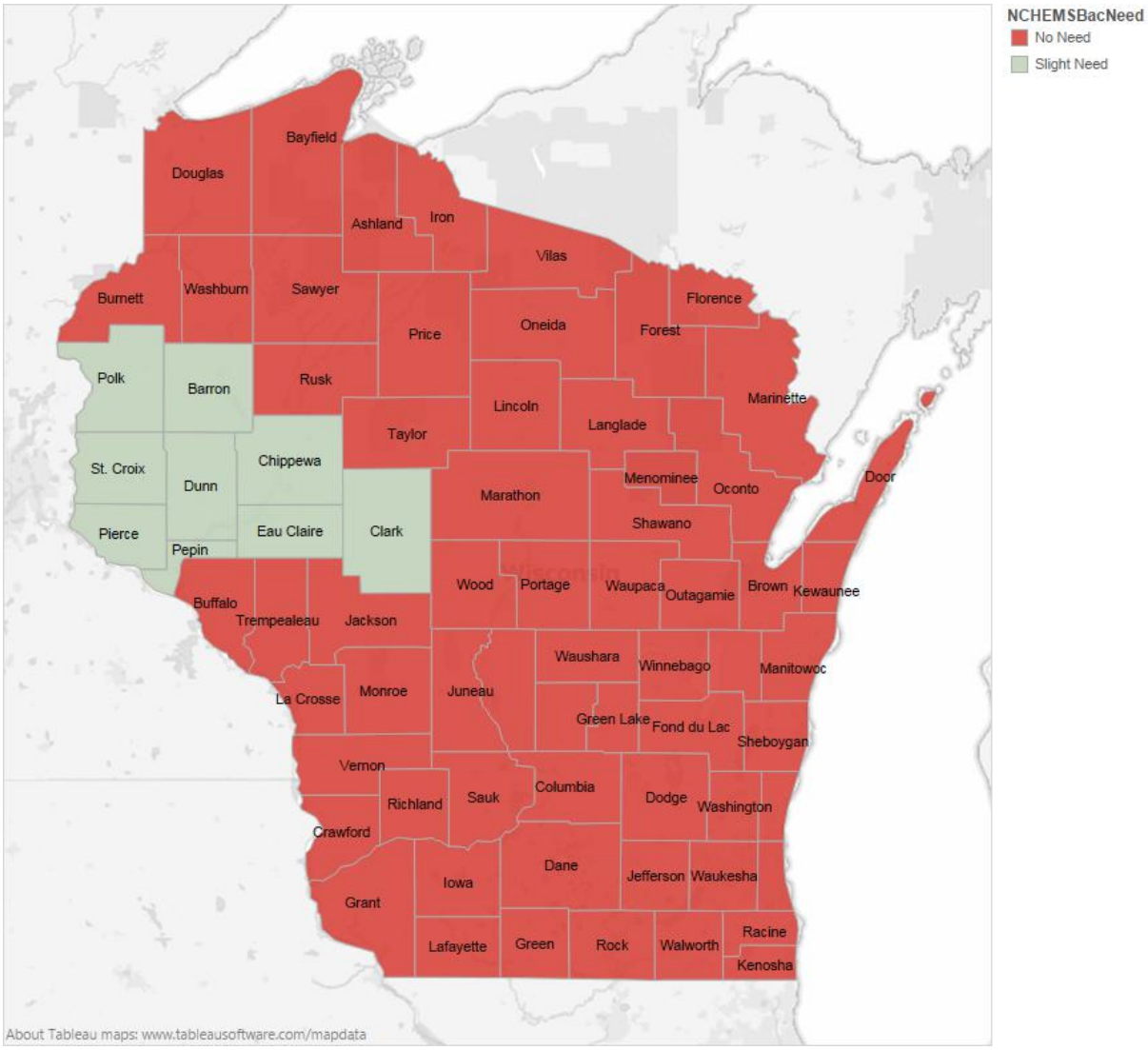
Mechanical engineers are needed in Region 1, 5, and 7. Regions 2 and 3 indicate a slight need for mechanical engineers.

Table A17.Mining Engineer Demand and Supply - Researches mines and designs mining operations for the efficient extraction of minerals such as metals and coal. Uses knowledge of geology and engineering to determine sites to be mined, and develops plans to extract minerals effectively. May specialize in one type of mineral or material. May inspect and monitor mines for the safety and health of miners

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	10	0	NA	Slight Need
1	Momentum West and Minneapolis	6	0	NA	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	2	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	2	0	NA	No Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A17. Baccalaureate Mining Engineering Need by Wisconsin Region, 2013

Mining engineers "research mines and design mining operations for the efficient extraction of minerals such as metals and coal. Use knowledge of geology and engineering to determine sites to be mined, and develops plans to extract minerals effectively. May specialize in one type of mineral or material. May inspect and monitor mines for the safety and health of miners (Burning Glass definition)."



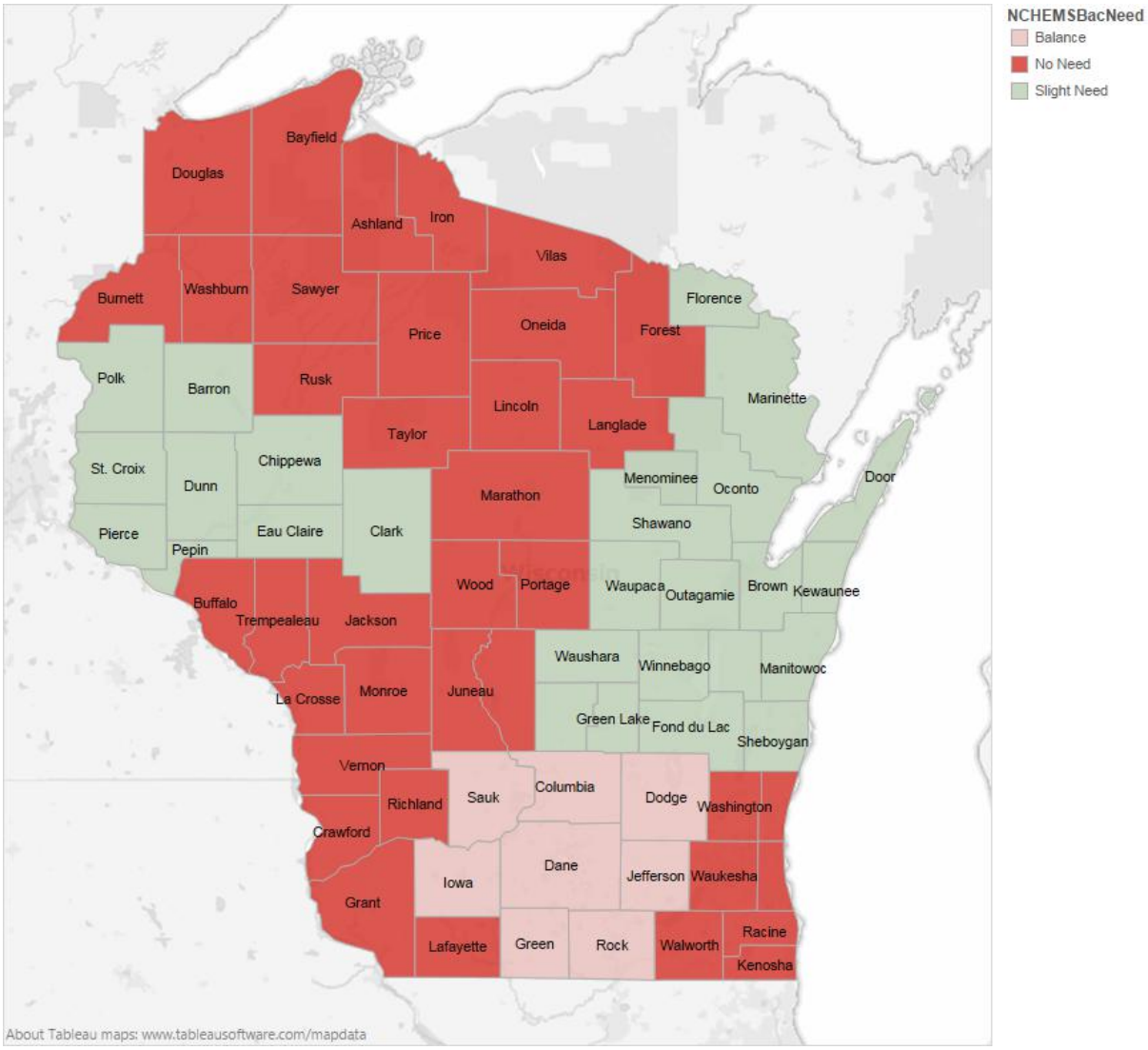
Region 1 has a slight need for Mining Engineers.

Table A18. Nuclear Engineer Demand and Supply - Researches and develops technology and systems that use nuclear energy and radiation. Maintains the safety of existing nuclear power systems, or develops nuclear power sources, or develops industrial and medical uses for radioactive material.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	19	17	1.1	Balanced
1	Momentum West and Minneapolis	9	0	NA	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	3	0	NA	Slight Need
6	Madison Region	6	17	0.4	Balanced
7	Milwaukee 7	2	0	NA	No Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	3	30	0.1	Balanced
1	Momentum West and Minneapolis	1	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	1	30	0.0	Balanced
7	Milwaukee 7	0	0	NA	No Need

Map A18. Baccalaureate Nuclear Engineering Need by Wisconsin Region, 2013

Nuclear engineers "research and develop technology and systems that use nuclear energy and radiation. Maintain the safety of existing nuclear power systems, or develop nuclear power sources, or develop industrial and medical uses for radioactive material (Burning Glass definition)."



There is a slight need for nuclear engineers in Regions 1 and 5.

Table A19. Optical / Laser Engineer Demand and Supply - Researches and develops technology that uses the science of light (optics). Optical technology includes fiber optic cables, which enable high-speed internet connections across long distances, and lasers, which can be used to make very small incisions and measurements. Works closely with scientists and engineers from other fields on advances in technology.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	8	4	1.9	Balanced
1	Momentum West and Minneapolis	6	3	2.0	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.0	Balanced
5	New North	2	1	2.8	Balanced
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Table A20. Reservoir / Petroleum Engineer Demand and Supply - Designs and develops methods for extracting oil and gas from beneath the surface of the earth. Determines the best process of extracting a deposit of gas or oil, designs drilling equipment, and develops and improves methods of extraction.

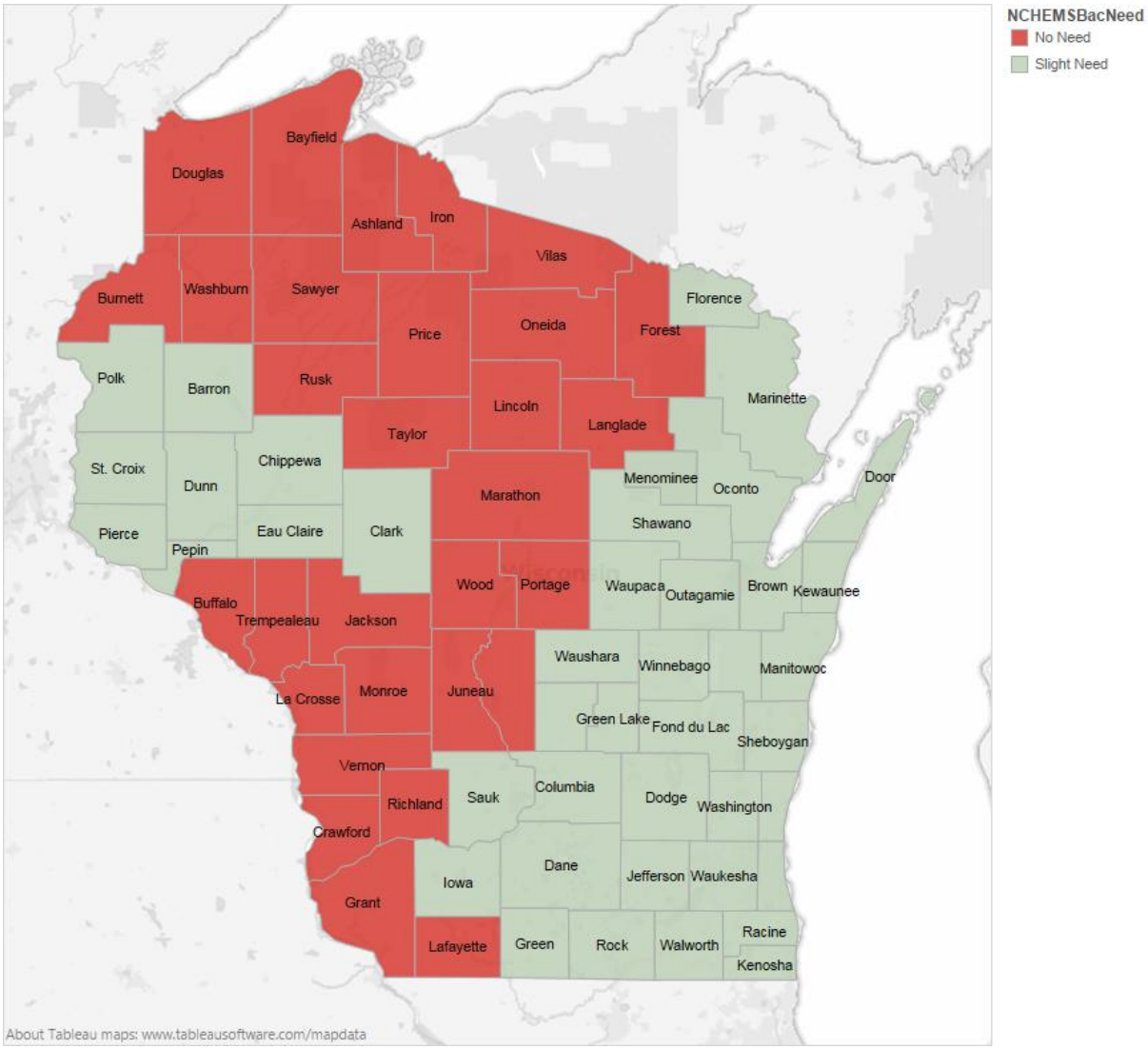
Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1	Momentum West and Minneapolis	7	1	13.6	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	3	0	NA	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Table A21. RF Engineer Demand and Supply - Works with technology and electronic equipment that uses radio waves, from cell phones to radio stations. Designs, installs, and repairs systems and equipment that transmit radio signals. May specialize in design or maintenance; may focus on the design of transmission equipment, such as radio antennae, or manage larger systems such as networks of cell phone towers.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	87	5	17.3	Slight Need
1	Momentum West and Minneapolis	72	3	22.4	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	3	0	NA	Slight Need
6	Madison Region	4	0	NA	Slight Need
7	Milwaukee 7	9	1	13.8	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	3	3	1.1	Balanced
1	Momentum West and Minneapolis	2	2	1.4	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A21. Baccalaureate RF Engineering Need by Wisconsin Region, 2013

RF engineers "work with technology and electronic equipment that uses radio waves, from cell phones to radio stations. Design, install, and repair systems and equipment that transmit radio signals. May specialize in design or maintenance; may focus on the design of transmission equipment, such as radio antennae, or manage larger systems such as networks of cell phone towers (Burning Glass definition)."



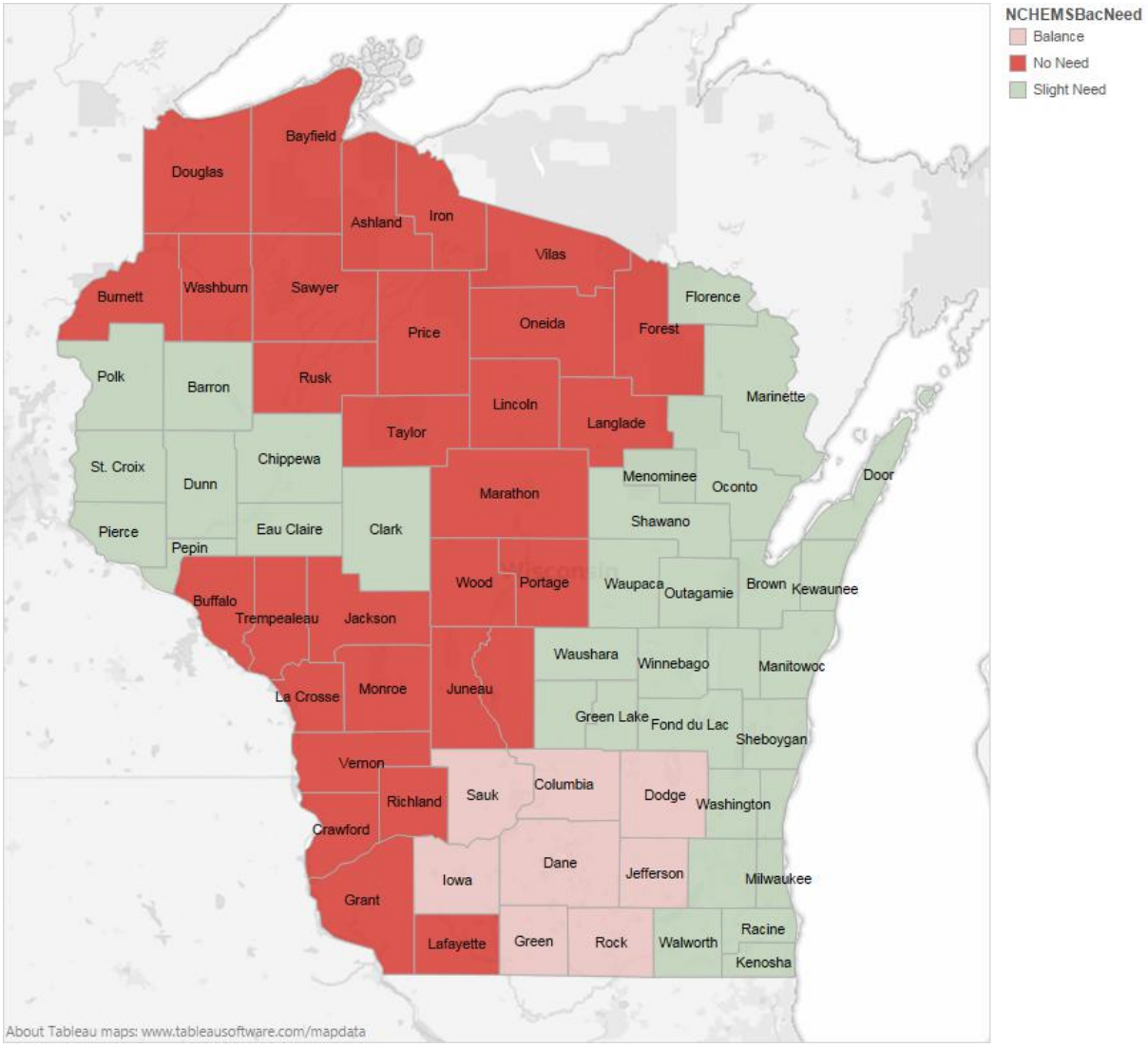
Regions 1, 5, 6, and 7 indicate a slight need for RF engineers.

Table A22. Transportation Engineer Demand and Supply - Designs and maintains transportation systems such as roads, ports, airports, and bus or subway systems.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	42	5	9.0	Slight Need
1	Momentum West and Minneapolis	11	1	15.3	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	9	0	NA	Slight Need
6	Madison Region	7	2	3.0	Balanced
7	Milwaukee 7	15	2	9.1	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	2	2	1.1	Balanced
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	1	0.3	No Need
7	Milwaukee 7	1	1	1.1	Balanced

Map A22. Baccalaureate Transportation Engineering Need by Wisconsin Region, 2013

Transportation engineers "design and maintain transportation systems such as roads, ports, airports, and bus or subway systems (Burning Glass definition)."



Regions 1, 5, and 7 show a slight need for transportation engineers.

Table A23. Validation Engineer Demand and Supply - Evaluates and maintains machinery and equipment used in manufacturing, and supervises workers that use and repair the machines.

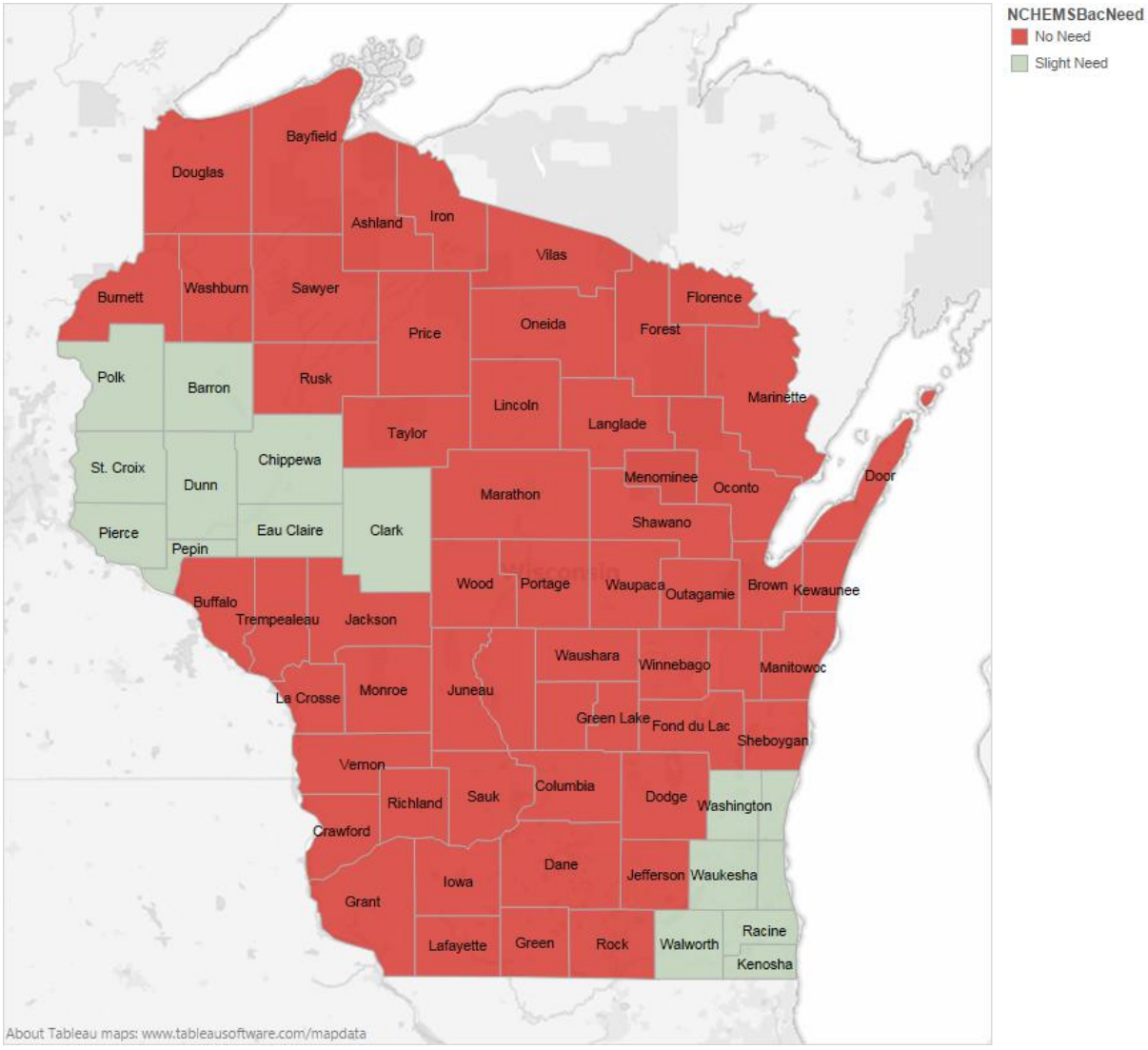
Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	182	261	0.7	Balanced
1	Momentum West and Minneapolis	95	116	0.8	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	1	0.0	No Need
5	New North	15	5	2.8	Balanced
6	Madison Region	23	70	0.3	Balanced
7	Milwaukee 7	49	62	0.8	Balanced
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	3	20	0.2	Balanced
1	Momentum West and Minneapolis	2	9	0.2	Balanced
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	11	0.0	No Need
7	Milwaukee 7	1	3	0.3	Balanced

Table A24. Water / Wastewater Engineer Demand and Supply - Specializes in the treatment and management of contaminated water. Designs sewage systems and water treatment plants.

Region	Economic Development Region (approx.)	Baccalaureate Degree			
		Demand	Supply	Demand:Supply Ratio	Need Category
1-7 Combined	All of Wisconsin and Minneapolis MSA	23	4	6.1	Slight Need
1	Momentum West and Minneapolis	10	1	7.2	Slight Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	1	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	1	0	NA	No Need
7	Milwaukee 7	11	1	9.1	Slight Need
Region	**Economic Development Region (approx.)**	**Graduate or Professional Degree**			
		Demand	**Supply**	**Demand:Supply Ratio**	**Need Category**
1-7 Combined	All of Wisconsin and Minneapolis MSA	0	0	NA	No Need
1	Momentum West and Minneapolis	0	0	NA	No Need
2	Visions Northwest and Grow North	0	0	NA	No Need
3	Centergy	0	0	NA	No Need
4	7 Rivers Alliance and Prosperity Southwest	0	0	NA	No Need
5	New North	0	0	NA	No Need
6	Madison Region	0	0	NA	No Need
7	Milwaukee 7	0	0	NA	No Need

Map A24. Baccalaureate Water/Wastewater Engineer Engineering Need by Wisconsin Region, 2013

Water/Wastewater engineers "specialize in the treatment and management of contaminated water. Design sewage systems and water treatment plants (Burning Glass definition)."



Regions 1 and 7 in Wisconsin exhibit a slight need for Water/Wastewater Engineers.

October 31, 2014

Dear President Cross and Senior Vice President Ward:

Over the past eighteen months, key faculty, administrators and northwest Wisconsin business and industry leaders have been discussing and studying the need for bringing additional engineering programs to UW- Eau Claire, UW-River Falls and UW-Stout. We have listened to business and community leaders tell us about the critical need for engineering degree programs based in northwest Wisconsin. We have commissioned and analyzed market studies for potential new engineering programs. In concert with our faculty and academic staff, we have thoughtfully developed and submitted "entitlement to plan" requests to UW System that build upon the unique strengths of our institutions. We have listened to members of the Legislature and Board of Regents articulate the importance of UW institutions taking decisive action to support economic development and job growth in the regions they serve. And, we have heard of the need for UW institutions to increase innovation and work more collaboratively.

As chancellors, it has become apparent to us that the students, communities and the economic future of northwest Wisconsin would be best served by UW-Eau Claire, UW-River Falls and UW-Stout working collaboratively, rather than in competition, to bring a suite of new engineering degree programs to our region. Thus, today, we submit to you a collective response to the NCHEMS engineering supply and demand study. Our response places that report in the broader context of other market studies that we have conducted, as well as adding the perspective we have gathered from business and community leaders in our region.

Moreover, we have worked together, in ways without precedent in the UW System, to develop a vision for a **Northwest Wisconsin Engineering Consortium** that will maximize the collective impact and minimize the duplication and cost of engineering programs in northwest Wisconsin. For students, the Consortium will provide flexible, innovative and cost-effective pathways to completing engineering degrees at our institutions. For the region, the Consortium will provide an enhanced talent pipeline and critical support for future economic development, and business retention and attraction.

We are asking key business and community leaders to provide important perspectives on the needs of the region and on our collaborative proposal. Letters will be provided to the UW System President's Office as soon as they are available, but no later than the end of Monday, November 17. We would hope that their correspondence and views would be considered and shared with members of the Board of Regents and others, as appropriate.

The UW System has three strong institutions in UW-Eau Claire, UW-Stout, and UW-River Falls—each with unique strengths—that are part of a growing region of the state. Our three institutions—representing over 26,000 students and 185,000 alumni--have worked together creatively to develop a vision to enhance the educational quality of the entire UW System and advance Wisconsin's economy and quality of life.

We respectfully ask for your support of the Northwest Wisconsin Engineering Consortium and approval of the select engineering degree programs at our institutions that form the basis of the Consortium. We would be delighted to discuss our vision with you and others at your convenience.

Sincerely,

Bob Meyer	James C. Schmidt	Dean Van Galen
Chancellor	Chancellor	Chancellor
UW-Stout	UW-Eau Claire	UW-River Falls

TO: President Ray Cross *via electronic mail*
Senior Vice President David J. Ward

FROM: Northwest Wisconsin Engineering Consortium
Chancellor Bob Meyer
Chancellor James Schmidt
Chancellor Dean Van Galen

DATE: October 31, 2014

RE: Response to NCHEMS Engineering Study

We have reviewed and discussed at length the study of Wisconsin's need for more engineers conducted by the National Center for Higher Education Management Systems (NCHEMS). We wholeheartedly support the data in the report indicating that Wisconsin has unmet needs for engineers in various fields. Furthermore, our institutions have commissioned similar studies over the years, which have indicated a need for more engineering programs in northwest Wisconsin. Finally, our business and industry partners have been expressing their support for additional engineering programs in northwest Wisconsin for many years.

This memo will lay out what we believe to be the most significant findings of the report, bolstered by data and material from other sources (attached) regarding northwestern Wisconsin. In addition, we would like to present our concept of how the Northwest Wisconsin Engineering Consortium can address regional shortages. We would be available at any time to discuss this memo or other issues concerning engineering education in northwest Wisconsin.

The most significant portion of the report, in our view, is the absolute confirmation of unmet needs across Wisconsin for trained engineers. Table 13 lays out that need for engineers, using Burning Glass and IPEDS data. In all of Wisconsin, there was a demand for 7,818 engineers, with a supply of only 1,644. This indicates 79 percent of all openings go unfilled. Only one of the seven regions reported "no need" for more engineers.

Concerning engineering overall, the NCHEMS report indicated that there is a demand for 359 engineers in Regions 1b (Momentum West), 2 (Visions Northwest and Grow North in northern Wisconsin) and 3 (Centergy in Wausau/central Wisconsin), with a potential supply of only 82. This is important because research indicates college students have a propensity to enroll in an institution within 51 miles of home (please refer to the 2012 Enrollment Trends Report by ACT).

Drilling down into the report's data, 16 categories of engineers were identified with a so-called "slight need" in selected Wisconsin regions, including environmental and materials engineers. Five classifications of engineers had documented "needs," including chemical/process engineers, electrical engineers, mechanical engineers and industrial engineers.

In the appendix, the need for mechanical engineers in Regions 1, 2 and 3 is 597, while the supply is only 97. For electrical engineers, the need is 575 and the supply is 13. For chemical engineers, the need is 223 and the supply is 55. These data clearly indicate significant shortages of mechanical, electrical and chemical engineers exist in our region.

We believe it is important to consider the sources used by NCHEMS to assess the need for engineers in Wisconsin: Burning Glass data from job boards, newspapers, employers, and other websites. Our campuses can supplement this report with additional information, such as Education Advisory Board reports and information provided by industry leaders and other regional stakeholders in northwestern Wisconsin. Our efforts to bring more engineering programs to our campuses has resulted from the close contact we have with the businesses and industries in northwest Wisconsin, as well as the efforts of our economic development officials to improve the supply of engineers in our area.

For example, Eric Turner, executive director of the Dunn County Economic Development Corp., wrote a column in the July 8, 2014, edition of the Dunn County News appealing for more engineering graduates in northwest Wisconsin. (The column was Mr. Turner's initiative. We did not know it was being published).

"Manufacturing is a huge part of our economy," Mr. Turner wrote. "It has the potential for being an even greater part of our local economy. However, in order for that to happen, we need more engineers."

Mr. Turner then made the case for our three institutions to offer these needed engineering programs: "Good students, who would be great engineers, are not being accepted into programs and are forced to earn their degrees elsewhere. The farther away they are from our region, the larger is the chance that they will not build their careers in the region. In the same vein, students who receive degrees in the southern part of the state are likely to stay in that part of the state.

The entire column is available at http://chippewa.com/dunnconnect/news/local/latest-developments/article_9866869a-607f-5370-8949-1d82dd0fe5ee.html

Furthermore, a 2013 report, "Narrowing the Skills Gap," sponsored by the Eau Claire County Economic Development Corp., pointed to the need for engineers and other high-skill employees in western Wisconsin. It called for a long-term action plan to "Bring engineering-related curriculum to universities in western Wisconsin" because of the problems employers have in trying to recruit employees in certain key occupations.

"This (recruiting engineers to western Wisconsin) can be a large undertaking involving significant expense with a low rate of success," the report concluded.

Tom Skritc, co-owner of Accu-Tech Plastics in Eau Claire, has said: "We have a tough time recruiting mechanical engineers into the area. Knowing the best avenues to recruit this talent and increasing our region's ability to attract this talent is vital to growing our company."

Retirements also are presenting problems for business and industry owners who depend on engineers. According to the NCHEMS report, 25.6 percent of mechanical engineers are 50 or older; 34.6 percent of electrical engineers are 50 or older and 21.1 percent of chemical engineers are 50 or older.

In October 2013, state Department of Workforce Development similarly reported that finding engineers will be particularly difficult for business and industry in western Wisconsin over the next two years. Lee Swindall, vice president of Business & Industry Development for the Wisconsin Economic Development Corp., told the Governor's Council on Workforce Investment that half of the current engineers in

Wisconsin were considering retirement and “market forces will not be sufficient to make up for the vacancies created by those retiring. We need a strategy.”

Swindall also cautioned the council: “There are not enough engineers produced in Wisconsin to fill the demand.”

Last year, UW-Stout asked the Education Advisory Board to review the demand for positions in three engineering categories—mechanical, electrical and chemical—from January 2010 through December 2013 in 31 northern and western Wisconsin counties. That review found a 91 percent increase in job postings for employees with mechanical engineering skills, a 41 percent increase in job postings for employees with electrical engineering skills, and a 63 percent increase in job postings for employees with chemical engineering skills. A recent Forbes magazine article notes that the factors affecting agriculture, such a fresh water supplies and decreasing farmland, paired with a growing demand for food, will lead to an increased demand for agricultural engineers. As a result, the article lists agricultural engineering as one of the best majors for the high school class of 2022 to study in college.

In sum, the economic development of northwestern Wisconsin depends on our ability to meet the current and future demand for engineers in this region. This is what Mike Miller, vice president of Marketing for Oxbo International Corp. in Clear Lake said: "Innovation is one of our corporate values. It drives us to design, test, and manufacture increasingly sophisticated agricultural equipment at our Clear Lake, Wis., facility. Our ability to recruit local graduates holding agricultural, electrical and mechanical engineering degrees from NWEC member universities would be a significant asset for us."

UW-Stout, UW-River Falls, and UW-Eau Claire have a solution: develop and offer an array of engineering programs through a collaborative consortium called the “Northwest Wisconsin Engineering Consortium” to serve as an economic catalyst for economic growth in the region. The consortium members will work together to develop an array of high-demand engineering programs with a memorandum of understanding stating that we will collaborate to develop a common core curriculum for seamless transfer of credits among our institutions. In addition, we intend to hold joint career fairs, develop a regional advisory board of industry partners, and provide outreach to PK-12 and the technical colleges to recruit students.

As chancellors, we work hard every day to ensure that our program offerings meet the needs of our business and industry partners in northwest Wisconsin. The formation of our Northwest Wisconsin Engineering Consortium is a natural outgrowth of that collaboration with business and industry.

We would be available at any time to discuss the details of this response.

attachments

Northwest Wisconsin Engineering Consortium

An Innovative and Collaborative *"College" of Engineering* at
UW-Eau Claire, UW-River Falls, and UW-Stout

INTRODUCTION

The Northwest Wisconsin Engineering Consortium (NWEC, hereafter the Consortium), comprised of the University of Wisconsin-Eau Claire, the University of Wisconsin-River Falls, and the University of Wisconsin-Stout, brings together a range of significant strengths, facilities, and resources in STEM disciplines to answer the call for increased partnerships between the universities and industry to develop talent and drive Wisconsin's economy. Each university is committed to being an effective partner with regional stakeholders and to developing additional Accreditation Board for Engineering and Technology (ABET) accredited engineering programs that provide value to students and to the region's economy. The Consortium, as an entity, will foster collaborations with K-12, technical and two-year colleges, and certainly with industry (through an external advisory board of business leaders and educational partners). The goal of the consortium is to develop high quality and responsive undergraduate engineering programs that serve the region by developing needed talent and drive the region's economy.

In a 2013 UW System newsletter, *Knowledge Powers Economic Development*, UW Regent Timothy Higgins highlights the importance and value for "the integration of business with the UW System and the future of Wisconsin's economic growth." This focus on connecting economic development to education and research is clearly supported by UW System institutions and informs the development of the Consortium. The universities along the I-94 corridor in northwestern Wisconsin see engineering education in the region as a natural outgrowth of each institution's existing strengths and program array, and as a response to the UW Board of Regents' call to action. The opportunity for the Consortium is underscored by the *Wisconsin Technology Council*, which observes "Western Wisconsin and the Twin Cities area make up the western core of the I-Q Corridor, a region rich in ideas, innovative workers, investment capital and some of the world's most exciting intellectual property—especially in biotechnology, the life sciences, information technology and advanced manufacturing."

The Consortium's partners can leverage geographical and institutional strengths by connecting their collective focus on undergraduate engineering programs that develop talent with industry needs to drive the regional economy.

OPPORTUNITY AND VALUE

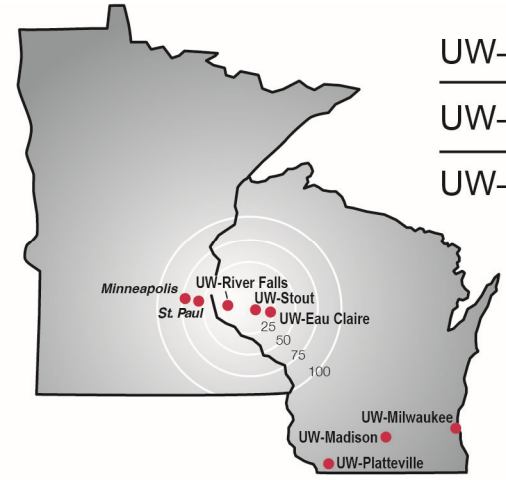
The 2013 *Wisconsin Economic Future Study* observes how there is a need to "strengthen ties between driver and industry cluster firms and the state's workforce development boards, technical schools, and universities to design workforce development strategies and encourage placement of management, engineering, and technical talent with Wisconsin firms."

This focus on northwestern Wisconsin has been underscored by the institutions collaborative approach to securing various program demand studies in engineering fields (conducted by the Education Advisory Board and Hanover Research), and these studies have reinforced the programmatic choices made by the partner institutions. In addition, existing program/industry partnerships and advisory boards have underscored that northwest Wisconsin businesses that are in critical need of engineering talent to sustain workforce and catalyze growth are currently unable to attract and retain the

necessary talent. As an example, Oxbo International, with a significant agricultural manufacturing firm located in Clear Lake, Wisconsin, finds it very difficult to recruit and retain engineering graduates who are willing to locate and stay in small town Wisconsin and retains strong connections with UW institutions for talent development. UW-Eau Claire, UW-River Falls, and UW-Stout, however, have a long history of drawing students from these small Wisconsin communities, who develop their intellectual and professional skills so that they can return to such communities and make a positive difference. Further, the institutions draw students to Wisconsin and connect them to Wisconsin businesses through internships and cooperative education programs.

Along with the connection to the region's small- and medium-sized businesses, the three institutions (and their students) benefit from the proximity to Minnesota's Twin Cities. The presence of large corporations with significant interests in agriculture, medical research and medical devices, computing and high technology, and manufacturing provide internship, cooperative learning, employment, and collaborative/applied research opportunities that can easily be connected to existing and new engineering and other STEM programs.

The common purpose of comprehensive universities is to serve a primarily regional population and to facilitate regional development. The national data is underscored by ACT's recent study that shows that the average student selects schools within fifty-one miles of their home. The national data is reinforced by institutional student data in Wisconsin. UW-River Falls, for example, draws 72% of its students from a one hundred mile radius of campus. Similarly, UW-Eau Claire draws nearly 50% of its students from Chippewa Valley, the Twin Cities, and Northern Minnesota regions alone, and UW-Stout draws 54% of its students from a one hundred mile radius of Menomonie. When one compares these data points to the fact that Platteville, WI is 220 miles (and more than four hours driving time) away from River Falls and that Milwaukee, WI is 269 miles and more than four hours from UW-Stout, it is clear that the region's students and economy cannot be served well by engineering programs further afield. Even the easternmost partner, UW-Eau Claire, is still nearly 180 miles away from UW-Madison. Indeed, the only nearby option for this region's high school graduates is to seek educational opportunities in Minnesota—thereby taking talent away from Wisconsin and committing these students to often much higher tuition costs at places like the University of Minnesota-Twin Cities (annual tuition and fees for $21,602 for engineering) and the University of St. Thomas (annual tuition and fees at $36,682).



UW-Madison	210 miles	2 hours, 22 minutes
UW-Platteville	212 miles	3 hours, 50 minutes
UW-Milwaukee	282 miles	4 hours, 24 minutes

Figure 1: Average distances and drive times from west central Wisconsin to existing UW System engineering programs

The Consortium can and will provide opportunities and it will deepen existing regional partnerships, such as the St. Croix Valley Educational Collaborative, that connect the universities to high schools and the technical colleges. Indeed, the regional cooperation can also readily partner with the UW-Barron County, which has an array of lower-division academic programming in engineering.

OBJECTIVES

The Northwest Wisconsin Engineering Consortium is focused on three objectives:

- Deliver cost-effective, ABET-accredited engineering education through an innovative, collaborative model that primarily serves the residents of northwestern Wisconsin and adjacent region;
- Produce an ongoing supply of highly qualified engineering talent to support economic growth and quality of life in the region;
- Create an economic environment attractive to the growth of engineering-related industries in the region through talent development and collaborative research and development.

THE PROPOSED MODEL

The University of Wisconsin-Eau Claire, the University of Wisconsin-River Falls, and the University of Wisconsin-Stout are the founding institutions for the Consortium. The Consortium will operate as a collaborative quasi-college of engineering for the partner universities; engaging our respective governance processes through the normal curriculum and academic program development, assessment, and audit/review processes. Students will be admitted to their home institution and will freely move between the academic programs offered by the Consortium partners, thereby taking advantage of each institution's strengths and foci. The Consortium will be coordinated by an inter-institutional committee of academic administrators and program faculty from each partner, with leadership for the committee rotating across the institutions. UW-Stout will designate the first committee chair and convene the group. The work of the committee will be supported by an external advisory board of industry partners and stakeholders (such as entities like Momentum West) who can provide (among other things) insight on student development, program goals, learning outcomes, industry sector needs, and economic development opportunities.

The Consortium will offer a flexible engineering student experience (not to be confused with the Flex Degree led by UW-Extension) based on similar models around the nation including several offered at The Massachusetts Institute of Technology (MIT) and recently highlighted in *Insider Higher Education* ("Engineering Your Degree", Inside Higher Ed, July 10, 2012). The new, more flexible ABET-accredited approach is based on the realization that today's engineers require a broader set of knowledge and skills to tackle the complex interdisciplinary problems of the world. Norman Fortenberry, executive director of the American Society for Engineering Education said, "There is a recognition within the engineering community that the challenges that engineers have to address require a greater deal of flexibility; a broader mix of skills than in the most traditional of traditional programs." Flexible engineering programs, like the ones at MIT, allow students more choice by reducing the number of required courses and letting students mix-and-match specialty areas within broad curricular areas. In addition, flexible engineering programs recognize the inherently inter-professional nature of today's engineering applications. Modern engineers must not only understand the richness and depth of their own specialty, but must also possess a meaningful understanding of how each specialty fits within a larger, more holistic picture.

Flexible engineering programs are particularly attractive to today's student who finds the restrictive, narrow focus of the traditional engineering programs artificially constraining. In fact, 2013 was the first year in which MIT's enrollment in the flexible mechanical engineering (ME) exceeded enrollments in the traditional ME program. ABET, the national accrediting body for engineering, has embraced the flexible engineering degree as a powerful tool for recruiting a broader range of students into the engineering disciplines. These programs are also particularly attractive to the Consortium's partners as they offer a natural extension of the Liberal Education and America's Promise (LEAP) initiative lead by the Association of American Colleges and Universities (AAC&U) and advocated by the University of Wisconsin System. The three partner institutions are aligned with the LEAP learning outcomes and with the broader ideals of an education that instills in students transferrable knowledge, skills, and values in support of life-long learning and engaged citizenship.

The Flexible Degree Array

The Consortium is designed as a fully cooperative, administratively lean entity with collaboration and a seamless student experience at its core. Students are admitted to specific institutions and engineering programs but, through a common core of courses, can move to another Consortium partner that possesses the specific engineering program desired. The three universities will provide dual-degree options (e.g., 3/2 Physics and Engineering degrees) across engineering and other STEM disciplines (such as the ones the UW comprehensives until recently had with UW-Madison). In addition, the partnering universities will seek articulations with two-year institutions to provide pathways for qualified students. Students will be admitted to any one of the partner institutions through its established admissions process. Students will satisfy the General Education (GE) and graduation requirements of their home institution. Students must be admitted to the program to register for any of the engineering curriculum. Once admitted, students enroll in either online or face-to-face pre-engineering/engineering core courses as well as engineering electives offered collectively by the partner institutions. These course offerings will be designed to ensure that students at each institution can travel easily, as necessary, between the three partner institutions without disrupting their daily class schedules. Students complete the core requirements for one of the available engineering emphases (The Consortium's institutions have entitlements to plan degree programs in Electrical Engineering, Chemical Engineering, Mechanical Engineering, Materials Science & Engineering, Environmental Engineering, and Agricultural Engineering). Students also enroll in elective curricula aligned with the core engineering emphases as illustrated in figure 2. In addition, a subset of the elective curricula will be specifically designed to allow participation by students from other core engineering emphases. For example, a mechanical engineering student could opt to take a materials science and engineering elective to broaden his/her experience, such as a course in nanomaterials or materials processing. Alternatively, a chemical or agricultural engineering student could choose an environmental engineering elective, such as a laboratory course in environmental chemistry or environmental engineering process. The ability to seamlessly integrate coursework from other engineering emphases highlights the inter-professional nature of the collaboration.

It is central to the cost-effective implementation of the curriculum that the expertise, facilities, employer relationships, and so forth of each partner institution be collectively available to all partner institutions. All partner institutions are fully committed to leveraging any and all available resources at the individual campuses to meet the collective needs of the Consortium and the students we serve.

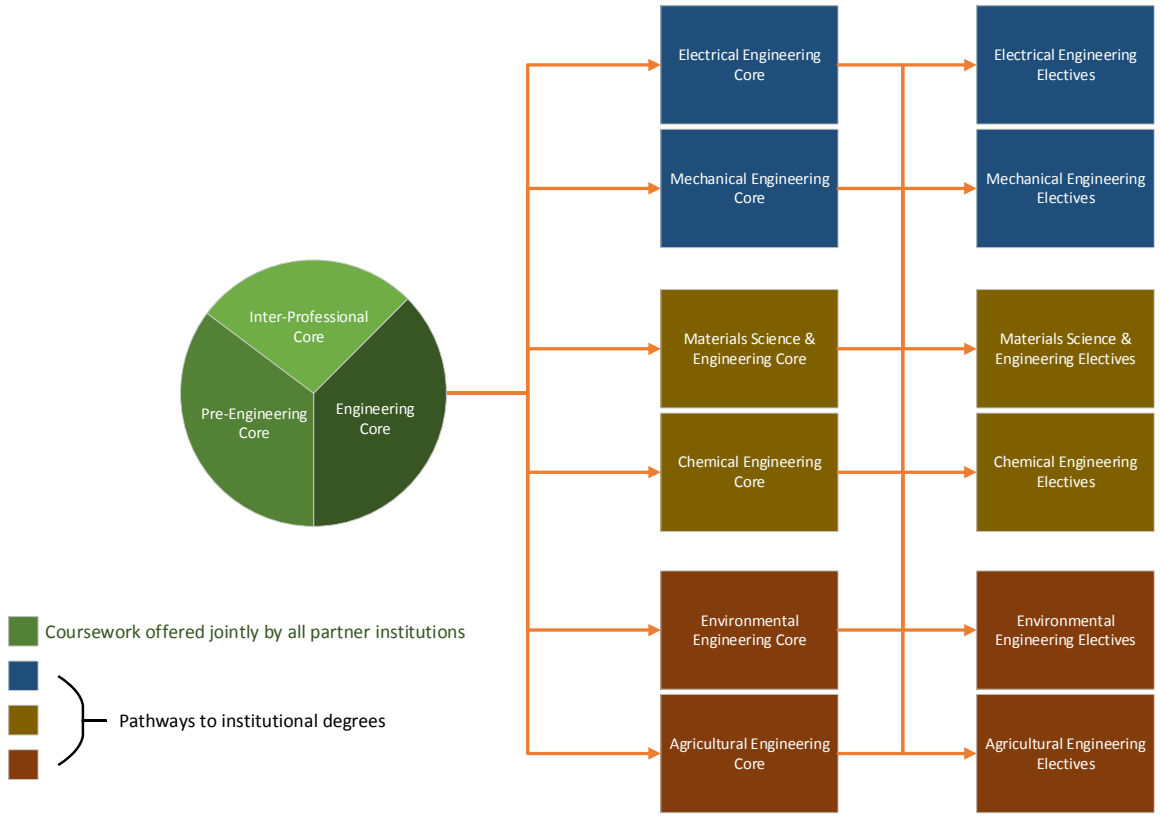


Figure 2: Flexible and Inter-Professional Engineering Curriculum

EDUCATIONAL PARTNERSHIPS

The Consortium will leverage already existing partnerships, such as the St. Croix Valley Educational Collaborative, that connect UW institutions with local and regional high schools and two-year institutions. An example is the effort at curricular crosswalks that involve high schools, technical colleges (CVTC and WITC), and UW-River Falls. The partnering institutions are also keen to collaborate with UW-Colleges, specifically through UW-Barron County, which offers lower-division science and engineering courses. There will also be an intentional effort to attract highly qualified and diverse students to Wisconsin by connecting with Twin Cities' schools, particularly those with a defined focus on STEM education. Bringing such talent to UW institutions and connecting them with Wisconsin business through academic training and internship experiences can increase and broaden the talent pool that will sustain the region's economic vibrancy.

These partnerships will also include focused and collaborative engagement with K-12 systems. The Consortium will identify high schools to link with and develop talent pipelines to the universities. Such efforts can include summer educational and transition programs, "college in the schools" offerings, and joint student recruitment efforts.

INDUSTRY PARTNERSHIPS

A cornerstone of the Northwest Wisconsin Engineering Consortium is to foster regional industry partnerships with the universities. The external advisory board will serve an important role but there are connections beyond, including connecting to regional economic development groups. The Consortium partners will host joint career fairs and industry events, the latter intended to connect business with university talent to help solve problems and meet challenges. Each university has units that are already connected to business and industry sectors, and it is planned that engineering faculty and students will be part of this engagement so that the learning, research, and professional development components are seamless and responsive to external needs.

ADDITIONAL OPERATIONAL CONSIDERATIONS

- **Transcription, Financial Aid, Reporting, and Awarding of the Degree**. While each engineering student will have a home institution (which generates the transcript and awards the degree) the "virtual" nature of the Consortium means that at certain times students may take classes on multiple campuses. The Financial Aid and Admissions offices will work in cooperation to assure that students are well supported and articulation and transfer/reverse transfer agreements are established as needed to assure that students can be mobile when and where they need to be. Each campus will award the Bachelor of Science degree (with the appropriate engineering major designated).

- **Future Expansion of Engineering Options**. Any and all additional engineering programs offered by the Consortium's partner institutions must be supported by all partner institutions prior to submission to the UW System and Board of Regents. Further, the partners will continue to explore joint and collaborative degree programs.

- **Accreditation, Assessment, Program Review**. An academic coordinating committee of the Consortium will help support the preparation of all documentation and information for accreditation (Higher Learning Commission and ABET), and the partner schools will offer assistance to each other. A joint Consortium curriculum committee with representatives from all partner institutions will examine assessment efforts, discuss curricular and program development, and crosswalk industry feedback to curricular development. Each partner will follow its own internal assessment, program audit and review, and be responsible for assessing student learning and continuous quality improvement efforts.

- **Program Support/Tuition and Fees**. The Consortium partners will seek to remain affordable and accessible to students, but also to develop a revenue base that is appropriate to supporting high-quality undergraduate engineering majors. This will be done through tuition and fees (similar to those approved for the Engineering Technology partnership in eastern Wisconsin) and through philanthropic support and grants/contracts. Philanthropic support will be central to the institutions' efforts to maintain affordability and support diversity and inclusiveness goals. The partnering institutions are not seeking additional state funds in the current biennium and do not, and will not, seek reallocation of resources from other UW System institutions to support the new programs. The Consortium may request future support through regular UW System processes (e.g. as part of the biennial budget Talent Infrastructure or Economic Development Incentive Grant process).

- **Northwest Wisconsin Engineering Consortium Advisory Board.** The Consortium will develop and regularly seek input from a joint Consortium Advisory Board comprised of industry and economic development representatives, as well as public school district representatives from the partner institutions' regions.

- **Outreach and Student Recruitment.** All partner institutions will collaborate on joint outreach activities including career fair, recruitment visits, and youth summer engineering camps. One goal will be to highlight the collective strengths of the partners and to provide a comprehensive regional appeal for engineering education in northwest Wisconsin. A second goal will be to deploy specific outreach efforts that target multicultural and disadvantaged students as well as women (notably underrepresented in a variety of engineering fields).

- **Consortium Identity.** A single, common website will be created and integrated into the web presence of each partner campus. To the students, the Consortium will look and feel like an academic college at the partner institutions.

SUMMARY

The **Northwest Wisconsin Engineering Consortium (NWEC)** is a collaborative response to UW System President Ray Cross' call for talent development and the UW System commitment to partner with external stakeholders to drive economic development. The vision for the Consortium would maximize collective impact and minimize the duplication and cost of engineering programs in northwest Wisconsin. For students, the partnering institutions would provide flexible, innovative and cost-effective pathways to completing engineering degrees at the respective universities. For the region, the Consortium would provide an enhanced talent pipeline and critical support for future economic development, and business retention and attraction.

Program Demand for a B.S. in Biosystems Engineering

Prepared for the University of Wisconsin-River

August 2013



In the following report, Hanover Research investigates the demand for a Bachelor of Science in Biosystems Engineering. The report consults degree completions data to measure student demand for biosystems engineering programs and examines labor market data to assess the employment outlook for program graduates. The report concludes with profiles of similar biosystems engineering programs currently offered at other higher education institutions.

HANOVER RESEARCH

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

In the modern era, society faces a diverse array of challenges, especially with regards to the environment, food, and biological processes. The role of engineers is to develop new technologies, processes, machines, programs, or tools to overcome these challenges. The emerging multidisciplinary field of biosystems engineering applies engineering tools and concepts to a wide variety of important problems. In many cases, biosystems engineering programs have evolved from agricultural engineering programs to address issues ranging from food processing to environmental degradation. Biosystems engineering programs also may incorporate renewable bioenergy, natural resources, biomedical engineering, and structures. This multidisciplinary scope helps prepare graduates for work in multidisciplinary teams, but it also impedes classification and categorization. This report will assess the demand for a Bachelor of Science in Biosystems Engineering from students and employers, in addition to profiling similar programs in the region.

The report structure is as follows:

- **Section I: Student Demand for a Biosystems Engineering Program** utilizes national and state-level degree completion data to assess the potential demand for a new biosystems engineering program. Completions data review multiple degree titles to better understand trends relevant to biosystems engineering, which is both multidisciplinary and uncommon.
- **Section II: Labor Market Demand for Biosystems Engineering Graduates** uses employment projections data from the Bureau of Labor Statistics and the Wisconsin Department of Workforce Development to analyze the professional outlook for biosystems engineering graduates from 2010 to 2020. Additionally, the section consults the Occupational Outlook Handbook and recent *Forbes* articles that provide additional perspective on career opportunities for employees with a Bachelor of Science in Biosystems Engineering.
- **Section III: Profiles of Biosystems Engineering Programs** examines four bachelor-level biosystems engineering programs in Wisconsin and other states in the region. The section also profiles the environmental engineering program at the University of Wisconsin – Platteville, given its potential to compete with a biosystems engineering program at the University of Wisconsin – River Falls. Within each profile, the report reviews the structure, cost, degree completions, and curriculum of the programs, in addition to information regarding graduates' occupations and salaries, when available.

KEY FINDINGS

- **Evidence suggests growth in biosystems engineering and similar programs, with high demand in environmental and biomedical areas.** Degree completions in biosystems engineering and related programs have been rising in the past five years, especially for environmental and biomedical engineering. Furthermore, many biosystems engineering programs have emerged in the past decade, often from other engineering programs. The National Center for Education Statistics also recently created a new degree category for biological and biosystems engineering in 2010.
- **Related career fields are small but growing quickly, with the highest growth in environmental and biomedical emphases.** Biomedical engineering is in high demand as a profession and as a major, with the profession expected to grow faster than almost any other profession over the course of the decade. Environmental and biomedical engineers are in high demand both regionally and nationally.
- **Most biosystems engineering programs are highly interdisciplinary, with an array of options for specializing in very different areas.** Of around 20 undergraduate programs closely related to biosystems engineering in the United States, every program either allows or requires students to develop a more specific area of specialty. Some of these specialties are rigid, while other institutions allow students to create their own area of focus.
- **The cost of these programs varies among institutions, but these programs are consistently offered for a similar price to other engineering programs at the institution.** In part due to the differences among the institutions studies, costs for these programs vary from $30,000 over the course of four years to $150,000, in addition to room and board. However, these institutions consistently offer biosystems engineering for a price similar to other engineering programs.
- **All biosystems engineering programs listed in the appendix present somewhat similar curricula.** Core courses begin with a thorough background in advanced calculus and differential equations, in addition to biology and chemistry. Most programs involve several courses in physics, including thermodynamics and mechanics. Additionally, requirements include basic and advanced engineering courses, including programming and design. Program- and concentration-specific courses include a variety of topics in biomaterials, environmental engineering, food engineering, biomedical engineering, instrumentation, agricultural engineering, and others. All students complete a senior design project.

SECTION I: STUDENT DEMAND FOR A BIOSYSTEMS ENGINEERING PROGRAM

This section investigates potential student demand for a new biosystems engineering undergraduate program through an analysis of degree completions trends.

DEGREE COMPLETIONS METHODOLOGY

The American Society of Agricultural and Biological Engineers (ASABE) is the main professional organization affiliated with the profession. ASABE notes how the profession of agricultural engineering has evolved to include engineering in the context of biosystems and biological processes, which has created a small array of inter-related disciplines.[1] As a result, nomenclature for biosystems engineering is often inconsistent, and many universities formerly classified or currently classify these programs as agricultural engineering or another related field, such as environmental engineering. The Institute of Biological Engineering also links biosystems engineering with biomedical engineering.[2] As a result, this report will analyze degree completions from these related fields, in addition to degree completions in biological and biosystems engineering. Section II will address the nuances and nomenclature of the profession in greater detail.

This report estimates student demand for the potential academic program by analyzing changes in the number of degrees completed in four academic disciplines. This method, while indirect, allows for an approximation of the demand for a range of similar academic disciplines. The National Center for Education Statistics (NCES) collects and publishes completions data for all higher education institutions within the United States in the Integrated Postsecondary Education Data System (IPEDS).[3] It is important to note that the data are self-reported by these institutions, and there may be inconsistencies in the classification of programs.

The NCES classifies academic disciplines according to a six-digit taxonomic system, which it terms the Classification of Instructional Programs (CIP). Institutions classify all of the completions data that they submit to IPEDS according to degree level (e.g., associate's degree, bachelor's degree) and CIP category. The CIP system does have a distinct category and code for biological and biosystems engineering (CIP 14.4501). However, this category was recently created and implemented in 2010; therefore, this report also examines completions data from the fields of agricultural engineering (CIP 14.0301), bioengineering and biomedical engineering (CIP 14.0501), and environmental and environmental health engineering (CIP 14.1401). Figure 1.1 displays descriptions for each of these disciplines.

[1] "Agricultural and Biological Engineering within ASABE - Definition." ASABE. http://www.asabe.org/about-us/about-the-profession/abe-defined.aspx
[2] "Biological Engineering Links." IBE. http://www.ibe.org/biological-engineering-links.html
[3] "IPEDS Data Center." National Center for Education Statistics. http://nces.ed.gov/ipeds/datacenter/

Figure 1.1: Descriptions of Biosystems Engineering and Related Disciplines

CIP CODE	FIELD OF STUDY	DESCRIPTION
14.4501	Biological/Biosystems Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and management of biological systems; and includes applications to biology, biochemistry, ecology, and microbiology. Includes instruction in organic chemistry; microbiology; biochemistry; chemical, biological, biochemical, and process engineering; thermodynamics; process control; kinetics and reactor design; electric circuits; biosystem modeling; and bioelectronics and instrumentation. Examples of degree titles: Biological Engineering, Biosystems Engineering, Biological Systems Engineering, Biomass Engineering, and Biological/Biosystems Engineering[4]
14.0301	Agricultural Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems, equipment and facilities for production, processing, storage, handling, distribution and use of food, feed, and fiber. Includes applications to aquaculture, forestry, human and natural resources. Examples of degree titles: Bioprocessing Engineering, Food Engineering, and Soil Engineering[5]
14.0501	Bioengineering and Biomedical Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of biomedical and health systems and products such as integrated biomedical systems, instrumentation, medical information systems, artificial organs and prostheses, and health management and care delivery systems. Examples of degree titles: Cell and Tissue Engineering, Neural Engineering, Biomaterials Engineering, and Biomechanics[6]
14.1401	Environmental/ Environmental Health Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for controlling contained living environments and for monitoring and controlling factors in the external natural environment, including pollution control, waste and hazardous material disposal, health and safety protection, conservation, life support, and requirements for protection of special materials and related work environments. Examples of degree titles: Environmental Engineering and Environmental Management Engineering[7]

Source: NCES

The tables in this section display the total number of completions for the academic years of 2007-08 through 2011-12. In addition, the tables report the compound annual growth rate (CAGR), average annual change, and standard deviation of annual changes. CAGR is a

[4] "Detail for CIP Code 14.4501." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=89351
[5] "Detail for CIP Code 14.0301." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88202
[6] "Detail for CIP Code 14.0501." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88206
[7] "Detail for CIP Code 14.1401." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88229

measure of annual growth over an extended period of time that is not affected by volatility in individual year-on-year growth changes. CAGR illustrates the yearly growth that would occur if growth throughout the period had been constant. The second measure, the average annual change, presents the average number by which completions changed annually. This figure indicates the raw magnitude of growth, which the CAGR does not measure. Lastly, the standard deviation of annual changes measures the volatility of annual growth. Larger standard deviations of annual changes indicate less consistent growth from one year to the next. Inconsistent growth may indicate annual fluctuations or accelerating growth or decline in the number of degrees awarded in a particular field.

NATIONAL COMPLETION TRENDS

National degree completions trends indicate that **demand for bachelor's degrees in biosystems engineering and related fields is increasing**. Degree completions grew most rapidly in bioengineering and biomedical engineering, with a CAGR of 21.7 percent from 2008 through 2012. Completions in environmental and environmental health engineering grew nearly as rapidly and more consistently, with a CAGR of 18.7 percent during the same period. It is clear that biological and biosystems engineering is a new but emerging and promising field, with fewer than 100 bachelor's degree completions throughout the country in any year. Despite the current size, related fields are growing, which lends credibility to the trend of consistent annual growth at near 10 percent. Figure 1.2 displays the degree completions information.

While a biosystems engineering program could have a variety of emphases, it is worth noting the areas of high demand. New programs in biological and biosystems engineering may attract more students for concentrations in the environment than in agriculture, according to available information. The majority of biosystems engineering programs allow students to concentrate in one of many areas, including agricultural engineering, food engineering, environmental engineering, renewable energy engineering, and natural resource engineering. Demand appears to be highest for environmental engineering and related concentrations, such as renewable energy and natural resources.

Bioengineering and biomedical engineering degree completions accelerated dramatically from 2011 to 2012, but it is difficult to gauge the sustainability of that growth. For biological and biosystems engineering, the computations only analyze the period from 2010 to 2012, as this is the only period during which there is data available for that CIP code.

Figure 1.2: Bachelor's Degree Completions in Biosystems Engineering and Related Disciplines

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Dev. of Annual Changes
Agricultural Engineering	697	779	836	889	972	8.7%	68.8	13.8
Environmental/Environmental Health Engineering	512	598	662	763	1,105	18.7%	125.8	74.1
Bioengineering and Biomedical Engineering	2,069	2,375	2,419	2,486	4,537	21.7%	617	834
Biological/Biosystems Engineering	-	-	73	79	88	9.8%	7.5	1.5
Total	*3,278*	*3,752*	*3,990*	*4,217*	*6,612*	*19.0%*	*833.5*	*907*

Source: IPEDS

For the five institutions reporting degree conferrals specifically for the biological and biosystems engineering CIP code, Figure 1.3 illustrates the trends in degree completions from 2010 through 2012. Figure 1.3 only includes degree conferrals for CIP code 14.4501. Three of the programs appear to be experiencing no growth. The biological engineering program at the University of Georgia, on the other hand, appears to have grown substantially from 2010 to 2012. In general, the novelty of the CIP code and biosystems engineering programs makes extracting trends and predicting future growth difficult and imprecise.

In more detailed IPEDS data, Auburn University and the University of Arizona demonstrate clear evidence of the program changing CIP codes in 2010 from agricultural engineering to biological and biosystems engineering. The University of Nebraska – Lincoln stopped reporting bioengineering and biomedical engineering with the class of 2009 and begins reporting biological and biosystems engineering conferrals in 2010.

Figure 1.3: Degree Completions in Biological and Biosystems Engineering by Program

Institution	2010	2011	2012	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Auburn University	20	14	18	-5.1%	-1	5
University of Arizona	20	19	16	-10.6%	-2	1
University of Georgia	9	14	17	37.4%	4	1
University of Idaho	-	-	9	-	-	-
University of Nebraska-Lincoln	24	32	28	8.0%	2	6
Total	***73***	***79***	***88***	***9.8%***	***7.5***	***1.5***

Source: IPEDS

DEGREE COMPLETIONS IN WISCONSIN

In the state of Wisconsin, there have not been any degree completions categorized within the field of biological and biosystems engineering. Given the evidence to suggest that demand for degrees in related fields is rising, the lack of biosystems engineering conferrals in Wisconsin may present an opportunity for the University of Wisconsin – River Falls to provide a program for a niche market. Figure 1.4 presents the trends in degree conferrals in related fields.

It appears that demand for undergraduate degree programs related to biosystems engineering are growing in popularity throughout the state. At the bachelor's degree level, only Marquette University and the University of Wisconsin – Platteville have conferred degrees for environmental and environmental health engineering. Marquette University, the Milwaukee School of Engineering, and the University of Wisconsin – Madison have conferred degrees for bioengineering and biomedical engineering. Furthermore, only the University of Wisconsin – Madison has conferred bachelor's degrees in agricultural engineering. The University of Wisconsin – Madison offers a degree program for biological systems engineering within the College of Agricultural and Life Sciences.[8]

Figure 1.4: Wisconsin Bachelor's Degree Completions in Biosystems Engineering and Related Disciplines

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Dev. of Annual Changes
Agricultural Engineering	11	24	17	20	19	14.6%	2	7.3
Environmental/Environmental Health Engineering	11	14	15	15	25	22.8%	3.5	3.9
Bioengineering and Biomedical Engineering	59	80	92	87	147	25.6%	22	24
Biological/Biosystems Engineering	-	-	-	-	-	-	-	-
Total	*81*	*118*	*124*	*122*	*191*	*24.0%*	*27.5*	*28*

Source: IPEDS

[8] "Welcome to Biological Systems Engineering!" University of Wisconsin – Madison. http://bse.wisc.edu/

SECTION II: LABOR MARKET DEMAND FOR BIOSYSTEMS ENGINEERING GRADUATES

This section examines the employment outlook for graduates of the proposed biosystems engineering program. The section provides Bureau of Labor Statistics (BLS) and state employment projections, supplemented by career information from the BLS and *Forbes*.

METHODOLOGY

The U.S. Bureau of Labor Statistics (BLS) provides labor market projections for a wide variety of occupations. The projections require categorization of occupations, with each BLS occupation receiving a unique SOC code and title. While this enables clear market projections, biosystems engineering is a multi-disciplinary program, and there are multiple relevant occupations for the program. The NCES provides an instrument for finding BLS-recognized occupations for the fields of study that the NCES recognizes. Given the focus of the proposed program, the most relevant identified occupations within the categorization scheme of the Bureau of Labor Statistics include the following:

- Agricultural Engineers (SOC 17-2021),
- Biomedical Engineers (SOC 17-2031),
- Environmental Engineers (SOC 17-2081), and
- Health and Safety Engineers, except Mining Safety Engineers and Inspectors (SOC 17-2111).

The Institute of Biological Engineering suggests that biological engineers would best fit in the BLS categories for agricultural, biomedical, chemical, and environmental engineers.[9] In a job setting, engineers work on teams, and the specific job title is often not very relevant. The most important aspect is the skill set, and the titles are often difficult to match with new programs that address multidisciplinary skills, such as biological or biosystems engineering.

The report will examine the BLS projections for agricultural engineers, biomedical engineers, environmental engineers, and health and safety engineers, since these are the categories that best fit the profession. This section will also provide further information on labor market conditions specifically for those in the occupations of agricultural engineer, environmental engineer, and biomedical engineer.

NATIONAL LABOR MARKET PROJECTIONS

Figure 2.1 presents the growth trends for agricultural engineers, biomedical engineers, environmental engineers, and health and safety engineers for the period from 2010 to

[9] "Job Market in Biological Engineering." Institute of Biological Engineering. http://blog.ibe.org/?p=187

2020. Given that 14.3 percent is the national average for job growth, agricultural engineering is not a rapidly growing profession. However, environmental engineering is projected to grow nearly 50 percent faster than the national average. Furthermore, BLS projections indicate that **the biomedical engineering profession will be one of the fastest-growing careers in the United States**.

Figure 2.1: Employment Projections for Occupations Related to Biosystems Engineering (Numbers in Thousands)

SOC Code	Title	Number		Change 2010-20		Job Openings due to Growth and Replacement
		2010	2020	Number	Percent	
17-2021	Agricultural Engineers	2.7	2.9	0.2	9.1	0.8
17-2031	Biomedical Engineers	15.7	25.4	9.7	61.7	13.1
17-2081	Environmental Engineers	51.4	62.7	11.3	21.9	22.6
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	23.7	26.8	3.1	13.0	8.2

Source: BLS

Regional Labor Market Projections

Due to the location of the University of Wisconsin – River Falls in the vicinity of Minneapolis and St. Paul, this sub-section will address both state labor market projections in Wisconsin and labor market projections for the Twin Cities region in Minnesota.

Wisconsin

The labor market projections from the Wisconsin Department of Workforce Development closely mirror the national trends for environmental engineers and health and safety engineers. The specific occupation title of agricultural engineer, however, is a very small field with no growth expected. Over the course of the decade from 2010 to 2020, the department projects only 20 job openings in the state, entirely due to the replacement of retiring workers. The outlook for environmental engineers, on the other hand, is very positive. The field is much larger and projected to grow at nearly twice the average rate in the state of 11.9 percent. **While the biomedical engineering profession is projected to grow very rapidly in Wisconsin, the field is still quite small within the state**. On average, there will be 62 positions available per year among the four professions in Figure 2.2.

Figure 2.2: Wisconsin Employment Projections for Occupations Related to Biosystems Engineering

SOC Code	Title	Number		Change 2010-20		Job Openings due to Growth and Replacement
		2010	2020	Number	Percent	
17-2021	Agricultural Engineers	70	70	0	0.0	20
17-2031	Biomedical Engineers	170	260	90	52.9	130
17-2081	Environmental Engineers	870	1,070	200	23.0	390

SOC Code	Title	Number		Change 2010-20		Job Openings due to Growth and Replacement
		2010	2020	Number	Percent	
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	220	250	30	13.6	80

Source: Wisconsin Department of Workforce Development[10]

Minneapolis – St. Paul

The Minnesota Department of Employment and Economic Development provides regional occupation projections for geographic segments of the state. Given the proximity of River Falls to the Twin Cities, this report provides projections for that region. Based on these projections, **the profession with the greatest opportunities in the metropolitan area will be biomedical engineering**. While growth in demand for agricultural engineers is slow, the overall outlook for occupations related to biosystems engineering in the area is positive. Across the four professions in Figure 2.3, there will be an average of 82 positions available each year.

Figure 2.3: Minneapolis-St. Paul Employment Projections for Occupations Related to Biosystems Engineering

SOC Code	Title	Number		Change 2010-20		Job Openings due to Growth and Replacement
		2010	2020	Number	Percent	
17-2021	Agricultural Engineers	23	25	2	8.7	-
17-2031	Biomedical Engineers	730	1,185	455	62.3	620
17-2081	Environmental Engineers	321	366	45	14.0	110
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	213	257	44	20.7	90

Source: Minnesota Department of Employment and Economic Development[11]

Occupational Outlook for Related Fields

According to the BLS Occupational Outlook Handbook, the 2010 median annual salary for agricultural engineers was $71,090.[12] BLS considers this occupation category to include biological and agricultural engineers, with responsibilities and areas of focus including the application of technological advances and engineering techniques to farming, pollution control, and biomass production. Additional specialties include power systems and machinery design, structural and environmental engineering, and food and bioprocess

[10] "Occupation Projections." Wisconsin Department of Workforce Development. http://worknet.wisconsin.gov/worknet/downloads.aspx?menuselection=da&pgm=occprj

[11] "Employment Outlook: Seven County Mpls-St Paul, MN." Minnesota Department of Employment and Economic Development. http://www.positivelyminnesota.com/apps/lmi/projections/Results.aspx?dataset=1&geog=2709TC0000&code=172021,172081,172111

[12] "Agricultural Engineers." BLS Occupational Outlook Handbook. http://www.bls.gov/ooh/architecture-and-engineering/agricultural-engineers.htm

engineering. According to the BLS, these professionals often work in research and development, management, production, or sales.

The BLS Occupational Outlook Handbook indicates that the 2010 median annual salary for environmental engineers was $78,740.[13] Environmental engineers work on recycling, waste disposal, public health, the control of water and air pollution. Internationally, they may work on the issues of safe drinking water, climate change, and sustainability. Their work often involves evaluating hazards and advising on methods to treat and contain such hazards. Some environmental engineers focus on minimizing the effects of acid rain, climate change, automobile emissions, and ozone depletion.

For 2010, the BLS Occupational Outlook Handbook notes the median salary for biomedical engineers as $81,540.[14] Biomedical engineers design systems and products, including artificial replacements for body parts and machines for diagnosing medical problems. In addition, biomedical engineers often design software and electrical systems to operate medical equipment. Specializations within the profession include bioinstrumentation, biomaterials, biomechanics, clinical engineering, medical imaging, orthopedic surgery, rehabilitation engineering, systems physiology, and cellular, tissue, and genetic engineering.

The median annual wage in Wisconsin for agricultural engineers was $75,690 in 2010.[15] For environmental engineers, the median annual wage was $74,290. For biomedical engineers, the median wage in Wisconsin was $79,610 in 2010.

***Forbes* notes that CareerCast recently ranked biomedical engineering as the second-best profession for 2013**, behind actuaries.[16] This is mainly for the growth opportunities and salary potential. Another recent *Forbes* article also notes that the factors effecting agriculture and the demand for food will lead to an increased demand for agricultural engineers.[17] As a result, the article lists Agricultural Engineering as one of the best majors for the class of 2022 to study, given the labor market demand. Another key career track, according to the article, will include biotechnology.

[13] "Environmental Engineers." BLS Occupational Outlook Handbook. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineers.htm
[14] "Biomedical Engineers." BLS Occupational Outlook Handbook. http://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm
[15] "Occupation Projections," Op. cit.
[16] Smith, J. "The Best and Worst Jobs for 2013." *Forbes*. April 23, 2013. http://www.forbes.com/sites/jacquelynsmith/2013/04/23/the-best-and-worst-jobs-for-2013/2/
[17] Knapp, A. "The Top Majors for the Class of 2022." *Forbes*. May 9, 2012. http://www.forbes.com/sites/alexknapp/2012/05/09/the-top-majors-for-the-class-of-2022/

SECTION III: PROFILES OF BIOSYSTEMS ENGINEERING PROGRAMS

In the United States, there are slightly more than 20 established programs in biosystems engineering and closely related fields. Figure A.1 in the appendix presents the key characteristics of these programs. This section profiles four programs in biosystems engineering. In addition, this section profiles the environmental engineering program at the University of Wisconsin – Platteville, given its potential to compete with a biosystems engineering program at the University of Wisconsin – River Falls.

THE UNIVERSITY OF MINNESOTA – TWIN CITIES (MINNEAPOLIS, MN)

The University of Minnesota offers a **Bachelor of Science in Bioproducts and Biosystems Engineering** (BBE) through the Department of Bioproducts and Biosystems Engineering.[18] The College of Food, Agricultural and Natural Resource Sciences (CFANS) and the College of Science and Engineering (CSE) jointly run the department, but students in the program graduate from the CSE. Students in CFANS may enroll during the freshman year as a Pre-Bioproducts and Biosystems Engineering students and transfer to CSE in their junior year. Students in the program choose from one of three areas of focus: Bioproducts Engineering (BPE), Environmental and Ecological Engineering (EEE), or Food Engineering (FE).

Tuition and Fees

Tuition for the 2013-2014 academic year at the University of Minnesota is $6,030 per semester for Minnesota residents and $9,155 per semester for students from out of state.[19] The College of Science and Engineering also charges a $300 college fee, and many courses within the major include course fees ranging from $15 to $110 per course.[20] The average cost of the program per year in addition to tuition would total approximately $800. Tuition and fees for four years would amount to about $55,000 for Minnesota residents and $80,000 for out-of-state students.

Degree Completions

According to the program website, **there are approximately 150 students in the program**.[21] The university considers the program to be strong in the wake of a 2006 consolidation that brought biosystems engineering and bioproducts engineering into one department.[22]

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[18] "About BBE." University of Minnesota. http://www.bbe.umn.edu/AboutBBE/index.htm

[19] "2013-2014 Undergraduate Tuition & Fees: Twin Cities Campus." University of Minnesota. http://www.onestop.umn.edu/pdf/tuition_ugrad_2013-2014.pdf

[20] [1] Ibid.
[2] "Course Fees." University of Minnesota. http://onestop.umn.edu/finances/costs_and_tuition/fees/course_fees.php

[21] "About BBE," Op. cit.

Curriculum

The University of Minnesota provides the degree requirements for a Bachelor of Science in BBE. Figure 3.1 presents these requirements, including the requirements for admission to the program. Students typically have a pre-major status as freshmen while they complete the requirements for admission to the program.

Figure 3.1: Degree Requirements for BBE Undergraduates at the University of Minnesota

Requirements for Admission to the Program	Program Requirements	
▪ Calculus I, II ▪ Multivariable Calculus ▪ General Biology ▪ Chemical Principles I, II* ▪ Introductory Physics for Science and Engineering I, II ▪ Mechanics and Structural Design	▪ Bioproducts and Biosystems Engineering Orientation ▪ Introduction to Engineering Design ▪ Engineering Principles of Molecular and Cellular Processes ▪ Material and Energy Balances in Biological Systems ▪ Biological and Environmental Thermodynamics	▪ Transport in Biological Processes I, II ▪ Process Control and Instrumentation** ▪ Introduction to Bio-based Materials Science ▪ Introduction to Probability and Statistics ▪ Linear Algebra and Differential Equations ▪ BBE Capstone Design**

*includes laboratory section **writing intensive course
Source: University catalog[23]

Figures 3.2, 3.3, and 3.4 present the curriculum requirements for the various focus areas within the major. Many of these areas have overlap, and the actual possibilities for focus area curricula are quite extensive. The tables are intended merely to provide a general idea of what coursework is involved for each concentration.

Figure 3.2: Curriculum Requirements for the Bioproducts Engineering Concentration within the BBE Program at the University of Minnesota

Bioproducts Engineering	
Core courses: ▪ Organic Chemistry ▪ Introduction to Thermodynamics, Kinetics, and Statistical Mechanics ▪ Bio-based Products Engineering Lab I, II ▪ Chemistry of Biomass and Biomass Conversion to Fuels and Products ▪ Bioproducts Engineering ▪ Biorenewable Resources ▪ Applied Surface and Colloid Science ▪ Biological Process Engineering	▪ Six credits of technical electives in BBE *AND* ▪ Six credits of technical electives covering: ▪ Chemistry ▪ Biochemistry ▪ Materials science ▪ Mechanical engineering ▪ Civil engineering ▪ Industrial engineering

Source: University catalog[24]

[22] "The First Century Forward: Bioproducts and Biosystems Engineering at the University of Minnesota 1909-2009." University of Minnesota. http://www.bbe.umn.edu/prod/groups/cfans/@pub/@cfans/@bbe/documents/article/cfans_article_288498.pdf

[23] "University Catalogs: Bioproducts and Biosystems Engineering B.B.E." University of Minnesota. https://webapps-prd.oit.umn.edu/pcas/viewCatalogProgram.do?programID=3124&strm=1129&campus=UMNTC

Figure 3.3: Curriculum Requirements for the Food Engineering Concentration within the BBE Program at the University of Minnesota

FOOD ENGINEERING		
Core courses: ▪ Bio-based Products Engineering Lab I ▪ Biochemistry ▪ Food Process Engineering ▪ General Microbiology with Laboratory ▪ Organic Chemistry ▪ Biological Process Engineering	Three of the following: ▪ Bioproducts Engineering* ▪ Sustainable Waste Management* ▪ Renewable Energy Technologies* ▪ Financial Decision Making* ▪ Engineering Safety*	At least three of the following: ▪ Bioproducts Engineering* ▪ Sustainable Waste Management* ▪ Renewable Energy Technologies* ▪ Financial Decision Making* ▪ Engineering Safety* ▪ Chemistry of Biomass and Biomass Conversion to Fuels and Products ▪ Food Science and Nutrition courses

*may not be double-counted
Source: University catalog[25]

Figure 3.4: Curriculum Requirements for the Environmental and Ecological Engineering Concentration within the BBE Program at the University of Minnesota

ENVIRONMENTAL AND ECOLOGICAL ENGINEERING			
Core courses: ▪ Biochemistry for the Agricultural and Health Sciences ▪ Ecological Engineering Principles	Three of the following four courses: ▪ Ecological Engineering Design ▪ Sustainable Waste Management Engineering ▪ Assessment and Diagnosis of Impaired Waters ▪ Watershed Engineering	At least three of the following: ▪ Plant, Algal, and Fungal Diversity and Adaptation ▪ Ecology ▪ Limnology ▪ GIS for Natural Resources ▪ Plant Nutrients in the Environment ▪ Environmental Sciences, Policy, and Management courses	At least four of the following: ▪ Bioproducts Engineering ▪ Biological Process Engineering ▪ Food Process Engineering ▪ Renewable Energy Technology ▪ Surveying and Mapping ▪ Civil Engineering Materials ▪ Environmental Engineering ▪ Groundwater Mechanics ▪ Waste and Wastewater Treatment ▪ Hydraulic Structures ▪ Open Channel Hydraulics ▪ Solid Hazardous Wastes ▪ Environmental Remediation Technology ▪ Engineering Safety

Source: University catalog[26]

Graduates

The CSE provides information on occupations for graduates broken down by area of focus. Figure 3.5 presents some of the occupations of graduates of the program, in addition to information on starting salaries and job placement.

[24] Ibid.
[25] Ibid.
[26] Ibid.

Figure 3.5: Career Opportunities for Graduates from the University of Minnesota's BBE Program

Bioproducts Engineering	Environmental and Ecological Engineering	Food Engineering
▪ Bioproducts Engineer ▪ Process Engineer ▪ Bioprocess Engineer ▪ Product Design Engineer ▪ Engineering Consultant ▪ Plant Manager ▪ Production Engineer ▪ Technical Sales Engineer ▪ Product Development Engineer	▪ Environmental Engineer ▪ Ecological Engineer ▪ Biosystems Engineer ▪ Water Resources Engineer ▪ Resource Conservation Engineer ▪ Project Manager ▪ Project Engineer ▪ Engineering Consultant	▪ Food Engineer ▪ Process Engineer ▪ Bioprocess Engineer ▪ Product Design Engineer ▪ Engineering Consultant ▪ Plant Manager ▪ Research Engineer
Salary and Placement		
Starting salaries between $55,000 and $70,000, nearly 100% placement for students taking advantage of opportunities	Starting salaries between $45,000 and $60,000, outstanding placement for students taking advantage of opportunities	Starting salaries between $45,000 and $60,000, nearly 100% placement for students taking advantage of opportunities

Source: Program brochures[27]

University of Illinois at Urbana-Champaign (Urbana and Champaign, IL)

The University of Illinois at Urbana-Champaign (Illinois) offers a four-year program for a **Bachelor of Science in Agricultural and Biological Engineering** (ABE) from the College of Engineering, in addition to a five-year program that combines the ABE curriculum with agricultural science.[28] The curriculum changed for the 2010 catalog, from a major with four specializations to a major with two concentrations and seven specializations. Students are also able to create other areas of specialization with the available course offerings. Figure 3.6 illustrates the current breakdown of the program's concentrations.

[27] [1] "Bioproducts Engineering." University of Minnesota. http://www.bbe.umn.edu/prod/groups/cfans/@pub/@cfans/@bbe/documents/asset/cfans_asset_405656.pdf
[2] "Environmental and Ecological Engineering." University of Minnesota. http://www.bbe.umn.edu/prod/groups/cfans/@pub/@cfans/@bbe/documents/asset/cfans_asset_405657.pdf
[3] "Food Engineering." University of Minnesota. http://www.bbe.umn.edu/prod/groups/cfans/@pub/@cfans/@bbe/documents/asset/cfans_asset_405659.pdf

[28] "Undergraduate Programs." University of Illinois at Urbana-Champaign. http://abe.illinois.edu/undergrad_programs

Figure 3.6: Breakdown of Specializations for the Bachelor of Science in Agricultural and Biological Engineering at Illinois

AGRICULTURAL ENGINEERING	BIOLOGICAL ENGINEERING CONCENTRATION
▪ Renewable Energy Systems ▪ Off-Road Equipment Engineering ▪ Soil and Water Resources Engineering	▪ Bioenvironmental Engineering ▪ Ecological Engineering ▪ Food and Bioprocess Engineering ▪ Nanoscale Biological Engineering

Source: Department of Agricultural and Biological Engineering[29]

***U.S. News and World Report* has repeatedly ranked the program at Illinois as either first or tied for first among agricultural and biological engineering programs.**[30] The head of the department has cited the quality of faculty, staff, and students as the main reason for these continually high rankings. This includes hiring new faculty members in new areas, such as bionanotechnology, bioinstrumentation, and biosystems analysis.

Tuition and Fees

Tuition at Illinois varies based on residency. Undergraduate Illinois residents majoring in engineering pay $16,754 per year, while non-residents pay $31,136.[31] There are additional fees amounting to $3,424, and room and board costs $10,636 per year.[32]

Degree Completions

Illinois does not report any degree completions in environmental engineering or biological and biosystems engineering, according to IPEDS. Figure 3.7 displays the trends in degree conferrals from the university for agricultural engineering and for bioengineering and biomedical engineering. **The program appears to have grown extensively since 2008, and this growth suggests that the program is strong**. The recent move to increase the size of the faculty and the variety of specializations available corroborates this evidence. However, growth in completions has been inconsistent. The growth in bioengineering and biomedical engineering degree completions occurred almost entirely between 2011 and 2012.

[29] Ibid.
[30] [1] "Biological/Agricultural Rankings." *U.S. News and World Report*. http://colleges.usnews.rankingsandreviews.com/best-colleges/rankings/engineering-doctorate-biological-agricultural
[2] "ABE Undergrad Program Remains Best in the Nation." University of Illinois at Urbana-Champaign. Aguust 19, 2010. http://abe.illinois.edu/ABE_Rank
[31] "2013-2014 Academic Year Undergrad Engineering Tuition Rate." University of Illinois at Urbana-Champaign. http://registrar.illinois.edu/financial/tuition_1314/AY/ugrad_engineering.html
[32] " Undergraduate Resident 2013-2014 Cost." University of Illinois at Urbana-Champaign. http://www.osfa.illinois.edu/cost/undergrad/res_1314.html

Figure 3.7: Illinois Bachelor's Degree Completions in Related Fields

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Agricultural Engineering	19	17	59	75	74	40.5%	13.75	17.8
Bioengineering and Biomedical Engineering	14	17	16	15	40	30.0%	6.5	10.8

Source: IPEDS

Curriculum

Figure 3.8 presents the course sequence for each concentration in parallel. The majority of the curriculum is the same across the concentrations, and students use the elective courses to create their areas of specialization. While only four courses definitively separate the concentrations, the elective space which is illustrated as shared is where most students will tailor the curriculum.

Figure 3.8: Course Sequences for the Bachelor of Science in Agricultural and Biological Engineering at Illinois

First Year	
Intro to Agricultural and Biological Engineering	
General Chemistry I, II*	
Engineering Orientation	
Engineering Graphics and Design	
Calculus I, II	
ABE Principles: Biological	
Physics: Mechanics	
Second Year	
Agricultural Engineering	**Biological Engineering**
ABE Principles: Machine System	
ABE Principles: Soil and Water	
Intro Computing: Engineering and Science	
Calculus III, Matrix Theory, and Differential Equations	
Thermal Physics	
ABE Principles: Bioenvironment	
ABE Principles: Bioprocessing	
Introductory Dynamics	
Physics: Electricity and Magnetism	
Statics	
Biological and natural sciences elective	Elementary Organic Chemistry I
Third Year	
Agricultural Engineering	**Biological Engineering**
Electricity and Electronic Circuits*	
Macroeconomic Principles	
Thermodynamics	
Two ABE technical electives	
Two liberal education electives	
Applied Statistical Methods I	Transport Processes in ABE

Third Year	
Agricultural Engineering	**Biological Engineering**
Introductory Fluid Mechanics or Momentum and Heat Transfer or Introductory Gas Dynamics	*Biological and natural sciences elective*
Introductory Solid Mechanics	Molecular and Cellular Basis of Life
Fourth Year	
Project Management	
Industry-Linked Design Project	
Biological and natural sciences elective	
ABE technical elective	
Two technical electives	
Two liberal education electives	
Two free electives	

*includes laboratory component
Source: Department of Agricultural and Biological Engineering.[33]

The Department of Agricultural and Biological Engineering reports an average starting salary of $54,000 for ABE graduates.[34] The department also emphasizes that students and graduates work in renewable energy, carbon sequestration, water quality, agriculture, air quality, and the environment, among other areas.

Michigan State University (East Lansing, MI)

The Department of Biosystems and Agricultural Engineering (BAE) at Michigan State University (MSU) offers a **Bachelor of Science in Biosystems Engineering** (BE).[35] The department notes that biosystems engineers at MSU solve problems related to food quality and safety, ecosystems protection, homeland security and health protection, biomass utilization, and renewable energy development. The department also highlights several graduates, many of whom work in the food industry.[36] Other graduates work for employers ranging from Walt Disney World Corporation to the U.S. Forest Services, as well as health care companies.

Within the BE major, students may pursue a **concentration in bioenergy engineering, biomedical engineering, ecosystems engineering, or food engineering**.[37] Concentrations are available to all BE students, but they are not required.

[33] "Agricultural and Biological Engineering Curriculum." University of Illinois at Urbana-Champaign. http://abe.illinois.edu/undergrad_programs/ABE-Curriculum
[34] "Why the Department of ABE at Illinois?" University of Illinois at Urbana-Champaign. http://abe.illinois.edu/future-students/why_ABE
[35] "BAE: About Us." Michigan State University. http://www.egr.msu.edu/bae/about-us
[36] "BAE: Meet Our Graduates." Michigan State University. http://www.egr.msu.edu/bae/meet-our-graduates
[37] "Biosystems Engineering." Michigan State University. http://www.egr.msu.edu/files_egr/files-ugs/MSU_CoEngr_BiosystemsEngineering.pdf

Tuition and Fees

MSU tuition varies by residency and progression through the curriculum. For Michigan residents, tuition is $428.75 per credit-hour during the first two years and $476.50 per credit-hour during the junior and senior years.[38] For non-residents, tuition is $1,125 per credit-hour during the first two years and $1,160.50 per credit-hour during the junior and senior years.[39] The engineering program also charges a programmatic fee of $567 per semester during the junior and senior years. Given the 128 credits necessary to earn the B.S. in Biosystems Engineering, four-year tuition for the program would be approximately $60,200 for Michigan residents. For non-residents, four year tuition would be approximately $148,500. Average room and board for four years would cost an additional $36,000.

Degree Completions

The NCES does not report any degree conferrals for bioengineering and biomedical engineering, environmental engineering, or health and safety engineering at MSU between 2008 and 2012. However, the data does indicate that MSU has conferred agricultural engineering degrees. While the program is small, degree completions have surpassed 2008 levels since falling by nearly 50 percent from 2008 to 2009. Figure 3.9 illustrates this trend.

Figure 3.9: Michigan State University Bachelor's Degree Completions in Agricultural Engineering

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Agricultural Engineering	24	13	23	25	30	5.7%	1.5	7.76

Source: IPEDS

Curriculum

Figure 3.10 lists the requirements for the College of Engineering and the Bachelor of Science in Biosystems Engineering at MSU. These are in addition to 23 credits in university requirements covering writing, humanities, social sciences, and introductory biology.

[38] "Resident Tuition, Fee, Tax and Housing Rates to Be Effective Fall Semester 2013 and Spring Semester 2014." Michigan State University. http://www.ctlr.msu.edu/COStudentAccounts/Tuition_FeesResident.aspx

[39] "Non-Resident Tuition, Fee, Tax And Housing Rates to Be Effective Fall Semester 2013 and Spring Semester 2014." Michigan State University. http://www.ctlr.msu.edu/COStudentAccounts/Tuition_FeesNonResident.aspx

Figure 3.10: Degree Requirements for Undergraduate BE Students at Michigan State University

College Requirements	Major Requirements	
▪ General Chemistry ▪ Calculus I, II ▪ Multivariable Calculus ▪ Introduction to Engineering Design and Modeling ▪ Physics for Scientists and Engineers I, II ▪ Differential Equations	▪ Introduction to Biosystems Engineering ▪ Engineering Analysis of Biological Systems ▪ Engineering Properties of Biological Materials ▪ Biosystems Engineering Laboratory Practice ▪ Heat and Mass Transfer in Biosystems ▪ Thermodynamics for Biological Engineering ▪ Survey of Organic Chemistry	▪ Microbial Systems Engineering ▪ Engineering Design and Optimization for Biological Systems ▪ Biosystems Design Techniques and Project ▪ Organismal and Population Biology ▪ Statics ▪ Introduction to Fluid Mechanics ▪ Biology Laboratory ▪ Chemistry Laboratory I
Additional Major Requirements		
Four courses from the following: ▪ Biosensors ▪ Electric power and control ▪ Sustainable bioenergy systems ▪ Food engineering ▪ Water resources systems ▪ Pollution engineering ▪ Biomass conversion ▪ Biomedical instrumentation	One course from the following: ▪ Pathogens ▪ Ecology ▪ Biotechnology ▪ Biology ▪ Biophysics	One course from the following: ▪ Microbiology ▪ Physiology ▪ Genetics ▪ Ecology

Source: Biosystems Engineering Curriculum Requirements[40]

Figure 3.11 presents the curriculum requirements for the four possible concentrations within the major. Each concentration requires between 14 and 17 credits, which is approximately one semester of coursework.

[40] "Biosystems Engineering," Op. cit.

Figure 3.11: Curriculum Requirements for BE Concentrations at Michigan State University

<table>
<tr><th colspan="2">BIOENERGY ENGINEERING</th><th colspan="2">ECOSYSTEMS ENGINEERING</th></tr>
<tr><td>Core courses:
▪ Sustainable Bioenergy Systems
▪ Biomass Conversion Engineering
▪ Bioenergy Feedstock Production

One course from the following:
▪ Microbial biotechnology
▪ The biology of fungi
▪ Algal biology</td><td>One course from the following:
▪ Biochemical engineering
▪ Bioprocessing laboratory
▪ Applied geophysics
▪ International environmental law and policy
▪ Design of alternative energy systems
▪ Combustion
▪ Microbial biotechnology
▪ Biology of fungi
▪ Algal biology</td><td>Core courses:
▪ Diffuse-Source Pollution Engineering
▪ Microbial Ecology
▪ Water Resources Systems Analysis and Modeling</td><td>Two courses from the following:
▪ Applied hydraulics
▪ Soil science
▪ Soil chemistry
▪ Soil biology
▪ Agricultural ecology
▪ Pollutants in the soil environment
▪ Forest ecology
▪ Wetland ecology and management
▪ Stream ecology
▪ Restoration ecology</td></tr>
<tr><th colspan="2">BIOMEDICAL ENGINEERING</th><th colspan="2">FOOD ENGINEERING</th></tr>
<tr><td>Core:
▪ Biosensors for Medical Diagnostics

One of two:
▪ Biomedical Instrumentation
▪ Biofluid Mechanics and Heat Transfer

One of two:
▪ Eukaryotic Pathogens
▪ Physiological Biophysics</td><td>Two courses from the following:
▪ The mechanisms of disease
▪ Molecular laboratory diagnostics
▪ Clinical immunology
▪ Eukaryotic pathogens
▪ Biomedical instrumentation
▪ Biofluid mechanics and heat transfer
▪ Biomaterials and biocompatibility
▪ Bioinformatics
▪ Physiological biophysics</td><td>Core courses:
▪ Food Engineering: Fluids
▪ Food Engineering: Solids
▪ Food Microbiology</td><td>Two courses from the following:
▪ Biochemistry
▪ Food science
▪ Food chemistry
▪ Food processing</td></tr>
</table>

Source: Biosystems Engineering Curriculum Requirements[41]

[41] Ibid.

SOUTH DAKOTA STATE UNIVERSITY (BROOKINGS, SD)

The Department of Agricultural and Biosystems Engineering at South Dakota State University (SDSU) trains undergraduate and graduate students to become engineers and technologists in the agricultural, biological and environmental industries.[42] The College of Engineering offers a **Bachelor of Science in Agricultural and Biosystems Engineering** through the department. Coursework and design projects solicited from industry contacts center around natural resource management, irrigation and drainage, water resources development, machine dynamics and design, precision agriculture, agricultural power, the properties and processing of biological materials, environmental control for livestock, indoor air quality, structures, control and disposal of agricultural wasters, computers, and instrumentation.[43]

Students specialize in one of four areas, including power and machines, structures and environment, food and biological materials, and natural resources.[44] Graduates may enter a variety of careers, with job titles including agricultural engineer, farmer, product development engineer, quality control engineer, industrial engineer, environmental engineer, design engineer, irrigation engineer, water resource engineer, and food process engineer.[45] Starting salaries typically fall between $30,000 and $50,000, according to the department's website.

Tuition and Fees

SDSU varies tuition by residency in South Dakota, Minnesota, or neither. Tuition is $139 per credit for residents of South Dakota, $170 per credit for residents of Minnesota, and $208 per credit for all other students.[46] There are additional fees of $118 per credit. The median cost in tuition and fees for a major in agricultural and biosystems engineering is $39,316, based on 2013-2014 tuition and fees.[47]

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[42] "Agricultural and Biosystems Engineering." South Dakota State University. http://catalog.sdstate.edu/preview_entity.php?catoid=22&ent_oid=1351

[43] "Agricultural and Biosystems Engineering Major." South Dakota State University. http://catalog.sdstate.edu/preview_program.php?catoid=22&poid=3946

[44] "Top Reasons to Choose Agricultural and Biosystems Engineering." South Dakota State University. http://www.sdstate.edu/abe/undergrad/abe/top-reasons-to-choose-agricultural-and-biosystems-engineering.cfm

[45] [1] "Power & Machinery." South Dakota State University. http://www.sdstate.edu/abe/undergrad/abe/careers/power-and-machinery.cfm
[2] "Structures and Indoor Environment." South Dakota State University. http://www.sdstate.edu/abe/undergrad/abe/careers/structures-and-indoor-environment.cfm
[3] "Natural Resources." South Dakota State University. http://www.sdstate.edu/abe/undergrad/abe/careers/natural-resources.cfm
[4] "Food and Biomaterials." South Dakota State University. http://www.sdstate.edu/abe/undergrad/abe/careers/food-and-biomaterials.cfm

[46] "Cost Estimate." South Dakota State University. http://www.sdstate.edu/admissions/financing/undergrad/cost/index.cfm

[47] "Tuition & Fees by Major." South Dakota State University. http://www.sdstate.edu/academic/tuition-fee-pricing.cfm

Degree Completions

For SDSU, the NCES reports only agricultural engineering degree conferrals during the period between 2008 and 2012. If these conferrals accurately reflect the major in agricultural and biosystems engineering, the program is neither large nor growing. However, there is extensive inconsistency among universities regarding how these programs are reported. The university does not offer information on the size of the program, but there is no indication that the university plans to discontinue the major.

Figure 3.12: South Dakota State University Bachelor's Degree Completions in Agricultural Engineering

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Agricultural Engineering	10	7	15	11	3	-26.0%	-1.75	5.93

Source: IPEDS

Curriculum

Figure 3.13 on the following page notes the curriculum requirements for a major in Agricultural and Biosystems Engineering at SDSU. These are in addition to system general education requirements and institutional graduation requirements. The major also requires 12 credits of relevant electives, approved by the advisor.

Figure 3.13: Degree Requirements for a Bachelor of Science in Agricultural and Biosystems Engineering at South Dakota State University

MAJOR REQUIREMENTS		
▪ Biology Survey I* ▪ General Chemistry I* ▪ Calculus II, III ▪ Differential Equations ▪ Visual Basic Programming ▪ Engineering Design Graphics I ▪ Computer Aided Drawing ▪ Introduction to Engineering and Technology ▪ Statics ▪ Dynamics	▪ Mechanics of Materials ▪ Thermodynamics ▪ Fluid Mechanics ▪ Basic Electrical Engineering I* ▪ Engineering Tools for Agricultural and Biological Engineers ▪ Project Development for Agricultural and Biological Engineers ▪ Agricultural Power and Machines* ▪ Agricultural Structures and Indoor Environment*	▪ Engineering Properties of Biological Materials* ▪ Natural Resources Engineering* ▪ Unit Operations of Biological Materials Processing* ▪ Instrumentation for Agricultural and Biological Systems* ▪ Monitoring and Controlling Agriculture and Biological Systems* ▪ Design Project III and IV
One course in engineering mathematics, numerical analysis, or statistics	One course covering organic and biochemistry or organic chemistry*	One internship, field experience, research project, or entrepreneurship course

*includes laboratory component
Source: Agriculutral and Biosystems Engineering Major Requirements[48]

Figure 3.14 on the following page presents the curriculum requirements for the four possible concentrations within the major. Food and Biomaterials Engineering involves significantly more coursework than the other three concentrations. While the Food and Biomaterials Engineering concentration lists over 50 credits of coursework, the remaining concentrations offer between 30 and 33 credits, representing an academic year of coursework. Much of the difference stems from the high credit value assigned to several Food and Biomaterials Engineering courses, including 10 credits for the series of Dairy Product Processing I and II.

[48] "Agricultural and Biosystems Engineering Major," Op. cit.

Figure 3.14: Curriculum Requirements for Agricultural and Biosystems Engineering Concentrations at South Dakota State University

Food and Biomaterials Engineering	Structures and Environment Emphasis
▪ Principles of Biological Separation Processing* ▪ Value-Added Meat Products* ▪ Advanced Meat Science* ▪ Water Supply and Wastewater Engineering* ▪ Industrial Waste Treatment ▪ Organic Chemistry II* ▪ Technical Control of Dairy Products I* ▪ Dairy Product Processing I, II* ▪ Dairy Plant Management ▪ General Microbiology* ▪ Food Microbiology* ▪ Food Science* ▪ Principles of Food Processing* ▪ Food Chemistry*	▪ Geotechnical Engineering* ▪ Structural Theory ▪ Steel Design ▪ Concrete Theory and Design ▪ Engineering Administration ▪ Principles of HVAC Engineering and HVAC System Design* ▪ Heat Transfer ▪ Computer Aided Design/Drawing* ▪ Automatic Controls
Power and Machinery Emphasis	**Water and Natural Resources Engineering Emphasis**
▪ Hydraulic and Pneumatic Systems* ▪ Fundamentals of Machine Design ▪ Vibrations ▪ Metallurgy* ▪ Industrial Engineering ▪ Internal Combustion Engines ▪ Heat Transfer ▪ Design of Machine Elements and Machine Design-Case Studies* ▪ Environmental Soil Management*	▪ Seminar ▪ Agricultural Waste Management ▪ Elementary Surveying* ▪ Water Supply and Wastewater Engineering* ▪ Hydrology ▪ Geotechnical Engineering* ▪ Soils* ▪ Environmental Soil Management* ▪ Irrigation – Crop and Soil Practices

*includes laboratory component
Source: Agriculutral and Biosystems Engineering Major Requirements [49]

The University of Wisconsin – Platteville (Platteville, WI)

The University of Wisconsin – Platteville (UW-Platteville) offers an environmental engineering program, which it considers the only undergraduate program in Wisconsin and one of only a few in the Midwest.[50] This program is not a degree in biosystems engineering, but the program focuses on the earth's biological, chemical, physical, and geological systems to protect ecosystems, biodiversity, and human health. There is a significant focus on controlling pollution and mitigating its effects.

The environmental engineering program at UW-Platteville was formerly a concentration within civil engineering, but the administration recently decided to expand the

[49] Ibid.
[50] "College of EMS: Environmental Engineering." University of Wisconsin – Platteville. http://www.uwplatt.edu/enve/

concentration into a full degree program. The environmental engineering degree completions have also recently and steadily grown.

The areas of study include the following:

- Air pollution control,
- Bioassays (biological indicators of pollution),
- Drinking water treatment,
- Environmental and occupational health,
- Environmental chemistry,
- Geographic Information Systems (GIS),
- Groundwater hydrology and remediation,
- Hazardous waste management,
- Solid waste management,
- Surface water quality,
- Wastewater treatment (domestic and industrial),
- Water and sewer system design (applied hydraulics), and
- Water resources and hydrology.[51]

Tuition and Fees

UW-Platteville offers tiered tuition based on residency in Wisconsin, Minnesota, Iowa, or Illinois. Wisconsin residents pay $7,463 in tuition and fees per academic year, while Minnesota residents pay $7,829 per year.[52] Residents of Iowa and Illinois can enroll through a Tri-State Initiative for $10,463 per year. Students who do not reside in any of these four states pay $15,036 per year in tuition and fees. The average cost of room and board for the year is an additional $6,400. The cost of the four year program is $29,852 for Wisconsin residents, $31,316 for Minnesota residents, $41,852 for residents of Iowa and Illinois, and $60,144 for all other students.

Degree Completions

UW-Platteville confers environmental engineering degrees, but it does not offer agricultural, biomedical, or biological engineering. Figure 3.15 displays degree conferrals at UW-Platteville for the B.S. in Environmental Engineering. Notably, **degree completions have steadily risen from 2008 to 2012**. While the program is relatively small, it has steadily grown.

[51] Ibid.
[52] "2012-13 Academic Year Cost Chart." University of Wisconsin – Platteville. http://www3.uwplatt.edu/admission/2012-13-academic-year-cost-chart

Figure 3.15: UW-Platteville Bachelor's Degree Completions in Environmental Engineering

Degree Program	2008	2009	2010	2011	2012	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Environmental Engineering	6	9	11	11	17	29.7%	2.75	2.17

Source: IPEDS

Curriculum

Figure 3.16 presents the suggested course of study for environmental engineering. This is based on a sample suggested course of study for environmental engineers at UW-Platteville. Within the program, there are a number of specialty areas, including water and wastewater treatment, environmental and occupational health, solid waste management, water resources and environmental chemistry. However, the program provides a background in all of these areas.

Figure 3.16: Sample Course of Study for a Bachelor of Science in Environmental Engineering at UW-Platteville

First Semester	Second Semester
First Year	
▪ Calculus and Analytic Geometry I ▪ Chemistry for Engineers ▪ Engineering Success Skills	▪ Calculus and Analytic Geometry II ▪ General Physics I ▪ Introduction to Engineering Projects ▪ Engineering/Computer Graphics
Second Year	
▪ Calculus and Analytic Geometry III ▪ Computer Applications ▪ Statics ▪ Elements of Surveying	▪ Differential Equations ▪ Microbiology ▪ Mechanics of Materials ▪ Environmental Engineering
Third Year	
▪ Statistical Methods ▪ Fluid Mechanics ▪ Environmental Chemistry and Lab	▪ Engineering Economy ▪ Hydrology ▪ Geotechnical Engineering I ▪ Engineering Geology
Fourth Year	
▪ Municipal Hydraulics ▪ Groundwater Hydrology ▪ Two Technical Electives	▪ Wastewater and Drinking Water Treatment ▪ Thermoscience ▪ Solid and Hazardous Waste ▪ Design Project

Source: University of Wisconsin – Platteville.[53]

[53] "Environmental Engineering." University of Wisconsin – Platteville. http://www3.uwplatt.edu/files/admission/12-0527%20Environmental%20Eng%20Fact%20Sheet_FINAL.pdf

APPENDIX

Figure A.1 presents the key characteristics of these programs. While Figure A.1 attempts to portray the majority of relevant programs, it is not an exhaustive list.

Figure A.1: Biosystems Engineering Programs

INSTITUTION	DEGREE	COLLEGE	DEPARTMENT	AREAS OF STUDY
University of Minnesota	B.S. in Bioproducts and Biosystems Engineering[54]	College of Food, Agricultural, and Natural Resource Sciences and the College of Science and Engineering	Department of Bioproducts and Biosystems Engineering	▪ Bioproducts Engineering ▪ Environmental and Ecological Engineering ▪ Food Engineering
University of Kentucky	B.S. in Biosystems Engineering[55]	College of Agriculture, Food and Environment	Department of Biosystems and Agricultural Engineering	
Auburn University	B.S. in Biosystems Engineering[56]	Samuel Ginn College of Engineering	Department of Agricultural and Biosystems Engineering	▪ Bioenergy and Bioproducts Engineering ▪ Ecological Engineering ▪ Food and Biological Engineering ▪ Production and Process Engineering ▪ Off-highway Vehicle Engineering
The University of Arizona	B.S. in Biosystems Engineering[57]		Department of Agricultural and Biosystems Engineering	▪ Biological Engineering ▪ Soil and Water Resources Engineering
Michigan State University	B.S. in Biosystems Engineering[58]	College of Engineering	Department of Biosystems and Agricultural Engineering	▪ Bioenergy Engineering ▪ Biomedical Engineering ▪ Ecosystems Engineering ▪ Food Engineering
Clemson University	B.S. in Biosystems Engineering[59]	College of Engineering and Science	Department of Environmental Engineering and Earth Sciences	▪ Bioprocess Engineering ▪ Ecological Engineering

[54] "Department of Bioproducts and Biosystems Engineering: Undergraduate Programs." University of Minnesota. http://www.bbe.umn.edu/UndergraduateProgram/index.htm
[55] "Undergraduate Engineering Degree Requirements." University of Kentucky. http://www.bae.uky.edu/academics/requirements.shtm
[56] "About BSEN." Auburn University. http://www.eng.auburn.edu/programs/bsen/about/index.html
[57] "Undergraduate program – B.S. in Biosystems Engineering." The University of Arizona. http://www.cals.arizona.edu/abe/page/undergraduate-education
[58] "Biosystems Engineering." Michigan State University. http://www.egr.msu.edu/age/objectives_outcomes.html
[59] "Biosystems Engineering Undergraduate Program." Clemson University. http://www.clemson.edu/ces/eees/undrgrad/be/index.html

INSTITUTION	DEGREE	COLLEGE	DEPARTMENT	AREAS OF STUDY
The University of Tennessee	B.S. in Biosystems Engineering[60]	Institute of Agriculture – College of Agricultural Sciences and Natural Resources	Department of Biosystems Engineering and Soil Science	
North Dakota State University	B.S. in Agricultural and Biosystems Engineering[61]	College of Engineering and Architecture	Department of Agricultural and Biosystems Engineering	▪ Agricultural Engineering ▪ Biosystems Engineering
Oklahoma State University	B.S. in Biosystems Engineering[62]	The College of Agricultural Sciences and Natural Resources and the College of Engineering, Architecture, and Technology	Department of Biosystems and Agricultural Engineering	▪ Biomechanical ▪ Bioprocessing and Biotechnology ▪ Environment and Natural Resources ▪ Food Processing
Iowa State University	B.S. in Biological Systems Engineering[63]	The College of Engineering and the College of Agriculture and Life Sciences	Agricultural and Biosystems Engineering Department	▪ Bioenvironmental Engineering ▪ Biorenewable Resources Engineering ▪ Food Engineering
South Dakota State University	B.S. in Agricultural and Biosystems Engineering[64]	College of Engineering	Department of Agricultural and Biosystems Engineering	▪ Food and Biomaterials Engineering ▪ Structures and Environment ▪ Power and Machinery ▪ Water and Natural Resources Engineering
California Polytechnic State University	B.S. in BioResource and Agricultural Engineering[65]	-	BioResource and Agricultural Engineering Department	

[60] "B.S. Degree in Biosystems Engineering." The University of Tennessee. http://bioengr.ag.utk.edu/students/BE_options.asp
[61] "Agricultural and Biosystems Engineering." North Dakota State University. http://www.ndsu.edu/ndsu/academic/factsheets/eng_arch/agbiosys.shtml
[62] "." Oklahoma State University.
[63] "Biological Systems Engineering Curricula." Iowa State University. http://www.abe.iastate.edu/undergraduate-students/biological-systems-engineering/bse-curricula/
[64] "Agricultural and Biosystems Engineering." South Dakota State University. http://catalog.sdstate.edu/preview_entity.php?catoid=22&ent_oid=1351
[65] "BS BioResource and Agricultural Engineering (BRAE)." California Polytechnic State University. http://brae.calpoly.edu/department/brae.html

Institution	Degree	College	Department	Areas of Study
University of Illinois at Urbana-Champaign	B.S. in Agricultural and Biological Engineering[66]	College of Agricultural, Consumer, and Environmental Sciences and the College of Engineering	Department of Agricultural and Biological Engineering	▪ Agricultural Engineering ▪ Renewable Energy Systems ▪ Off-Road Equipment Engineering ▪ Soil and Water Resources Engineering ▪ Biological Engineering ▪ Bioenvironmental Engineering ▪ Ecological Engineering ▪ Food and Bioprocess Engineering ▪ Nanoscale Biological Engineering
Virginia Tech	B.S. in Biological Systems Engineering[67]	The College of Agriculture and Life Sciences and the College of Engineering	Department of Biological Systems Engineering	
University of Nebraska – Lincoln	B.S. in Biological Systems Engineering[68]	College of Engineering	Biological Systems Engineering Department	▪ Biomedical Engineering ▪ Environmental and Water Resources Engineering ▪ Bioenergy and Food Engineering
University of California, Davis	B.S. in Biological Systems Engineering[69]	College of Agricultural and Environmental Sciences and the College of Engineering	Department of Biological and Agricultural Engineering	▪ Biotechnology Engineering ▪ Agricultural and Natural Resources Engineering ▪ Food Engineering
Kansas State University	B.S. in Biological Systems Engineering[70]	College of Agricultural and Environmental Sciences and the College of Engineering	Department of Biological and Agricultural Engineering	▪ Biological Engineering ▪ Environmental Engineering ▪ Machine Systems Engineering

[66] "Agricultural and Biological Engineering: Undergraduate Programs." University of Illinois at Urbana-Champaign. http://abe.illinois.edu/undergrad_programs
[67] "Department of Biological Systems Engineering: Undergraduate Program." Virginia Tech. http://www.bse.vt.edu/undergraduate/index.html
[68] "Biological Systems Engineering." University of Nebraska – Lincoln. http://bse.unl.edu/web/bsen/
[69] "Biological Systems Engineering." University of California, Davis. http://admissions.ucdavis.edu/majors/major_view.cfm?major=ebse
[70] "Biological and Agricultural Engineering." Kansas State University. http://catalog.k-state.edu/content.php?catoid=13&navoid=1322

Institution	Degree	College	Department	Areas of Study
University of Idaho	B.S. in Biological Systems Engineering[71]	The College of Agricultural and Life Sciences	The Department of Biological and Agricultural Engineering	
Frlorida A&M University	B.S. in Biological and Agricultural Systems Engineering[72]	College of Agricultural and Food Sciences	Division of Engineering Sciences and Technology	▪ Bioprocessing and Food Engineering ▪ Natural Resources Conservation Engineering
Texas A&M University	B.S. in Biological and Agricultural Engineering[73]	College of Agriculture and Life Sciences and the College of Engineering	Department of Biological and Agricultural Engineering	▪ Renewable Energy Engineering ▪ Food and Bioprocess Engineering ▪ Environmental and Natural Resources Engineering ▪ Machine Systems Engineering
University of Georgia	B.S. in Biological Engineering[74]	College of Engineering		▪ Biochemical ▪ Biomedical ▪ Environmental
Environmental Engineering Programs in the Region				
University of Wisconsin – Platteville	B.S. in Environmental Engineering[75]	College of Engineering, Mathematics and Science	Environmental Engineering Department	
Marquette University	B.S. in Environmental Engineering[76]	College of Engineering	Civil, Construction and Environmental Engineering Department	

Sources identified in table.

[71] "Biological Systems Engineering." University of Idaho. http://www.uidaho.edu/cals/bae/programs/biologicalsystemsengineering

[72] "Biological and Agricultural Systems Engineering." Florida A&M University. http://www.famu.edu/cesta/main/index.cfm/academic-programs/biological-and-agricultural-systems-engineering/

[73] "BAEN Curriculum." Texas A&M University. http://baen.tamu.edu/academics/undergraduates/baen-curriculum/

[74] "B.S. in Biological Engineering." University of Georgia. http://www.engr.uga.edu/degrees/undergraduate/b-s-in-biological-engineering/

[75] "Environmental Engineering." University of Wisconsin – Platteville. http://www3.uwplatt.edu/files/admission/12-0527%20Environmental%20Eng%20Fact%20Sheet_FINAL.pdf

[76] "Environmental Engineering Major." Marquette University. http://www.marquette.edu/explore/major-environmental-engineering.shtml

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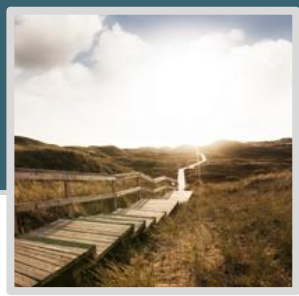
Program Demand for a B.S. in Environmental Engineering Technology

Prepared for the University of Wisconsin-River Falls

July 2013


In the following report, Hanover Research investigates the feasibility of a Bachelor of Science degree in Environmental Engineering Technology. The report consults degree completions data to measure student demand for environmental engineering technology programs before examining labor market data to assess the employment outlook for program graduates. The report concludes with profiles of similar environmental energy programs currently offered at other higher education institutions.

HANOVER RESEARCH

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

Interest in environmental engineering, the field concerned with managing and protecting the natural environment, has grown steadily throughout the past 50 years. The Clean Air Act in 1963 represented the beginning of federal efforts to improve and protect the natural environment.[1] Decades of environmental legislation followed the Clean Air Act, including the establishment of the U.S. Environmental Protection Agency in 1970[2] and the passage of the Clean Water Act in 1972.[3] Public and commercial interest in environmental protection ensued, driving an expanding industry dedicated to the protection and preservation of the natural environment.

Environmental engineers develop much of the technology that sustains that industry, designing wastewater treatment systems, pollution remediation strategies, and hazardous waste management programs. The implementation of such technology is the responsibility of environmental engineering (EE) technicians and technologists.

This report seeks to determine the feasibility of a new Bachelor of Science in Environmental Engineering Technology program at the University of Wisconsin-River Falls (UW-RF) that will equip EE technicians and technologists to succeed in the environmental industry. The report is divided into the following sections:

- **Student Demand for an Environmental Engineering Technology Program** – this section examines whether there is evidence of sufficient student interest to sustain the proposed degree program. We consult national and statewide degree completions data to approximate student demand and explore the existing literature for other indicators of student interest in EE technology.
- **Labor Market Demand for Environmental Engineering Technology Graduates** – this section considers the career prospects for holders of EE technology bachelor's degrees. National, regional, and state employment projections estimate the amount of growth in environmental engineering technology and related occupations through the end of the decade. Targeted searches for available jobs related to environmental engineering technology supplement the employment projections as measures of labor market demand.
- **Profiles of Environmental Engineering Technology Programs** – this section briefly profiles six similar academic programs that offer EE technology degrees. The section includes four baccalaureate programs and two associate degree programs.

[1] "History of the Clean Air Act." United States Environmental Protection Agency. http://www2.epa.gov/laws-regulations/summary-clean-air-act

[2] Nixon, R. "Reorganization Plan No. 3 of 1970." United States Environmental Protection Agency, July 9, 1970. http://www2.epa.gov/aboutepa/reorganization-plan-no-3-1970

[3] "Summary of the Clean Water Act." United States Environmental Protection Agency. http://www2.epa.gov/laws-regulations/summary-clean-water-act

KEY FINDINGS

- Completions data indicate that student demand for bachelor's degrees in environmental engineering technology is increasing. However, these figures should be considered with caution, as the overall number of degree completions throughout the country is very small.
- National and regional labor market projections forecast a small but positive employment outlook for environmental engineering technicians. The Bureau of Labor Statistics predicts that opportunities for environmental engineering technicians nationwide will grow by over 24 percent between 2010 and 2020, and environmental engineering technician opportunities in Wisconsin and its surrounding states are expected to increase by almost 17 percent over the same time period.
- Similar to the degree completions data, however, this only represents an increase of around 250 jobs over 10 years, and should be considered with caution. Job searches returned no open positions for individuals with bachelor's degrees in environmental engineering technology. While environmental engineering technician positions were more common, these jobs often only require an associate's degree.
- Four-year environmental engineering technology degree programs are extremely rare. Our research did not reveal any four-year environmental engineering technology programs within 600 miles of River Falls, and there are not currently any ABET-accredited four-year environmental engineering technology programs. Two-year programs are more common, although few are located in the Upper Midwest and only two are located in Wisconsin.

SECTION I: STUDENT DEMAND FOR AN ENVIRONMENTAL ENGINEERING TECHNOLOGY PROGRAM

This section investigates potential student demand for a new bachelor's degree program in EE technology. We begin with an in-depth analysis of degree completion trends and proceed to a thorough explanation of other indicators of student demand.

DEGREE COMPLETIONS METHODOLOGY

In this report, we estimate student demand for new academic programs by analyzing changes in the number of degrees completed in five academic disciplines. This method, while indirect, allows us to approximate demand for a range of similar academic disciplines. We can infer that in disciplines where the number of degree completions is increasing, student demand for such programs is trending upward.

The National Center for Education Statistics (NCES) collects and publishes completions data for all U.S. higher education institutions in the Integrated Postsecondary Education Data System (IPEDS). In any analysis of IPEDS data, it is important to note that the data are self-reported by institutions, so some institutions may classify data differently than other institutions or report information in varying levels of detail. The IPEDS data is nonetheless useful in identifying trends throughout the higher education system.[4]

The NCES classifies academic disciplines according to a six-digit taxonomic system called the Classification of Instructional Programs (CIP). Institutions classify all completions data they submit to IPEDS according to degree award level (e.g., associate degree, bachelor's degree) and CIP category. The CIP system recognizes environmental engineering technology/ technician as a distinct discipline (CIP 15.0507). We examined completions in that category, but we also expanded our analysis to include other related disciplines. EE technology includes information from a number of fields, including waste management, pollution remediation, hazardous waste management, and environmental sustainability. To provide a broader portrait of demand for degrees in the environmental engineering industry, we analyzed completions in environmental/environmental health engineering (CIP 14.1401), energy management and systems technology/technician (CIP 15.0503), water quality and wastewater treatment management and recycling technology/technician (CIP 15.0506), and hazardous materials management and waste technology/technician (CIP 15.0508). Descriptions of each of these disciplines are displayed in Figure 1.1 on the following page.

[4] "IPEDS Data Center." National Center for Education Statistics. http://nces.ed.gov/ipeds/datacenter/

Figure 1.1: Descriptions of Environmental Engineering Technology and Related Disciplines

CIP CODE	FIELD OF STUDY	DESCRIPTION
14.1401	Environmental/ Environmental Health Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for controlling contained living environments and for monitoring and controlling factors in the external natural environment, including pollution control, waste and hazardous material disposal, health and safety protection, conservation, life support, and requirements for protection of special materials and related work environments.[5]
15.0503	Energy Management and Systems Technology/Technician	A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing energy-efficient systems or monitoring energy use. Includes instruction in principles of energy conservation, instrumentation calibration, monitoring systems and test procedures, energy loss inspection procedures, energy conservation techniques, and report preparation.[6]
15.0506	Water Quality and Wastewater Treatment Management and Recycling Technology/Technician	A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using water storage, waterpower, and wastewater treatment systems. Includes instruction in water storage, power and/or treatment systems and equipment; testing and inspection procedures; system maintenance procedures; and report preparation.[7]
15.0507	Environmental Engineering Technology/ Environmental Technology	A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using indoor and outdoor environmental pollution control systems. Includes instruction in environmental safety principles, testing and sampling procedures, laboratory techniques, instrumentation calibration, safety and protection procedures, equipment maintenance, and report preparation.[8]
15.0508	Hazardous Materials Management and Waste Technology/Technician	A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in identifying and disposing of hazardous materials. Includes instruction in environmental safety principles, biohazard identification, testing and sampling procedures, laboratory techniques, instrumentation calibration, hazardous waste disposal procedures and systems, safety and protection procedures, equipment maintenance, and report preparation.[9]

Source: NCES

The tables in this section display the total number of completions from the 2006-07 academic year to the 2010-11 academic year. In addition, the tables report the **compound annual growth rate (CAGR)**, average annual change, and standard deviation of annual changes. CAGR is a measure of annual growth over an extended period of time that disregards the volatility of individual year-to-year changes in growth. CAGR functions as a

[5] "Detail for CIP Code 14.1401." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88229
[6] "Detail for CIP Code 15.0503." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88262
[7] "Detail for CIP Code 15.0506." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88264
[8] "Detail for CIP Code 15.0507." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88265
[9] "Detail for CIP Code 15.0508." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=87320

simplified representation of growth within a given time period as if growth had occurred at a constant rate throughout the period. The second measure, the **average annual change**, provides the average number by which completions rose or fell annually. This figure offers an indication of the raw magnitude of growth, which the CAGR does not. Lastly, the **standard deviation of annual changes** gauges the volatility of annual growth. The larger the standard deviation of annual changes, the less consistent the growth from one year to the next. Inconsistent growth may reflect either annual fluctuations or accelerating growth or decline of conferrals in a particular field.

National and Statewide Completion Trends

EE technology bachelor's degrees qualify graduates to work as both EE technologists and EE technicians. This distinction is discussed in detail in Section II of the report. EE technologist positions generally require a bachelor's degree, while EE technician roles frequently require only an associate degree. New bachelor's degree programs in EE technology, which are rare, may attract aspiring EE technologists and technicians that would otherwise choose to pursue an associate degree. Because of this, we examine degree completions at the bachelor's *and* associate degree levels.

National Degree Completions

National degree completions trends indicate that demand for bachelor's degrees in EE technology-related disciplines is increasing. The most rapid growth over the past five years has been in the field of energy management and systems technology, which has grown by an average of 39 percent annually since 2007. However, it should be noted that the total number of degree completions in this area is small, with only 119 conferrals in 2011. The specific field of environmental engineering technology has grown an average of 4 percent annually since 2007. Figure 1.2 displays the degree completions data in table form, and Figure 1.3 illustrates the data graphically.

Completions in EE technology-related disciplines at the associate degree level, displayed in Figures 1.4 and 1.5, are substantially more numerous than at the bachelor's degree level. Completions in all the examined disciplines except environmental and environmental health engineering have increased over the past five years. Energy management and systems technology completions are increasing more rapidly than in other fields, averaging 67 percent growth over the past five years and exploding between 2010 and 2011 from 177 completions to 566 completions. Surges of this kind can often be explained by degree re-categorization, where one or more institutions re-categorize degree programs from one CIP code to another. In this case, however, there does not appear to be a corresponding drop in related disciplines that would suggest such an occurrence. Hazardous materials management and waste technology and water quality and wastewater treatment management and recycling technology are also high-growth fields of study at the associate degree level, increasing annually by 12.7 and 12.4 percent respectively.

New programs in EE technology may attract more students if they emphasize components of environmental engineering that are in high demand, such as energy management and systems technology.

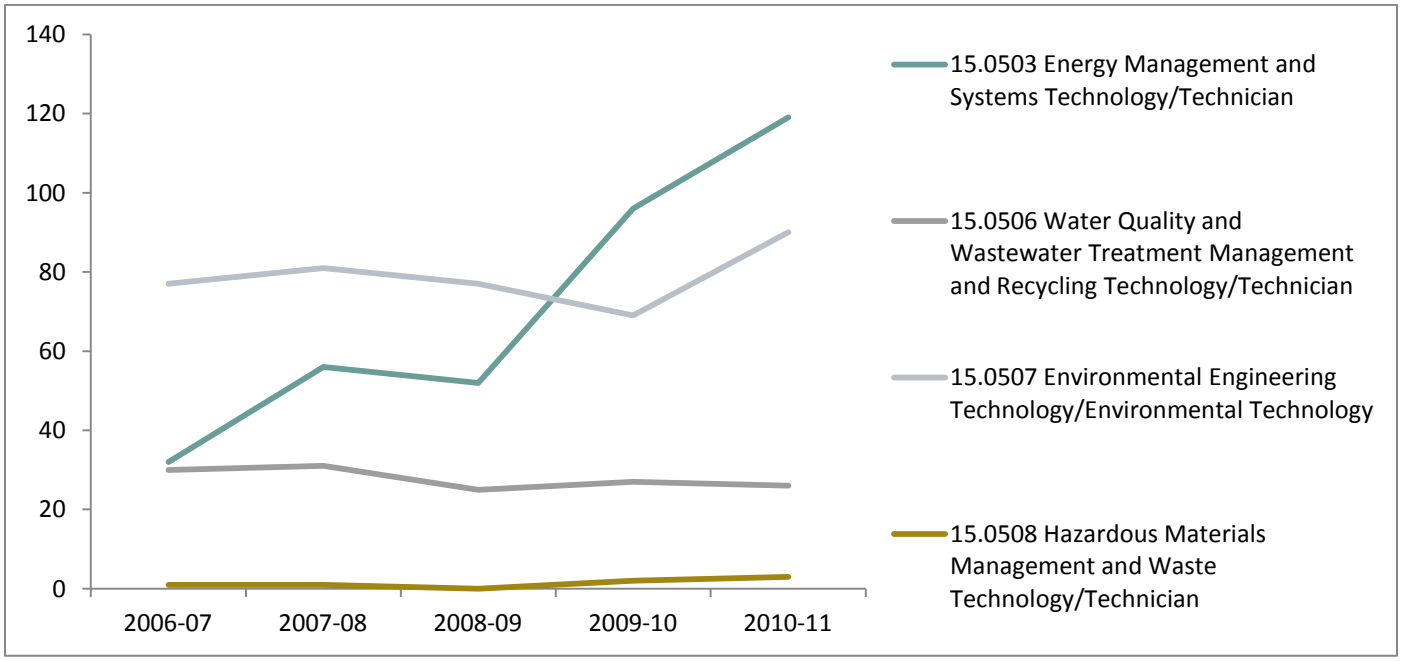
Hazardous materials management and waste technology is a very small field, with only three reported bachelor's degree completions in 2011, which may present a niche that new EE technology degree programs can fill.

Figure 1.2: Bachelor's Degree Completions in Environmental Engineering Technology and Related Disciplines

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Environmental/Environmental Health Engineering	447	512	598	662	763	14.3%	79.0%	15.4
Energy Management and Systems Technology/Technician	32	56	52	96	119	38.9%	21.8%	17.1
Water Quality and Wastewater Treatment Management and Recycling Technology/Technician	30	31	25	27	26	-3.5%	-1.0%	3.1
Environmental Engineering Technology/Environmental Technology	77	81	77	69	90	4.0%	3.3%	11.1
Hazardous Materials Management and Waste Technology/Technician	1	1	0	2	3	31.6%	0.5%	1.1

Source: IPEDS

Figure 1.3: 2006-2011 Bachelor's Degree Completion Trends in Environmental Engineering Technology and Related Disciplines



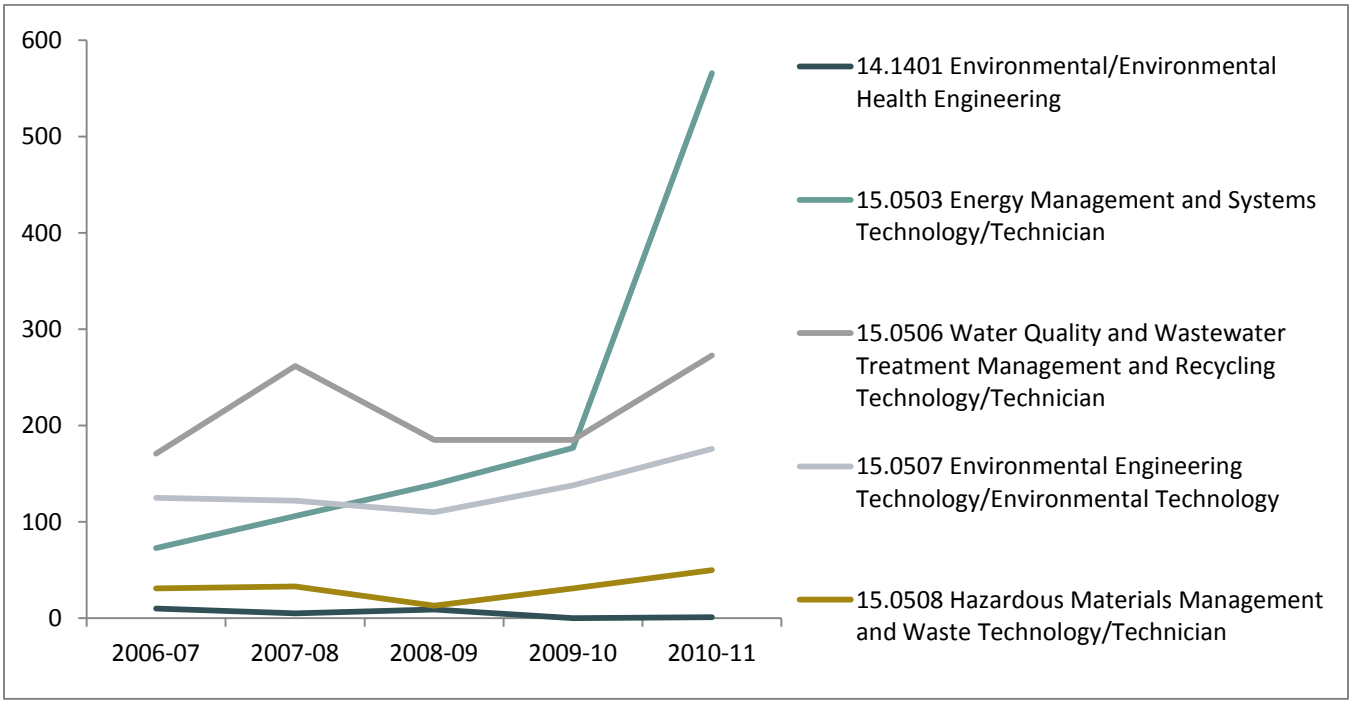
*Environmental engineering bachelor's degrees (CIP 14.1401) have been omitted from this chart to allow greater detail for technology/technician-level programs.
Source: IPEDS

Figure 1.4: Associate Degree Completions in Environmental Engineering Technology and Related Disciplines

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Environmental/Environmental Health Engineering	10	5	9	0	1	-43.8%	-2.3%	5.1
Energy Management and Systems Technology/ Technician	73	106	139	177	566	66.9%	123.3%	153.4
Water Quality and Wastewater Treatment Management and Recycling Technology/Technician	171	262	185	185	273	12.4%	25.5%	69.6
Environmental Engineering Technology/Environmental Technology	125	122	110	138	176	8.9%	12.8%	20.8
Hazardous Materials Management and Waste Technology/Technician	31	33	13	31	50	12.7%	4.8%	15.8

Source: IPEDS

Figure 1.5: 2006-2011 Associate Degree Completion Trends in Environmental Engineering Technology and Related Disciplines



Source: IPEDS

Degree Completions in Wisconsin

Bachelor's and associate's degree completions at the state level reveal a dearth of EE technology offerings in Wisconsin. IPEDS reports no bachelor's degree completions in EE technology fields, and just 15 environmental and environmental health engineering degrees were completed in 2011 (see Figure 1.6). Completions in EE technology-related fields were uncommon at the associate degree level, as well (see Figure 1.7). Students only completed associate degrees in energy management and systems technology, and water quality and wastewater treatment management and recycling technology. Where completions were reported, though, demand appears to be growing. Energy management and systems technology completions were first reported in 2011, so a growth trend has not been established. Water quality and wastewater treatment management and recycling technology completions have increased over the past five years, driven primarily by a major surge between 2010 and 2011.

At the bachelor's degree level, Marquette University and the University of Wisconsin-Platteville are the only institutions that offer environmental engineering degrees. At the associate degree level, Mid-State Technical College offers a degree in energy management and systems technology, and Milwaukee Area Technical College and Moraine Park Technical College offer degrees in water quality and wastewater treatment management and recycling technology.[10]

[10] "IPEDS Data Center," Op. cit.

Figure 1.6: Wisconsin Bachelor's Degree Completions in Environmental Engineering Technology and Related Disciplines

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Environmental/Environmental Health Engineering	14	11	14	15	15	1.7%	0.25	2.2

Source: IPEDS

Figure 1.7: Wisconsin Associate Degree Completions in Environmental Engineering Technology and Related Disciplines

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Energy Management and Systems Technology/Technician	-	-	-	-	21	N/A	-	-
Water Quality and Wastewater Treatment Management and Recycling Technology/Technician	19	7	11	11	51	28.0%	8	19.4

Source: IPEDS

Other Indicators of Student Demand

Little attention in any examined educational or industry literature is given to EE technology as a standalone discipline. Rather, much of the discussion centers on studies in environmental engineering. However, where demand for environmental engineers is increasing, demand for environmental engineering technologists to support the design and implementation of new technologies is likely to follow.

Student interest in environmental engineering degrees is growing, according to the American Society for Engineering Education (ASEE). The ASEE reports that the total number of bachelor's degrees awarded is steadily increasing. The NCES completions data from Figure 1.2 support this assertion. The ASEE also notes that environmental engineering attracts far more female students than other engineering disciplines: 43.2 percent of EE bachelor's degree students are women, compared to 18 percent of bachelor's degree students in other engineering disciplines.[11]

The number of ABET-accredited EE programs is increasing, reflecting growing interest in the subject. ABET currently accredits 60 EE bachelor's degree programs,[12] compared with 51 in 2008.[13]

[11] Gibbons, M. and Chen, I. "Environmental Impact." American Society for Engineering Education, September 2009. http://www.prism-magazine.org/sept09/includes/Databytes.pdf

[12] "Find Accredited Programs." ABET. http://main.abet.org/aps/AccreditedProgramSearch.aspx/AccreditationSearch.aspx

[13] "Going Global Accreditation Takes Off Worldwide: 2008 Annual Report." ABET, 2009. p.32. http://www.abet.org/uploadedFiles/Publications/Annual_Report/abet-2008-annual-report.pdf

The Cooperative Institutional Research Program (CIRP) included environmental engineering in its freshman survey for the first time in 2012. The survey, which asks incoming college freshmen about their intended major, recognizes over 80 different academic disciplines. The inclusion of environmental engineering in the survey indicates that student interest in the subject has grown enough to merit a separate category. Environmental engineering was the eighth-most popular engineering major (out of 12) mentioned by freshman respondents.[14]

[14] Pryor, J.H., et al. "The American Freshman: National Norms Fall 2012." Cooperative Institutional Research Program, 2012. p.27. http://heri.ucla.edu/monographs/TheAmericanFreshman2012.pdf

SECTION II: LABOR MARKET DEMAND FOR ENVIRONMENTAL ENGINEERING GRADUATES

This section examines the employment outlook for graduates of the proposed EE technology degree. We consult BLS and state employment projections and conduct job searches to evaluate the employability of EE technology graduates.

ENVIRONMENTAL ENGINEERING TECHNOLOGISTS AND ENVIRONMENTAL ENGINEERING TECHNICIANS

Study in engineering technology fields can lead to two similar, yet distinct, careers: engineering technologists and engineering technicians. Engineering technicians generally focus on servicing, operating, and maintaining technological equipment. Engineering technologists, on the other hand, focus on implementing engineering technology, often focusing on higher-level responsibilities such as product improvement, manufacturing, and construction.[15] ABET, the organization that accredits many engineering degree programs, differentiates between the two occupations based on the level of education completed. Graduates of two-year programs are classified as engineering technicians, while graduates of four-year programs are classified as engineering technologists.[16] The BLS likewise notes that applicants need only have an associate degree to qualify for most EE technician jobs, and some employers may not require a postgraduate degree at all.[17]

Some sources extend the technologist-technician differentiation to the field of environmental engineering, recognizing EE technologists and EE technicians as distinct roles. However, our research suggests that there is little distinction between the two positions in the labor market. The BLS occupational handbook recognizes EE technician as a distinct occupation, and opportunities for EE technicians are listed on a number of employment websites. There is little mention of EE technologists in the labor market information, though. This dearth of information may indicate that employment opportunities for EE technologists are not widespread, or it may mean that the labor market in general classifies technologist and technician responsibilities under the same job title.

The lack of attention given to EE technologists in the labor market suggests that the environmental industry has not yet designated positions for technicians with four-year degrees. Conversely, higher education institutions have not produced significant numbers of graduates with four-year credentials in EE technology. Until the environmental industry recognizes a need for more highly skilled technologists, graduates with bachelor's degrees in EE technology may find themselves competing with associate degree holders for EE

[15] "Who is a Technician, Technologist or Engineer?" Canton State University of New York. http://www.canton.edu/csoet/elec/technician.html
[16] "Engineering vs. Engineering Technology." ABET. http://www.abet.org/engineering-vs-engineering-technology/
[17] "Environmental Engineering Technicians: How to Become One." Bureau of Labor Statistics, March 29, 2012. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineering-technicians.htm#tab-4

technician positions. Some employers explicitly seek EE technicians with bachelor's degrees, and the bachelor's degree should elevate the profile of candidates applying to other EE technician positions.

SALARY AND WORK CONDITIONS

The BLS' occupational outlook handbook profiles the work environment, employment outlook, and salary information for EE technicians. Because EE technicians and technologists with a bachelor's degree will have a more advanced education than most of their EE technician counterparts, it follows that BLS information about EE technician salary and work conditions may understate the situation for bachelor's degree holders. The BLS occupational information for EE technicians, however, still serves as a relevant starting point for deeper analysis of the employment outlook for technicians or technologists with four-year degrees.

EE technicians work in laboratories, offices, and fieldwork settings. They operate and maintain environmental technology and equipment, conduct surveys and samplings, maintain and review technical documents, and manage environmental remediation operations.[18] EE technicians earn approximately $43,390 annually.[19] The industries that employ the greatest number of EE technicians include:

- Management, scientific, and technical consulting services
- Local government, excluding education and hospitals
- Waste management and remediation services
- Testing laboratories
- State government, excluding education and hospitals[20]

LABOR MARKET PROJECTIONS BY INDUSTRY

The BLS' national employment outlook, summarized in Figure 2.1, predicts growth across the five industries that employ the largest number of EE technicians. The BLS predicts that the field of management, scientific, and technical consulting services, in particular, will experience explosive growth through the end of the decade.[21]

[18] "Environmental Engineering Technicians: What Environmental Engineering Technicians Do." Bureau of Labor Statistics, March 29, 2012. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineering-technicians.htm#tab-2

[19] "Environmental Engineering Technicians: Pay." Bureau of Labor Statistics, March 29, 2012. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineering-technicians.htm#tab-5

[20] "Environmental Engineering Technicians: Work Environment." Bureau of Labor Statistics, March 29, 2012. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineering-technicians.htm#tab-3

[21] "Employment and output by industry." Bureau of Labor Statistics, February 1, 2012. http://www.bls.gov/emp/ep_table_207.htm

Figure 2.1: National Employment Projections for Industries that Employ the Largest Number of Environmental Engineering Technicians

Industry	Employment		Annual Employment Change, 2010-20		CAGR
	2010	2020	Number	%	
Management, scientific, and technical consulting services	991,400	1,567,000	575.6	58.1%	5.2%
Local government, excluding enterprises, educational services, and hospitals	4,117,200	4,350,100	232.9	5.7%	0.6%
Waste management and remediation services	356,700	434,400	77.7	21.8%	2.2%
State government, excluding enterprises, educational services, and hospitals	1,889,600	2,017,900	128.3	6.8%	0.7%

*Testing laboratories are not included in the most recent BLS industrial employment projections.
Source: BLS

National Labor Market Projections

The BLS does not recognize EE technologist as one of the approximately 1,000 occupations about which it provides statistics. To estimate market demand for EE technologists and related positions in the absence of a specific BLS classification, we examined the labor market statistics for both environmental engineers and EE technicians. It is logical to assume that opportunities for EE technologists and skilled EE technicians will follow the trends exhibited for environmental engineers and EE technicians. Figure 2.2 displays the BLS 10-year employment projections for environmental engineers and EE technicians.

The projections in Figure 2.2 reveal a faster-than-average predicted growth rate for EE occupations through the end of the decade. **The BLS expects opportunities for environmental engineers and EE technicians to grow over 2 percent annually,** exceeding the projected national average job growth rate of 1.35 percent. The EE technician position, in particular, is expected to grow rapidly, increasing by 2.17 percent annually.[22] The BLS attributes this growth to increasing interest in decontaminating polluted sites and growing concerns about wastewater treatment. The BLS expects federal, state, and local government investment in these areas to increase in the near future, sustaining employment growth throughout the industry.[23] The O*NET resource center, which contains information on a range of occupations, projects that demand for environmental engineers and EE technicians will increase as environmental protection initiatives and legislation become more common.[24]

[22] "Long Term Occupational Projection Data." Bureau of Labor Statistics, February 1, 2012. http://www.bls.gov/emp/ep_table_102.htm
[23] "Environmental Engineering Technicians: Job Outlook." Bureau of Labor Statistics, March 29, 2012. http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineering-technicians.htm#tab-6
[24] Dierdorff, E.C., et al. "Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations." O*NET, February 12, 2009. p.26. http://www.onetcenter.org/dl_files/Green.pdf

Interestingly, employment projections for technicians in other engineering fields are far less optimistic than for EE technicians. Opportunities for engineering technicians in general are expected to grow only 5.4 percent between 2010 and 2020, and the BLS predicts that opportunities for technicians in fields like aerospace engineering will decrease through the end of the decade.[25]

Figure 2.2: National Employment Projections for Environmental Engineers and Environmental Engineering Technicians

Occupation	SOC Code	Employment		Employment Change, 2010-20		CAGR	Job Openings, 2010-20*
		2010	2020	Number	%		
Environmental Engineers	17-2081	51,400	62,700	11,300	21.9%	2.01%	22,600
Environmental Engineering Technicians	17-3025	18,800	23,300	4,600	24.3%	2.17%	8,200
Engineering Technicians, Except Drafters	*17-3020*	*451,900*	*476,500*	*24,600*	*5.4%*	*0.53%*	*111,100*
All Occupations	-	143,068,200	163,537,100	20,468,900	14.3%	1.35%	54,787,400

* Due to growth and replacement needs
Source: BLS

State and Regional Labor Market Projections

Wisconsin

The most recent Wisconsin state employment projections, displayed in Figure 2.3, project opportunities for environmental engineers to increase by 2.09 percent annually through the end of the decade. The field is predicted to expand more rapidly in Wisconsin than at the national level. The Wisconsin projections do not provide growth estimates for EE technicians, so the environmental engineer predictions are the only relevant statistics for this analysis. Based on our understanding of the field of environmental engineering and the relationship between technologists and engineers, as well as the trend occurring at the national level, it follows that the growth for environmental engineers shown in Figure 2.3 will correspond to similar growth for EE technologists and technicians.[26]

Figure 2.3: Wisconsin Employment Projections for Environmental Engineers

Occupation	SOC Code	Employment		Employment Change, 2010-20		CAGR	Average Annual Job Openings
		2010	2020	Number	%		
Environmental Engineers	17-2081	870	1,070	200	23.0%	2.09%	39
All Occupations	-	2,923,230	3,269,910	346,680	11.9%	1.13%	103,410

Source: Wisconsin Department of Workforce Development

[25] "Long Term Occupational Projection Data." Bureau of Labor Statistics, Op. cit.
[26] "Long Term Occupational Projection Data." Wisconsin Department of Workforce Development, September, 2012. http://worknet.wisconsin.gov/worknet/downloads.aspx?menuselection=da&pgm=occprj

Surrounding States

Because environmental engineering remains a relatively small field, we expanded our analysis of employment projections to the five states surrounding Wisconsin (Illinois, Indiana, Iowa, Michigan, and Minnesota). The departments of labor in Indiana and Iowa did not release employment projections for environmental engineers or EE technicians, so the data in this subsection are limited to Illinois, Michigan, Minnesota, and Wisconsin. The projections for each of these states, as well as the aggregate totals from all the states combined, are displayed in Figure 2.4.[27]

The regional data predict that employment opportunities in environmental engineering and EE technology will increase through the end of the decade. Opportunities for environmental engineers are predicted to increase most rapidly in Wisconsin, while opportunities for environmental engineering technicians are expected to increase most rapidly in Illinois.

Minneapolis-St. Paul Area

The Minnesota Department of Employment and Economic Development (MDEED) publishes employment projections for six different regions within the state. We include the MDEED projections for the Minneapolis-St. Paul region in our analysis because of its proximity to River Falls. Employment projections for the Minneapolis-St. Paul region, displayed in Figure 2.5, also indicate that opportunities for environmental engineering technicians and environmental engineers will increase over the next decade, albeit at a slower pace than at the national level.[28]

[27] [1] "Long Term Occupational Projection Data." Wisconsin Department of Workforce Development, Op. cit.
[2] "Long Term Occupational Projection Data." Illinois Department of Employment Security. http://www.ides.illinois.gov/page.aspx?item=911
[3] "Long Term Occupational Projection Data." Michigan Department of Technology, Management, and Budget. http://milmi.org/cgi/dataanalysis/AreaSelection.asp?tableName=Occprj
[4] "Long Term Occupational Projection Data." Minnesota Department of Employment and Economic Development. http://www.positivelyminnesota.com/apps/lmi/projections/

[28] "Employment Outlook." Minnesota Department of Employment and Economic Development. http://www.positivelyminnesota.com/apps/lmi/projections/Results.aspx?dataset=1&geog=2709TC0000&code=

Figure 2.4: Regional Employment Projections for Environmental Engineering Technology-Related Occupations

State	Occupation	SOC Code	Employment		Employment Change, 2010-20		CAGR	Average Annual Job Openings
			2010	2020	Number	%		
Wisconsin	Environmental Engineers	17-2081	870	1,070	200	23.0%	2.09%	39
Minnesota	Environmental Engineers	17-2081	431	490	59	13.7%	1.29%	16
	Environmental Engineering Technicians	17-3025	246	281	35	14.2%	1.34%	9
Illinois	Environmental Engineers	17-2081	1,285	1,353	68	5.29%	0.52%	35
	Environmental Engineering Technicians	17-3025	680	808	128	18.82%	1.74%	26
Michigan	Environmental Engineers	17-2081	1,430	1,640	209	14.60%	1.38%	53
	Environmental Engineering Technicians	17-3025	570	660	88	15.50%	1.48%	20
Entire Region (IL, MI, MN, WI)	Environmental Engineers	17-2081	4,016	4,553	536	13.35%	1.40%	143
	Environmental Engineering Technicians	17-3025	1,496	1,749	251	16.78%	1.75%	55

* Indiana and Iowa did not report employment projections for environmental engineers and environmental engineering technicians.
Source: State departments of labor

Figure 2.5: Minneapolis-St. Paul Regional Employment Projections for Environmental Engineers and Environmental Engineering Technicians

Occupation	SOC Code	Employment		Employment Change, 2010-20		CAGR	Average Annual Job Openings
		2010	2020	Number	%		
Environmental Engineers	17-2081	321	366	45	14.0%	1.47%	11
Environmental Engineering Technicians	17-3025	168	188	20	11.9%	1.26%	5
All Occupations	-	1,680,012	1,882,072	202,060	12.0%	1.27%	60,132

Source: Minnesota Department of Employment and Economic Development

OTHER INDICATORS OF LABOR MARKET DEMAND

CURRENT JOB OPENINGS

Hanover performed searches on a number of different job search websites (Indeed.com, Monster.com, USAJOBS.gov)[29] to broaden this report's perspective on the employment prospects for EE technology graduates. One of the apparent benefits of the bachelor's in EE technology over an associate degree is that it qualifies graduates to work as either technologists or technicians. Hanover initially searched for "environmental engineering technologist" positions to identify jobs that bachelor's degree holders are uniquely qualified for. The search, however, returned no results on any of the job search websites. Hanover then expanded the search to "engineering technologist," which returned no openings relevant to bachelor's degree holders with EE technology expertise. These failed searches, while not comprehensive, **indicate that positions tailored to a four-year EE technology degree may not be widely available**. EE technology graduates with four-year degrees may only find jobs as EE technicians or as technologists in fields unrelated to environmental engineering.

EE technician positions are much more common than EE technologist positions. Searches for "environmental engineering technician" returned a range of job opportunities, four of which are described in Figure 2.6. This brief cross-section of available positions reveals that the term "environmental engineering technician" can encompass a variety of jobs requiring different levels of education. A number of environmental engineering technician positions explicitly seek applicants with bachelor's degrees in fields like environmental science and environmental engineering. Such positions may provide employment opportunities for EE technology graduates.

Regional searches for environmental engineering technician positions revealed only one job opportunity in Wisconsin, Minnesota, Iowa, or Michigan. EE technology graduates from UW-RF may therefore need to venture outside of the region to find employment opportunities related to their degree.

[29] [1] "Indeed.com." http://www.indeed.com/
[2] "Monster.com." http://www.monster.com/
[3] "USAJOBS." https://www.usajobs.gov/

Figure 2.6: Environmental Engineering Technician Job Openings

POSITION	LOCATION	DESCRIPTION	EDUCATION REQUIREMENT
Entry Level Engineer/Engineering Technician	Milwaukee, WI	Responsibilities include: erosion and sediment control plan design; application for necessary erosion control and/or storm water permits; construction site erosion and sediment control inspection; meeting with construction crews and regulatory agency staff as needed; GPS usage; technical report writing.[30]	Associate or Bachelor's
Environmental Engineer Technician	Los Angeles, CA	Monitors and analyzes environment and conducts studies on methods and equipment to meet environment and health standards. Assures activities being performed having an environmental impact are communicated and accomplished according to the environmental management systems.[31]	Bachelor's
Environmental Technician	Asheville, NC	Conducts phase one environmental site assessments. Possible involvement with in industrial hygiene services such as asbestos-containing materials, lead-based paint and IAQ/mold testing, soil and groundwater studies, underground storage tank assessments and monitoring, and sampling during contaminated soil and groundwater removal and remediation.[32]	Bachelor's
Civil/Environmental Engineering Technician	Presque Isle, ME	Assist in various civil and environmental engineering projects. Responsibilities may include water, wastewater, stormwater, solid waste, roadways, cost estimating, and environmental monitoring.[33]	Associate or Bachelor's
Environmental Engineering Technician	Plaquemine, LA	Maintains safety and environmental performance by: providing environmental health and safety training; monitoring compliance with company and agency requirements; maintain the industrial hygiene program; manage plant hazardous and non-hazardous waste.[34]	High School Diploma, Associate Preferred

[30] "Entry Level Engineer / Engineering Technician Job Opening at Kapur & Associates, Inc. in Milwaukee, WI; West Allis, WI; Glendale, WI." Wisconsin Job Network. http://www.wisconsinjobnetwork.com/j/t-entry-level-engineer--engineering-technician-e-kapur--associates-inc-l-milwaukee,-wi;-west-allis,-wi;-glendale,-wi-jobs-j3749378.html?keywords=environmental%20engineering%20technician

[31] "Environmental Engineer Technician." Nestle. http://nestlejobs.com/us/los-angeles/nestle-usa/jobid3461990-environmental-engineer-technician?src=JB-10172

[32] "Environmental Technician." Engineering Consulting Services. https://jobs-ecslimited.icims.com/jobs/2417/environmental-technician/job?mode=job&iis=Indeed&iisn=Indeed.com

[33] "Civil/Environmental Engineering Technician." Jobs in ME. http://www.jobsinme.com/seek/resultdetail.aspx?jobnum=232369

[34] "Environmental Engineering Technician." Kelly Services. https://kelly.secure.force.com/CandidateExperience/CandExpJobDetails?id=a7V8000000004Fa&utm_source=Indeed&utm_medium=organic&utm_campaign=Indeed

SECTION III: PROFILES OF ENVIRONMENTAL ENGINEERING TECHNOLOGY PROGRAMS

This section profiles EE technology programs at six higher education institutions to provide a perspective on the structure and availability of EE technology programs throughout the country.

Research into existing bachelor's degree programs in EE technology reveals one immediate observation: **four-year degree programs in EE technology are extremely rare**. In fact, ABET does not currently accredit any four-year EE technology programs. Temple University, which offers an environmental technology concentration for its general engineering technology degree, offers the only accredited EE technology-related four-year program identified during research for this report. Our research identified no four-year EE technology programs of any kind in the Upper Midwest; the closest bachelor's degree program is located in Murray, Kentucky.

Two-year EE technology degree programs are more common than four-year programs, but there are only four ABET-accredited two-year EE technology programs.[35] Unaccredited two-year programs can be found in a variety of states, although our research revealed only two such programs in Wisconsin.

These findings suggest that the proposed UW-RF EE technology program would be the first or one of the first institutions in the Upper Midwest to offer a bachelor's degree in EE technology. If UW-RF secured accreditation for the program, it would be among the first institutions in the country to host an accredited four-year EE technology program.

TEMPLE UNIVERSITY (PHILADELPHIA, PA)

Temple University offers an Environmental Technology concentration for its general Bachelor of Science in Engineering Technology (BSET) degree. Graduates of the program obtain a degree in General Engineering Technology, but they may choose to specialize in one of six different engineering technology fields: Mechanical Technology, Construction Technology, Environmental Technology, Computer Technology, Energy Technology, and Mechatronics.[36]

The BSET program aims to prepare students for work as engineering technologists, concentrating on applied knowledge rather than abstract theory. The coursework prescribed to students emphasizes practical experience, eschewing many of the advanced

[35] "Find Accredited Programs." ABET. http://main.abet.org/aps/AccreditedProgramSearch.aspx/AccreditationSearch.aspx

[36] "Engineering Technology." Temple University. http://engineering.temple.edu/department/engineering-technology

science and math courses taught in traditional engineering programs.[37] The objectives of the General Engineering Technology program are:

- Graduates will demonstrate competence and progression in the practice of modern engineering technology.
- Graduates will demonstrate the necessary communication, teamwork and management and/or leadership skills to participate effectively in a team environment.
- Graduates will demonstrate commitment to life-long learning and continuous improvement and contribution to society through professional practice.[38]

The BSET program at Temple is flexible, allowing students to take classes during the day or at night. Full- and part-time options are available. The full-time program can be completed in four years, while the part-time program will require more time to complete.[39]

Degree Completions

The IPEDS completion data for bachelor's degrees in general engineering technology and environmental engineering technology suggest that participation in the Environmental Technology program at Temple has declined over the past five years.[40]

Figure 3.1: Temple University Bachelor's Degree Completions in General Engineering Technology and Environmental Engineering Technology

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Engineering Technology, General	14	13	5	5	7	-15.9%	-1.75%	3.8
Environmental Engineering Technology/Environmental Technology	1	1	1	-	-	-	-0.25%	0.4

Source: IPEDS

Curriculum

The BSET program requires students to complete 124 total semester hours of coursework. All engineering technology students must complete the same 92 hours of core classes (including 40 hours of general studies courses), but Temple allows some flexibility to complete the remaining 32 hours. Students may work with faculty members to develop a customized degree plan with technical and free electives, or they may choose one of the six engineering technology concentrations already defined by Temple (including Environmental Technology). The Environmental Technology degree plan supplements the core engineering

[37] Ibid.
[38] Bulleted points taken verbatim from: "General Engineering Technology." Temple University. http://engineering.temple.edu/mechanical-engineering/general-engineering-technology
[39] Ibid.
[40] "IPEDS Data Center." National Center for Education Statistics. http://nces.ed.gov/ipeds/datacenter/

technology coursework with six courses in subjects like solid and hazardous waste engineering and air pollution control systems. The entire degree plan for the BSET in Environmental Technology is displayed in Figure 3.2 below.[41] Students interested in additional practical experience may pursue cooperative education opportunities with employers during their fourth year in the BSET program. The cooperative education program extends the program length by one year.[42]

Figure 3.2: Temple University Engineering Technology Curriculum

Core Engineering Technology Courses	
Introduction to Engineering	Electric Devices and Systems I and Lab
The Environment	Engineering Graphics
Mechanics of Solids	General Chemistry I and Lab
Materials Technology	General Physics I, II and Lab
Statics	Precalculus
Fluid Mechanics or Thermodynamics	Calculus I, II
Engineering Professional Seminar	Statistics
Environmental Technology Concentration Courses	
Applied Fluid Mechanics	Air Pollution Control Systems
Environmental Engineering	Applied Hydraulics
Solid and Hazardous Waste Engineering	Water and Wastewater Systems
General Studies Courses	
Mosaic I, II	Public Speaking
Analytical Reading and Writing	Human Behavior
Technical Writing	Race and Diversity
US Society	Economic Analysis
Global/World Society	Microeconomics

Source: Temple University

Murray State University (Murray, KY)

Murray State University (MSU) offers an unaccredited Bachelor of Science in EE technology. The MSU program focuses on a broad range of environmental subjects. Some of the topics covered by the EE technology program include: solid and hazardous waste management and site remediation, water pollution assessment and control, and environmental regulatory compliance.[43]

[41] "Undergraduate Student Information Handbook." Temple University. May, 2011. pp.22-23. http://www.temple.edu/studentaffairs/orientation/core/files/ENGHandbook.PDF

[42] "Engineering Technology." Temple University. http://www.temple.edu/bulletin/Academic_programs/schools_colleges/eng/programs/engtech_eng_tech/eng_eng_tech.shtm

[43] "Environmental Engineering Technology." Murray State University. http://www.murraystate.edu/Academics/CollegesDepartments/CollegeOfScienceEngineeringandTechnology/CollegeOfSciencePrograms/industrialEngineeringTech/EnvEngTech.aspx

Graduates of the program have pursued careers in industrial, consulting, and regulatory settings, including:

- Environmental Consultants
- Remediation Contractors
- Municipalities
- Test Laboratories
- State, Federal, or Governmental Agencies
- Chemical Processing Corporations
- Manufacturing Companies[44]

Degree Completions

According to the MSU EE technology alumni page, the program declined in size between 1992 and 2002 from around 10 graduates annually to approximately five graduates annually. More recent information from MSU about the size of the program is not available.[45] The IPEDS completions data for MSU, however, indicate that the number of graduates in water quality and wastewater treatment management and recycling technology, the reported CIP category most closely related to environmental engineering technology, have fluctuated over the past years, and have never exceeded eight graduates in one year (see figure 3.3).[46]

Figure 3.3: Murray State University Bachelor's Degree Completions in Water Quality and Wastewater Treatment Management and Recycling Technology

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Water Quality and Wastewater Treatment Management and Recycling Technology/Technician	2	5	8	2	-	-	-0.5	3.8

Source: IPEDS

Curriculum

Students in the MSU EE technology program must complete 120 credit hours of coursework to graduate. Students complete 44 hours of general university studies, 41 hours of core engineering courses, and 35 hours of EE technology courses (see Figure 3.4).[47] Like the EE technology program at Temple University, the MSU program allows students to pursue cooperative learning opportunities.[48]

[44] Ibid. Bullet points copied verbatim.
[45] "Alumni." Murray State University. http://campus.murraystate.edu/org/eets/alumni.htm
[46] "IPEDS Data Center," Op. cit.
[47] "Environmental Eng. Technology Curriculum." Murray State University. http://www.murraystate.edu/Academics/CollegesDepartments/CollegeOfScienceEngineeringandTechnology/CollegeOfSciencePrograms/industrialEngineeringTech/EnvEngTech/Curriculum.aspx
[48] "Coop and Internship Forms." Murray State University. http://www.murraystate.edu/Academics/CollegesDepartments/CollegeOfScienceEngineeringandTechnology/CollegeOfSciencePrograms/industrialEngineeringTech/internships.aspx

Figure 3.4: Murray State University Environmental Engineering Technology Curriculum

CORE ENGINEERING COURSES	
Plane Surveying	Mechanical and Electrical Systems
Sustainable Design and Construction	Hydraulics
Construction Estimating I	Engineering Economy
Construction Planning and Management	Professional Development Seminar I
Technical Writing	Introduction to CAD/Technical Drawing
Statics for Technology	Technical Math III
ENVIRONMENTAL TECHNOLOGY TECHNICAL COURSES	
Water Quality Technology I, II	Thermodynamics and Energy Development
Air Quality Technology	Remediation Technology
Solid and Hazardous Waste Management	Essentials of Chemistry and Biochemistry
Environmental Regulatory Affairs	Introduction to Environmental Engineering Technology
UNIVERSITY STUDIES COURSES	
Introduction to Public Speaking	General Physics I, II and Lab
Critical Reading, Writing, and Inquiry	Principles of Macroeconomics
Global Awareness/Cultural Diversity elective	World Civilization and Cultures
Technical Math I, II	Western Humanities Tradition
Ethics, Responsibility, and Civic Engagement elective	The Earth and the Environment

* Students also must participate in a professional internship and complete a senior project to graduate.

WEST VIRGINIA UNIVERSITY INSTITUTE OF TECHNOLOGY (MONTGOMERY, WV)

West Virginia University Institute of Technology (WVUIT) offers an unaccredited "plus-two" Bachelor of Science in Engineering Technology – Environmental (BSET-E). The plus-two program provides the final two years of baccalaureate education for students that have already completed an associate degree. Applicants must have completed an associate degree or equivalent coursework in an environmental engineering-related discipline to gain admission to the program.[49] The objectives of the BSET-E program are to produce graduates who are versed in:

- Technical core topics related to fluids, environmental chemistry and processes, applied thermodynamics, geology, and biology;
- Technical specialty areas of environmental analysis and systems design, physical and organic chemistry, and microbiology;
- Physics principles having an emphasis in applied mechanics, added technical topics in physics/chemistry/biology consistent with the program orientation, and having application to environmental systems and processes; and
- Advanced mathematics to solve technical problems.[50]

[49] "Engineering Technology – Environmental Emphasis." West Virginia University Institute of Technology. http://etenviro.wvutech.edu/

[50] Ibid. Bullet points copied verbatim.

BSET-E graduates have recently accepted jobs as assistant field engineer and environmental specialist. WVUIT graduates may also pursue careers in the "analysis, design, development, implementation, and/or oversight of more advanced environmental systems and processes."[51]

Degree Completions

WVUIT did not report any degree completions before the 2009-10 academic year. Between the 2009-10 and 2010-11 academic years, completions in the general engineering technology program (which includes three different concentrations) decreased from 16 to 12, but the lack of more specific data prevents relevant conclusions based on these data.[52]

Figure 3.5: West Virginia University Institute of Technology Bachelor's Degree Completions in General Engineering Technology

Degree Program	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Engineering Technology, General	16	12	-25.0%	-4.0%	-

Source: IPEDS

Curriculum

Students in the BSET-E program complete four semesters of coursework consisting of 67 total semester credits. The curriculum excludes many general education credits that are included in four-year curricula, although students are required to take American and Western culture courses.[53] Because the BSET-E program is a transfer program, students' curricula at WVUIT may vary depending on their past experience.[54] The entire WVUIT curriculum is displayed in Figure 3.6 on the following page.

[51] Ibid.
[52] "IPEDS Data Center," Op. cit.
[53] "Engineering Technology – Environmental." West Virginia University Institute of Technology. http://etenviro.wvutech.edu/cu
[54] "Engineering Technology – Environmental Emphasis," Op. cit.

Figure 3.6: West Virginia University Institute of Technology Engineering Technology – Environmental Curriculum

Fifth Semester	Sixth Semester
▪ Laboratory Science ▪ Advanced Technical Math ▪ Scientific/Technical Writing ▪ Industrial Safety ▪ Environmental Engineering Technology	▪ Laboratory Science ▪ Artistic Expression ▪ Geology ▪ Codes, Contracts, and Cost Analysis ▪ Advanced Computer Applications
Seventh Semester	**Eighth Semester**
▪ American Culture ▪ Western Culture ▪ Organic Chemistry I and Lab ▪ "C" Programming for Technology ▪ Technical Specialty Elective	▪ The Individual in Society ▪ Technical Specialty Electives (2) ▪ Microbiology ▪ Energy Conversion Systems ▪ Senior Seminary and Project

* Students must also take or have taken a course in hydrologic systems.
Source: WVUIT

Shawnee State University (Portsmouth, OH)

Shawnee State University (SSU) offers a bachelor's degree in EE technology. SSU does not provide extensive information about the program other than its curriculum and the program's goals. The EE technology program, one of four engineering technology programs at SSU, aims to train students in operations, maintenance, and management.[55]

Degree Completions

SSU did not report any degree completions in EE technology before 2011, so IPEDS contains only one year of completions data for the SSU EE technology program. The available data indicate that the SSU program is small, graduating only five students in 2011.[56]

Curriculum

The SSU EE technology curriculum, shown in Figure 3.7, consists of 128 total credit hours of coursework. Students must complete 24 hours of general studies, 40 hours of natural science and mathematics courses, and 64 hours of engineering technology courses. The curriculum emphasizes waste processing and hazardous materials management: 10 of the 21 engineering technology courses focus on water treatment or hazardous waste.[57]

[55] "Environmental Engineering Technology." Shawnee State University. http://www.shawnee.edu/acad/ie/environ.html
[56] "IPEDS Data Center," Op. cit.
[57] "Environmental Engineering Technology." Shawnee State University. http://www.shawnee.edu/acad/ie/environ.html

Figure 3.7: Shawnee State University Environmental Engineering Technology Curriculum

Mathematics and Natural Science Courses	
PreCalculus	Introduction to Organic Chemistry
Calculus 1	Air Pollution
General Biology 1	Physical Geology and Human Environments
Microbiology	Physics 1
General Chemistry 1	Physics 2
Environmental Engineering Technology Courses	
Introduction to Environmental Engineering	Toxicology
Laboratory Techniques	Thermodynamics
Water Treatment Techniques	Management of Hazardous Materials
Wastewater Treatment Techniques	Hazardous Waste Treatment & Control Technology
Hazardous Waste Management	Hydrology for Technologists
Introduction to Solid Waste Management Technology	Introduction to Geographical Information Systems
Industrial Waste Treatment	Statistical Procedures for Analysis of Environmental Data
Fluid Dynamics	Environmental Law & Policy
Automation for Environmental Technology	Hazardous Site Remediation
Engineering Drawing 1	Computer Programming for Technology
Introduction to Electricity/Electronics	

* Students must also complete 24 hours of general education courses mandated for all university students.
Source: Shawnee State University

Cincinnati State Technical and Community College (Cincinnati, OH)

Cincinnati State Technical and Community College (CSTCC) offers one of the only ABET-accredited two-year EE technology programs. The program has a strong vocational emphasis, assembling the classes needed to enter the workforce as an EE technician in a short period of time. Although the CSTCC curriculum will inevitably differ from and lack the depth of a four-year program curriculum, it provides a basic overview of the subjects that an accredited four-year program will likely include.[58] Students with more specific interests can specialize in stormwater[59] or water and wastewater majors.[60]

According to CSTCC, the EE technology program is designed to qualify graduates for careers as:

[58] "Environmental Engineering Technology Degree." Cincinnati State Technical and Community College. http://www.cincinnatistate.edu/real-world-academics/academics/center-for-innovative-technologies/copy9_of_bt_program_template

[59] "Environmental Engineering Technology Degree – Stormwater Major." Cincinnati State Technical and Community College. http://www.cincinnatistate.edu/real-world-academics/academics/center-for-innovative-technologies/copy10_of_bt_program_template

[60] "Environmental Engineering Technology Degree – Water and Wastewater Major." Cincinnati State Technical and Community College. http://www.cincinnatistate.edu/real-world-academics/academics/center-for-innovative-technologies/copy11_of_bt_program_template

- Air Sampling and Monitoring Technician
- Environmental Compliance Specialist
- Environmental Health and Safety Technician
- Field Sampling Technician
- Laboratory Manager
- Park Naturalist[61]

The CSTCC program also has transfer relationships with a number of four-year institutions, including Murray State University and Shawnee State University.[62]

Degree Completions

Degree completions data for CSTCC suggest that the EE technology program is small; completions have fluctuated between two and eight completions per year since the 2006-07 academic year.[63]

Figure 3.8: Cincinnati State Technical and Community College Associate Degree Completions in Environmental Engineering Technology

Degree Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Environmental Engineering Technology/Environmental Technology	8	7	2	6	4	-15.9%	-1.0%	3.4

Source: IPEDS

Curriculum

The EE technology curriculum at CSTCC comprises four semesters of coursework and two semesters of cooperative education. The program is heavily focused on the environmental sciences, including classes in conservation science, chemistry, physics, and geology. The CSTCC curriculum also contains eight technical courses, ranging from environmental sampling to environmental regulations and permits. Students must take mathematics classes through calculus. The curriculum has a small liberal arts component, including electives in the humanities and social sciences and English composition. The full curriculum is displayed in Figure 3.9.[64]

[61] "Employment Options." Cincinnati State Technical and Community College.
[62] "Environmental Engineering Technology Degree." Cincinnati State Technical and Community College. http://www.cincinnatistate.edu/real-world-academics/academics/center-for-innovative-technologies/copy9_of_bt_program_template
[63] "IPEDS Data Center," Op. cit.
[64] "Program Curriculum." Cincinnati State Technical and Community College.

Figure 3.9: CSTCC Environmental Engineering Technology Curriculum

SEMESTER 1	SEMESTER 2
▪ Environmental Sampling ▪ Environmental Science: Conservation and Cleanup ▪ English Composition ▪ Fundamentals of Chemistry ▪ Algebra and Trigonometry	▪ Functions and Calculus ▪ Physics 1: Algebra and Trigonometry-Based ▪ Environmental Chemistry ▪ Solid and Hazardous Waste Management ▪ Water and Wastewater Treatment and Analysis
SEMESTER 4	**SEMESTER 6**
▪ English Composition Elective ▪ Air Pollution Control ▪ Treatment Technologies ▪ Fluid Mechanics ▪ Environmental Geology ▪ Environmental Regulations and Permits	▪ Humanities/Social Sciences Elective 1 ▪ Humanities/Social Sciences Elective 2 ▪ Environmental Statistics ▪ Technical Elective ▪ Site Mapping and GIS ▪ Public Speaking

* Semesters 3 and 5 provide elective cooperative education opportunities.
Source: Cincinnati State Technical and Community College

FOX VALLEY TECHNICAL COLLEGE (APPLETON, WI)

One of the only institutions (along with Northcentral Technical College)[65] in Wisconsin that hosts a program in EE technology is Fox Valley Technical College, which offers an unaccredited associate degree in Energy and Environmental Engineering Technology.[66] The key topics addressed by the program include "energy efficiency, energy alternatives, energy conservation, energy cost, environmental management systems, and the impact of energy usage on the environment."[67]

FVTC already has a general transfer agreement with UW-RF, and graduates of the two-year FVTC program may be well-suited to continue to UW-RF for a four-year degree in EE technology.[68] There is a history of "2+2" engineering technology partnerships between FVTC and UW-RF, which allow students to complete the first two years of a degree at FVTC before proceeding to complete a bachelor's degree at UW-RF. UW-RF and FVTC formally announced such a partnership for an agriculture engineering technology bachelor's degree in 2011.[69]

[65] "Applied Engineering Technology – Environmental Associate." Northcentral Technical College. http://www.ntc.edu/programs/tech-trades/106237B
[66] "Energy & Environmental Engineering Technology." Fox Valley Technical College. http://www.fvtc.edu/public/academics/degree.aspx?plan=10-481-4
[67] "Energy & Environmental Engineering Technology." Fox Valley Technical College. http://www.fvtc.edu/public/academics/degree.aspx?plan=10-481-4
[68] "Credit Transfer with Four-Year Colleges." Fox Valley Technical College. http://www.fvtc.edu/public/content.aspx?ID=1627&PID=1
[69] "FVTC & UW-RF Working to Help Ag Engineering Students." Wisconsin Ag Connection. August 23, 2011. http://www.wisconsinagconnection.com/story-state.php?Id=1020&yr=2011

FVTC offers its energy and EE technology program on a flexible schedule and allows students to complete the program through online classes.[70]

Degree Completions

FVTC did not report any degree completions in EE technology or related fields in the past five years according to IPEDS, suggesting that participation in the program is low or nonexistent.[71]

Curriculum

The FVTC Energy and EE Technology curriculum concentrates largely on the energy and sustainability elements of environmental engineering, as opposed to more traditional EE topics such as waste management, pollution remediation, and water treatment. The curriculum, displayed in Figure 3.10, also has a defined business component, requiring courses in business strategy, supply chain management, and economics.[72] Students who complete the FVTC program may therefore lack some of the core classes taught in other two- and four-year EE technology programs.

Figure 3.10: Fox Valley Technical College Energy and Environmental Engineering Technology Curriculum

Semester 1	Semester 2
▪ Fundamentals of Energy ▪ Interpretation of Engineering Drawings ▪ Manufacturing Processes ▪ Written Communication ▪ College Technical Math 1	▪ Intro to the ISO 14000 Series ▪ Sustainability as a Business Strategy ▪ Energy Production & Use ▪ Communication, Oral/Interpersonal ▪ General Biology
Semester 4	**Semester 5**
▪ OSHA Environmental Technology ▪ Carbon Footprint Reduction Management ▪ Economics & Procurement of Energy ▪ Economics ▪ Psychology of Human Relations	▪ Safety & Environmental Health ▪ Energy & Environmental Conservation ▪ Introduction to Supply Chain Management ▪ E-portfolio Assessment ▪ Introduction to Ethics: Theory & Application ▪ Contemporary American Society

* Students also take Introduction to Project Management and Introduction to Lean Manufacturing during one summer semester ("Semester 3")
Source: Fox Valley Technical College

[70] "Energy & Environmental Engineering Technology." Fox Valley Technical College. http://www.fvtc.edu/public/academics/degree.aspx?plan=10-481-4
[71] IPEDS Data Center," Op. cit.
[72] "Fox Valley Technical College Manufacturing Technologies Division Program Plan: Energy & Environmental Engineering Technology." Fox Valley Technical College, April 18, 2013. Retrieved from http://www.fvtc.edu/public/content.aspx?ID=1976&PID=10

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Program Demand for a B.S. in Mechanical Engineering

Prepared for the University of Wisconsin – River Falls

December 2012



In the following report, Hanover Research investigates the demand for a bachelor's degree in Mechanical Engineering at both the national and state levels. Degree completion data are used to assess student demand for Mechanical Engineering programs, while employment projections provided by national and state governments are utilized to assess labor market demand. The report concludes with profiles of the five Mechanical Engineering bachelor's programs that currently exist in Wisconsin.

HANOVER RESEARCH

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

As the ideas and objects that we produce become increasingly complex, it is essential to have a workforce of skilled, educated specialists capable of studying, designing, and maintaining the systems that support our society. Engineers – mechanical engineers in particular – fill that role, mastering the knowledge and skills required to manufacture everything from microscopic devices to large machinery. In order to do their jobs effectively, though, engineers need to receive extensive instruction in advanced subjects such as materials, thermodynamics, and fluid mechanics.[1] Mechanical Engineering (M.E.) programs at higher education institutions provide this instruction. This report will investigate the demand for such programs, both with students and with employers, followed by an examination of existing bachelor's-level Mechanical Engineering programs in Wisconsin.

This report is structured as follows:

- **Section I: Student Demand for a Bachelor's Degree in Mechanical Engineering** utilizes national and state-level degree completion data to assess the potential demand for a new Mechanical Engineering program. The completions data are supplemented by a brief review of other indicators of student interest.
- **Section II: Labor Market Demand for Mechanical Engineers** uses employment projections data from the Bureau of Labor Statistics and the Wisconsin Department of Workforce Development to analyze the professional outlook for Mechanical Engineering graduates over the next decade. Additionally, the section consults other sources to gain a better perspective on career opportunities for employees with bachelor's degrees in Mechanical Engineering.
- **Section III: Mechanical Engineering Programs in Wisconsin** examines each of the five bachelor-level Mechanical Engineering programs in the state. Each program's priorities and curriculum are described along with any other relevant information regarding the program.

KEY FINDINGS

- Completion data indicate that demand among students for Mechanical Engineering degrees at the bachelor's level is increasing. Nationwide, the compound annual growth rate for Mechanical Engineering is greater than the national average of all undergraduate degrees, as well as that of other engineering disciplines.
- In Wisconsin, Mechanical Engineering completion rates are increasing, but at a slower pace than some other engineering disciplines such as Architectural and Civil

[1] "What is Mechanical Engineering?" Columbia University. http://me.columbia.edu/what-mechanical-engineering

Engineering. Four of five Wisconsin institutions saw slight overall increases in the number of M.E. bachelor's degrees conferred from 2007 to 2011, with the exception of Marquette University.

- Among all engineering disciplines, Mechanical Engineering has the greatest number of total annual degree completions at both the state and national levels. In fact, a report published in the *Wall Street Journal* asserts that it is the 23rd most popular academic field of study in the nation.
- Job opportunities for Mechanical Engineering graduates are currently increasing at the national level and are predicted to continue to increase over the next decade. Observations show that national demand for engineers is outpacing the predicted supply. In Wisconsin, however, opportunities for mechanical engineers are increasing at much slower rates.
- The largest number of employment opportunities for Mechanical Engineering graduates is within "mechanical engineer" positions, but a large number of opportunities exist for cost estimators and engineering managers, as well. Of the professions considered in this report, cost estimator is the occupation expected to grow most rapidly over the next 10 years.
- The five institutions profiled in this report follow similar curricula. Beyond general institutional requirements, students must complete advanced courses in Math Physics, and Chemistry, as well as numerous M.E. core courses. These include: Dynamics, Material Science, Thermodynamics, Mechanics of Materials, Fluids, Circuits/Electromechanics, Heat Transfer, Manufacturing Processes, Machine Elements, and others. All programs require graduates to complete a culminating senior design project as well.
- Many of these institutions offer programs for students to earn practical experience in their field. Co-op programs allow students to spend a summer or semester working for a regional employer, gaining a better understanding of how their academic coursework can apply to real world occupations. Certain institutions also offer study abroad experiences, a B.S./M.S. program, or a "2+2" program for students with an associate's degree from a partnering technical college.

SECTION I: STUDENT DEMAND FOR A BACHELOR'S DEGREE IN MECHANICAL ENGINEERING

The first section of this report examines student demand for mechanical engineering bachelor's degree programs. To estimate student demand, we utilize degree completion data at the state and national level. This section also considers other indicators of student interest in mechanical engineering, such as reports published by national newspapers and postsecondary educational institutions.

METHODOLOGY

Demand for new academic programs can be estimated effectively, if indirectly, by examining recent trends in degree completion among similar programs at other universities. Completion trends function as rough predictors of student demand for a given academic program. For this report, looking at completions data for M.E. bachelor's degrees in Wisconsin and the nation as a whole assists in our assessment of demand for a similar program at UW-River Falls. We can reasonably infer that where completions of bachelor's degrees in Mechanical Engineering are increasing, demand for M.E. programs is also trending upward.

In this report, we utilize the **compound annual growth rate (CAGR)** metric to measure the growth or decline of the Mechanical Engineering field. CAGR is a measure of annual growth over an extended period of time that disregards the volatility of individual year-to-year changes in growth. CAGR functions as a simplified representation of growth within a given time period as if growth had occurred at a constant rate throughout the period. In addition to CAGR, some tables include standard deviation values that provide an idea of the extent to which completion numbers fluctuate on a yearly basis.

The completions data in this report were gathered from the Integrated Postsecondary Education Data System (IPEDS), a survey database managed by the National Center for Education Statistics (NCES). The NCES classifies academic programs using its Classification of Instructional Programs (CIP), a taxonomic system that assigns unique four- or six-digit numeric codes to different academic programs. The IPEDS database is populated with completions data that all U.S. institutions of higher education must classify according to CIP codes and submit to the NCES.[2]

For this report, there is a single, clearly-defined CIP code that covers all M.E. programs (14.1901).[3] This code will be used throughout the report to identify bachelor's degree programs in Mechanical Engineering. It is important to recognize that there is no guarantee

[2] Integrated Postsecondary Education Data System. NCES. http://nces.ed.gov/ipeds/datacenter/
[3] "Detail for CIP Code 14.1901." NCES. http://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88233

that the IPEDS data are comprehensive, as completions data are self-reported by the institutions.

The NCES collects completions data for a variety of academic award levels, including associate's, bachelor's, and master's degrees. In order to maintain relevance to UW – River Fall's prospective M.E. program, we focused on completions data for bachelor's degrees only.

National and State-Wide Completion Trends

This subsection contains degree completions tables created from the IPEDS data for bachelor's level completions in M.E. programs between 2007 and 2011.

National Completions

The data collected from the IPEDS library show that **the field of Mechanical Engineering has seen consistent growth nationally** every year except 2009, when total completions decreased very slightly. The NCES data in Figure 1.1 indicate that completions of M.E. bachelor's degrees have increased at a rate (4 percent) that exceeds national trends for other engineering degrees (3 percent) and bachelor's degrees in general, regardless of discipline (2 percent).

Figure 1.1: National Completions, Bachelor's Degrees in Mechanical Engineering (CIP 14.1901)

National Degree Category	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Mechanical Engineering Programs	**16,887**	**17,693**	**17,663**	**18,867**	**19,563**	**4%**	**669**	**446**
All Engineering Programs	68,313	69,799	70,418	74,084	77,742	3%	2,357	1,340
All Academic Programs	1,625,987	1,662,275	1,702,829	1,756,432	1,827,639	2%	50,143	13,595

Source: IPEDS

Completions in Wisconsin

Figure 1.2 on the following page presents bachelor's degree completions data for M.E. programs in Wisconsin between 2007 and 2011. For comparison purposes, the table also includes completion data grouped into "all engineering" and "all academic" categories. The IPEDS database shows that five Wisconsin institutions currently offer a bachelor's degree in Mechanical Engineering:

- Marquette University

- Milwaukee School of Engineering (MSOE)
- The University of Wisconsin-Madison (UW-Madison)
- The University of Wisconsin-Milwaukee (UW-Milwaukee)
- The University of Wisconsin-Platteville (UW-Platteville)

Of these five programs, UW-Madison confers the highest number of M.E. degrees, followed by MSOE, UW-Platteville, UW-Milwaukee, and Marquette. In 2011, M.E. programs accounted for 30 percent of all Wisconsin engineering completions and 1.2 percent of total statewide completions. The IPEDS data also show that in Wisconsin, Mechanical Engineering ranked 17th on the 2011 list of CIP categories accounting for the most bachelor's degree completions.

The average CAGR for M.E. completions in Wisconsin is 2 percent. This pace of growth is in line with the state average CAGR for all disciplines (2 percent), but it is less rapid than the CAGR for engineering degrees in general (4 percent). The CAGR value varies between institutions, as well: Marquette has the lowest CAGR (-7 percent), while MSOE and UW-Platteville have the highest CAGR (5 percent). However, the negative CAGR for Marquette does not necessarily indicate a dramatic contraction in its M.E. program; the high standard deviation (relative to the total number of completions) indicates that the number of students completing the program fluctuates greatly on a year-to-year basis.

Figure 1.2: Wisconsin Completions, Bachelor's Degrees in Mechanical Engineering (CIP 14.1901)

University	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
UW-Madison	178	171	143	169	185	1%	1.75	21
Milwaukee School of Engineering	95	77	79	113	116	5%	5.25	19
UW-Platteville	86	106	63	67	104	5%	4.5	30
UW-Milwaukee	56	58	58	66	61	2%	1.25	5
Marquette University	55	45	52	54	42	-7%	-3.25	8
Grand Total	**470**	**457**	**395**	**469**	**508**	**2%**	**9.5**	**52**
All Engineering Programs - WI	1,571	1,443	1,457	1,571	1,701	4%	33	103
All Academic Programs - WI	37,037	37,716	38,257	38,877	40,046	2%	752	246

Source: IPEDS

The IPEDS data in Figure 1.3 on the following page demonstrate that in Wisconsin, **Mechanical Engineering is the most popular engineering program by total number of completions**, with 77 percent more completions than the next largest field. Its modest growth rate of 2 percent is surpassed only by Architectural, Civil, and Bioengineering/ Biomedical Engineering.

The IPEDS completion data show that **Mechanical Engineering is an academic field that continues to grow, although the M.E. growth rate in Wisconsin is slower than the national growth rate**. All but one of the current M.E. programs in Wisconsin show positive growth. And while Mechanical Engineering does not have the explosive growth of programs such as Architectural Engineering, it remains the engineering program with the greatest number of total completions.

Figure 1.3: Wisconsin Completions, Bachelor's Degrees in Engineering Fields (>50 Completions per Year)

Academic Program	2007	2008	2009	2010	2011	CAGR	Average Annual Change	Standard Deviation of Annual Changes
Mechanical Engineering	**470**	**457**	**395**	**469**	**508**	**2%**	**9.5**	**37**
Civil Engineering	238	244	253	253	286	5%	12	17
Electrical/Electronics Engineering	240	192	195	188	218	-2%	-5.5	20
Bioengineering/Biomedical Engineering	126	97	131	139	137	2%	2.75	15
Architectural Engineering	44	46	58	61	88	19%	11	16
Industrial Engineering	92	64	64	97	85	-2%	-1.75	14
Computer Engineering, General	90	65	76	73	72	-5%	-4.5	8
Chemical Engineering	72	67	59	49	71	0%	-0.25	9

Source: IPEDS

Other Indicators of Student Demand

There is minimal literature on trends relating to growing or declining student interest in M.E. programs; however, some evidence that Mechanical Engineering is a popular degree choice does exist. According to a recent *Wall Street Journal* article citing work by the Georgetown University Center on Education and the Workforce, Mechanical Engineering is a lucrative, stable, and popular degree choice. The piece reported that **Mechanical Engineering is the 23rd most popular major among students in the United States**, surpassed only by Electrical Engineering among engineering disciplines. Of the top 25 most popular fields of study in that report, **Mechanical Engineering has the second-highest median salary and the third-lowest unemployment rate**.[4]

[4] "From College Major to Career." *The Wall Street Journal*. http://graphicsweb.wsj.com/documents/NILF1111/#term=

A 2008 study by Colorado State University and Utah State University on factors influencing college major selection concludes that **two of the three most important factors in students' college major choices are long-term earning potential and job stability**.[5] This reflects positively on the future of mechanical engineering educational programs, as studies such as Georgetown University's "What's it Worth" project continue to show that engineering degrees prove to be the most valuable from a career earnings standpoint.[6] Findings from the Georgetown study, illustrated in Figure 1.4, demonstrate that within the broad category of engineering, M.E. graduates have the sixth-highest median salaries.[7] Further, an American Society of Engineers (ASME) 2012 salary survey suggests that engineers in Wisconsin metropolitan areas make more than their counterparts across the country. The survey shows that the median income for engineers in Wisconsin cities is slightly higher than the national average.[8]

Figure 1.5: Median Salary by Engineering Degree Program

ACADEMIC PROGRAM	MEDIAN SALARY	2011 DEGREE COMPLETIONS
Petroleum Engineering	120,000	1,030
Aerospace Engineering	87,000	3,388
Chemical Engineering	86,000	6,391
Electrical Engineering	85,000	11,880
Naval Architecture/Marine Engineering	82,000	365
Mechanical Engineering	**80,000**	**19,563**
Metallurgical Engineering	80,000	115
Mining and Mineral Engineering	80,000	226
Civil Engineering	78,000	12,605
Engineering Mechanics, Physics, and Science	78,000	1,001
All Engineering Degrees	75,000	77,742

Source: Georgetown University, IPEDS

[5] Cho, J., et. al. "An Exploratory Study on Factors Influencing Major Selection." *Issues in Information Systems,* 9:1, 2008, p.171. http://iacis.org/iis/2008/S2008_1060.pdf

[6] Carnevale, A., et. al. "What's it Worth." Georgetown University Center on Education and the Workforce. May 24, 2011. http://cew.georgetown.edu/whatsitworth/

[7] Carnevale, A., et. al. "Engineering." Georgetown University. May 24, 2011. http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/engineering.pdf

[8] "The Engineering Income and Salary Survey." American Society of Mechanical Engineers. April 1, 2012, p.29-31. http://files.asme.org/asmeorg/Jobs/Manage/32673.pdf

SECTION II: LABOR MARKET DEMAND FOR MECHANICAL ENGINEERING GRADUATES

Section two of this report transitions from student demand for M.E. programs to employer demand for M.E. graduates. The primary sources utilized in this section are the employment projections provided by the U.S. Bureau of Labor Statistics' (BLS) and Wisconsin's Department of Workforce Development. The section closes with an examination of other indicators of labor market demand for M.E. graduates.

METHODOLOGY

While higher education completions data refer to CIP codes that are directly linked to specific areas of academic study, labor market data rely on the Standard Occupational Classification (SOC) system. This six-digit method of organization includes 840 detailed occupations arranged in 23 major groups.[9] To streamline the process of analyzing labor market and education statistics collectively, the National Crosswalk Service Center provides CIP to SOC crosswalk tables. For this report, the crosswalk identifies five occupations that align with the CIP for Mechanical Engineering:

- Architectural and Engineering Managers (SOC 11-9041)
- Cost Estimators (SOC 13-1051)
- Aerospace Engineers (SOC 17-2011)
- Mechanical Engineers (SOC 17-2141)
- Postsecondary Engineering Teachers (SOC 25-1032)

EMPLOYMENT PROJECTIONS

NATIONAL LABOR MARKET OUTLOOK

The four occupations of Architectural and Engineering Managers, Cost Estimators, Aerospace Engineers, and Mechanical Engineers are included in our analysis in this section. However, the BLS does not keep data on specific branches of postsecondary teaching, instead only providing employment projections for postsecondary teachers in general. For this reason, along with the understanding that the majority of postsecondary teaching jobs require an advanced degree beyond the bachelor's level, we have omitted Postsecondary Engineering Teachers from the tables below.

As shown in Figure 2.1 on the following page, total employment of professional Mechanical Engineers is higher than that of the other occupations considered in this report. The BLS predictions indicate that this should remain true for the next eight years. In the next decade, however, **the occupation of Cost Estimator is predicted to experience significant**

[9] "Standard Occupational Classification." U.S. Bureau of Labor Statistics. http://www.bls.gov/SOC/#classification

growth, increasing total employment by 36 percent and creating 103,000 open positions annually. The BLS estimates that by 2020 there will be nearly as many Cost Estimators as Mechanical Engineers.

Opportunities for Mechanical Engineers and Architectural and Engineering Managers are expected to grow at similar rates, at just under 9 percent per year. Even Aerospace Engineering, the field with the fewest estimated openings, is expected to grow at a rate of almost 5 percent.[10] It should be noted that these job opportunities are not exclusive to holders of bachelor's degrees in mechanical engineering; mechanical engineers with more advanced degrees, engineers from other disciplines, and non-engineers may occupy many of the available positions shown below.

Figure 2.1: National Occupational Outlook for Mechanical Engineering-Related Jobs

2010 National Employment Matrix title and code		Employment		Employment change, 2010-20		Average Annual Openings due to growth and replacement needs, 2010-20	Typical education needed for entry
		2010	2020	Number	Percent		
11-9041	Architectural and Engineering Managers	176,800	192,000	15,200	8.6%	49,700	Bachelor's degree
13-1051	Cost Estimators	185,400	252,900	67,500	36.4%	103,000	Bachelor's degree
17-2011	Aerospace Engineers	81,000	85,000	4,000	4.9%	800	Bachelor's degree
17-2141	Mechanical Engineers	243,200	264,600	21,300	8.8%	99,600	Bachelor's degree

Source: U.S. Bureau of Labor Statistics

Nationally, the comparison between degrees completed and job openings is favorable: 253,100 jobs (99,600 as "Mechanical Engineers") on average are predicted to be available annually while only 19,563 bachelor's-level mechanical engineers graduated in 2011. Using a 4 percent CAGR, that number increases to 27,844 graduates in 2020. At this level, job opportunities are greatly outpacing degree completions.

Wisconsin Labor Market Outlook

Wisconsin's state labor projections are notably different from those of the nation as a whole. Except for Aerospace Engineering, **all of the examined occupations in Wisconsin show slower projected growth than their national counterparts**. In fact, the data actually predict a decline in employment for Engineering Manager and Mechanical Engineer positions.

The Wisconsin labor data shown in Figure 2.2 estimate that between 2008 and 2018, an average of 440 job opportunities for holders of bachelor's degrees in Mechanical

[10] "Employment by Occupation." U.S. Bureau of Labor Statistics. http://www.bls.gov/emp/ep_table_102.htm

Engineering will be available annually (but only 190 as "Mechanical Engineers"), while the data from Figure 1.2 at the beginning of this report indicate that higher education institutions in Wisconsin produced 508 bachelor's-level M.E. graduates in 2011. If the CAGR for Wisconsin M.E. completions is extended through 2018, the number of graduates produced swells to 584. Thus, **the data may suggest that Wisconsin universities are producing M.E. graduates at a slightly faster rate than the state labor market is creating job opportunities**.

Figure 2.2: Wisconsin Occupational Outlook for Mechanical Engineering-Related Jobs

2008 Wisconsin Employment Matrix Title and Code		Employment		Employment Change, 2008-18*		Average Annual Openings due to Growth and Replacement Needs, 2008-18	Typical Education Needed for Entry
		2008	2018	Number	Percent		
11-9041	Engineering Managers	3,870	3,750	- 120	- 3.1%	80	Bachelor's or higher degree, plus work experience
13-1051	Cost Estimators	5,380	5,920	540	10.1%	170	Bachelor's degree
17-2011	Aerospace Engineers	110	110	10	5.6%	0	Bachelor's degree
17-2141	Mechanical Engineers	7,440	7,320	- 120	- 1.6%	190	Bachelor's degree

* Employment numbers are rounded to the nearest 10. Because of this rounding, numbers and percentages may not add up precisely.
Source: Wisconsin Department of Workforce Development, Statewide Long-Term Projections[11]

Other Indicators of Labor Market Demand

Despite the state-level labor projections in Wisconsin, other indicators of demand for mechanical engineers are more positive. A 2011 survey of employers by the National Association of Colleges and Employers (NACE) revealed that **Mechanical Engineering is one of the five most sought-after bachelor's-level degrees,** as demonstrated in Figure 2.3 below. According to the same NACE study, Mechanical Engineering is also the fifth most in-demand undergraduate degree for the Midwest region.[12]

Figure 2.3: Most In-Demand Majors, 2011

Rank	Academic Field
1	Finance
2	Accounting
3	Computer and Information Sciences
4	Electrical Engineering

[11] "OEA 2008-2018 Statewide Long-Term Projections." Wisconsin Office of Economic Advisors. http://dwd.wisconsin.gov/oea/employment_projections/long_term_projections.htm
[12] "Job Outlook 2012." National Association of Colleges and Employers. November 2011, p.15. http://www.careers.uiowa.edu/leadershipacademy/NACE%20Job_Outlook_2012.pdf

Rank	Academic Field
5	**Mechanical Engineering**
6	Business Administration/Management
7	Management Information Systems
8	Computer Engineering
9	Economics
10	Logistics/Materials Management

Source: National Association of Colleges and Employers

In a 2011 white paper, Identified, an organization that analyzes employment trends by collecting data on over 50 million Facebook users, created its own metric to measure labor market demand for employees with specific academic backgrounds. The Identified score measures how often employers search for, view, message, and hire employees with a certain academic background. According to the report, engineers of all kinds were "searched for, viewed, contacted, and hired 23 percent more often" than candidates with other academic backgrounds. Interestingly, this is not only true for technical fields such as engineering or science; for non-technical jobs in general, engineering graduates are more desirable than graduates from other programs.[13]

Further, a 2012 report from Wanted Analytics that evaluated labor market opportunities for mechanical engineers by measuring the volume of job advertisements identified **areas of Wisconsin among the best locations for mechanical engineers to find jobs**. These metropolitan areas are listed in Figure 2.4 below.[14] Wanted Analytics' research of job listings also concludes that among engineering disciplines, Mechanical Engineers are the most in-demand.[15]

Figure 2.4: Wanted Analytics, Best Places for Mechanical Engineers to Look for Work

Rank	Metropolitan Area
1	Detroit-Warren-Livonia, MI
2	Albany-Schenectady-Troy, NY
3	New Orleans-Metairie-Kenner, LA
4	State College, PA
5	Logan, UT
8	**Madison, WI**
10	**La Crosse, WI**
20	**Milwaukee-Waukesha-West Allis, WI**

Source: Wanted Analytics

[13] "Revenge of the Nerds: Part 1 of 3." Identified. December 21, 2011, p.3. http://identified.typepad.com/wp/revengeofthenerdspart1.pdf

[14] "The Top 20 Best & Worst Places to Look for Work: Mechanical Engineers." Wanted Analytics. August 16, 2012, p.4. http://www.wantedanalytics.com/insight/c/uploads/2011/05/Mechanical-Engineer_August-2012.pdf

[15] Rowe, A. "Most In-Demand Engineers." Wanted Analytics. September 22, 2012. http://www.wantedanalytics.com/insight/2012/09/22/most-in-demand-engineers/

A 2012 Wanted report focused on mechanical engineering opportunities asserts that **"the talent pool of Mechanical Engineers remains limited and hiring demand is out-pacing the supply of qualified candidates"** and "despite slow job growth in manufacturing industries… hiring for Engineers to design and build machines has grown quickly in the past years."[16]

According to a 2011 survey by the American Society of Mechanical Engineers (ASME), engineers themselves have a positive view of the potential for careers in mechanical engineering. Ninety-seven percent of mechanical engineers surveyed felt "optimistic" or "moderately optimistic" about the future of the engineering profession's ability to meet global challenges. This optimism is shared among all engineering industries, though it is more tempered in the downsizing aerospace industry. The 2011 ASME survey also reveals that:

> While there is a belief that overall global opportunities will increase along with the number of engineers working in developing countries, survey respondents for the most part do not expect they will need to relocate in order to pursue the most meaningful opportunities. This finding reflects the belief that the growth of locally trained mechanical engineering talent is predicted to provide the needed expertise.[17]

The available data seem to concur that the national market is fertile for M.E. graduates. BLS data indicate that opportunities will outpace graduation rates over the next eight years, and reports by the NACE and Identified argue that Mechanical Engineering is a degree in high demand among employers. The ASME suggests that mechanical engineers in general feel optimistic about the future of engineering both nationally and internationally. At the Wisconsin state level, however, the data are less conclusive. Labor predictions seem to indicate that opportunities for mechanical engineers will increase only modestly, and at a slower pace than the increase in M.E. graduates. However, Wanted Analytics' job ad survey does claim that Wisconsin hosts some of the best places for job-seeking mechanical engineers.

[16] Lombardi, A. "Hiring for Mechanical Engineering Skills Still Increasing." Wanted Analytics. March 28, 2012. http://www.wantedanalytics.com/insight/2012/03/28/hiring-for-mechanical-engineering-skills-still-increasing/

[17] "The State of Mechanical Engineering: Today and Beyond." American Society of Mechanical Engineers. June 2011, p.5, 6. http://files.asme.org/asmeorg/Campaigns/MS/2012/32754.pdf?channel=METODAY&Campaign=ME-STUDY?cm_mmc=METODAY-_-ME-STUDY-_-Email

SECTION III: MECHANICAL ENGINEERING PROGRAMS IN WISCONSIN

In this final section, Hanover profiles the five existing bachelor's level M.E. programs in Wisconsin. All of the programs offer four-year, accredited programs that culminate in the conferral of a bachelor's degree in Mechanical Engineering.

The programs profiled in this section include:

- Marquette University, Bachelor of Science in Mechanical Engineering
- Milwaukee School of Engineering, Bachelor of Science in Mechanical Engineering
- The University of Wisconsin-Milwaukee, Bachelor of Science in Engineering (B.S.E.) in Mechanical Engineering
- The University of Wisconsin-Madison, Bachelor of Science in Mechanical Engineering
- The University of Wisconsin-Platteville, Bachelor of Science in Mechanical Engineering

MARQUETTE UNIVERSITY

The stated mission of the B.S. in Mechanical Engineering program at Marquette University is to "offer a high quality, up-to-date, nationally-recognized engineering program which prepares students for successful careers." The department also strives to cultivate graduates who are able to:

- Solve mechanical engineering problems in the areas of mechanical systems, thermal/fluid systems, and manufacturing systems by applying fundamental knowledge in mathematics and science.
- Solve open-ended (design-oriented) problems by judiciously applying the skills of perception, synthesis, analysis, selection/rationale, realization, verification, collaboration, and communication.
- Collaborate effectively within a professional environment by consistently demonstrating the personal characteristics of productivity, responsibility, integrity, supportiveness, and enthusiasm.
- Take ownership of personal and career advancement.[18]

The typical degree path for a B.S. in Mechanical Engineering at Marquette includes **134 total credit hours**. Students take two general engineering classes during freshman year along with Math, Physics, and English requirements. The sophomore, junior, and senior years are

[18] Bulleted points taken verbatim from: "Educational Objectives." Marquette University. http://bulletin.marquette.edu/undergrad/collegeofengineering/departmentofmechanicalengineering/#typicalprogramformechanicalengineeringmajors

then comprised almost entirely of courses in the Mechanical Engineering catalog. M.E. students are also given the opportunity to focus their coursework on one of three specific specializations: Energy Systems, Manufacturing Systems, and Mechanical Systems. Figure 3.1 below demonstrates a typical course schedule for a student pursuing the B.S. in Mechanical Engineering at Marquette.

Figure 3.1: Marquette University, Typical Mechanical Engineering Coursework

First Term	Second Term
Freshman Year	
▪ ENGL 1001: Rhetoric and Composition I ▪ GEEN 1200: Engineering Discovery I ▪ MATH 1450: Calculus I ▪ PHYS 1003: General Physics with Intro Calculus I ▪ Core elective	▪ Core Rhetoric 1002 ▪ GEEN 1210: Engineering Discovery II ▪ MATH 1451: Calculus II ▪ PHYS 1004: General Physics with Intro Calculus II ▪ Core elective
Sophomore Year	
▪ CHEM 1001: General Chemistry I ▪ MEEN 2110: Statistics ▪ GEEN 2951: Professional Development for Engineers ▪ MEEN 2460: Material Sciences ▪ MATH 2450: Calculus III ▪ Core elective	▪ CHEM 1002: General Chemistry II ▪ MEEN 2120: Dynamics ▪ MEEN 2130: Mechanics of Materials ▪ MEEN 2210: Electromechanical Engineering Systems ▪ MATH 2451: Differential Equations
Junior Year	
▪ MEEN 3220: Dynamics of Mechanical Systems ▪ MEEN 3310: Thermodynamics I ▪ MEEN 3320: Fluid Mechanics ▪ MEEN 3426: Engineering Statistics ▪ MEEN 3460: Materials Selection in Mechanical Design ▪ PHIL 1001: Philosophy of Human Nature	▪ MEEN 3210: Multidisciplinary Engineering Systems ▪ MEEN 3250: Design of Machine Elements I ▪ MEEN 3330: Fundamentals of Heat Transfer ▪ MEEN 3443: Manufacturing Engineering ▪ PHIL 2310: Theory of Ethics
Senior Year	
▪ MEEN 3260: Numerical Methods of Mechanical Systems ▪ MEEN 3340: Thermodynamics II ▪ MEEN 4920: Principles of Design ▪ MEEN 4590: Engineering Fundamentals Review ▪ MEEN elective ▪ THEO 1001: Introduction to Theology	▪ MEEN 4998: Senior Design Project ▪ MEEN elective ▪ MEEN elective ▪ THEO elective ▪ Core/Free elective

Source: Marquette University[19]

In addition to the standard coursework, Engineering students at Marquette have the opportunity to participate in a **co-op program that combines academic study and work experience**. The co-op is a partnership between local employers, students, and the university that allows students to alternate between work and learning semesters. At

[19] Ibid.

Marquette, 47 percent of eligible junior- and senior-standing Engineering students participate in the co-op program.[20]

The B.S. in Mechanical Engineering at Marquette is a four-year program; however, in addition to the standard four-year B.S., Marquette offers two other paths to obtaining a B.S. in Mechanical Engineering. The **"2 + 2" program** is the result of an arrangement between Marquette and Waukesha Country Technical College to provide a pathway for students at the technical college to apply their associate's degrees toward earning a B.S. degree at Marquette. Participating students who meet specific grade-point and coursework criteria may receive junior standing upon transfer to Marquette's M.E. program.[21] **Marquette also offers a five year B.S./M.S. program**, which allows exceptional juniors to take master's level courses in their senior year. One additional year of study is required for students to graduate with the M.S. degree.[22]

Graduates of Marquette's M.E. program have gone on to work for companies such as:

- A.O. Smith Corporation
- Briggs & Stratton Corporation
- Caterpillar
- Eaton Corporation
- Ford Motor Company
- General Motors Corporation
- Harley-Davidson
- Johnson Controls
- Kimberly-Clark Corporation[23]

The NCES reported that 42 students graduated from Marquette with a B.S. in Mechanical Engineering in 2011, which was the lowest figure from the examined five-year period. While this number contributes to Marquette's negative CAGR value, the data do not show a consistent pattern of declining completion rates. Completions increased between 2008 and 2010 before dropping in 2011. For this reason and because of the program's small size relative to the other programs in this report, it is difficult to make a reliable conclusion about the growth or decline of the Marquette M.E. program.

[20] "Engineering Co-op Program." Marquette University. http://www.marquette.edu/engineering/coop_eng/whatis.shtml
[21] "2 + 2 Program with WCTC." Marquette University. http://www.marquette.edu/engineering/mechanical/ugrad_2plus2.shtml
[22] "Five Year B.S./M.S. Program." Marquette University. http://www.marquette.edu/engineering/mechanical/ugrad_5year.shtml
[23] "Overview." Marquette University. http://www.marquette.edu/engineering/mechanical/overview.shtml

MILWAUKEE SCHOOL OF ENGINEERING

Milwaukee School of Engineering (MSOE) offers a four-year B.S. in Mechanical Engineering degree. Nationally, MSOE's School of Engineering ranked 14th in the *U.S. News and World Report* 2013 list of best universities where doctorate degrees are not offered.[24] Specifically, MSOE's M.E. program was ranked 11th on the list of best M.E. programs at universities that do not offer doctorate degrees.[25]

The M.E. program's stated goal is to prepare its students for industry or advanced learning by fostering socially- and ethically-responsible graduates in an intimate, involved learning environment. Its educational objectives are to produce engineering graduates who will be productive, self-aware contributors who show initiative and interest in continued professional development. MSOE's M.E. program also seeks to fulfill a given set of student outcomes. It aims to graduate students that:

- Have an ability to apply knowledge of math, engineering, and science;
- Have an ability to design and conduct experiments, and to analyze and interpret data;
- Have an ability to design a system, component or process to meet needs within realistic constraints;
- Have the ability to function on multi-disciplinary teams;
- Have the ability to identify, formulate, and solve mechanical engineering problems;
- Have an understanding of professional and ethical responsibility;
- Have an ability to communicate effectively;
- Have the broad education necessary to understand the impact of engineering solutions in a global and societal context;
- Have the recognition of need for, and an ability to engage in, life-long learning;
- Have a knowledge of contemporary issues;
- Have the ability to use techniques, skills, and tools in engineering practice; and
- Have the ability to work professionally in both thermal and mechanical systems areas.[26]

The MSOE M.E. curriculum follows a standard four-year structure, beginning with a broad-based education in the freshman year that transitions into focused engineering courses during the sophomore year. Juniors study specialized fields in-depth, and the senior year is

[24] "Best Undergraduate Engineering Programs Rankings." *U.S. News and World Report.* http://premium.usnews.com/best-colleges/rankings/engineering-no-doctorate/page+2

[25] "Mechanical Rankings." *U.S. News and World Report.* http://premium.usnews.com/best-colleges/rankings/engineering-mechanical/page+2

[26] Bulleted points taken verbatim from: "BSME Program Educational Objectives and Student Outcomes." Milwaukee School of Engineering. http://www.msoe.edu/academics/academic_departments/mechanical_engineering/bsme/goals.shtml

focused on the application of the knowledge acquired in the previous three years.[27] Like many other M.E. programs, MSOE's B.S. program culminates in a senior design project, which in the past has included submissions of human powered vehicles, contributions to NASA's lunar lander projects, and intelligent ground vehicles.[28] Figure 3.2 below demonstrates a model schedule for a full-time student completing the B.S. in Mechanical Engineering.

Figure 3.2: Milwaukee School of Engineering, Typical Mechanical Engineering Coursework

QUARTER 1	QUARTER 2	QUARTER 3
FRESHMAN YEAR		
▪ CH 200: Chemistry I ▪ EN 131: Composition ▪ MA 136: Calculus for Engineers I ▪ ME 1601: Intro to Engineering Design ▪ OR 100: Freshman Orientation ▪ ME 1001: Mechanical Engineering Freshman Seminar	▪ HU 100: Contemporary Issues in the Humanities ▪ MA 137: Calculus for Engineers II ▪ ME 190: Computer Applications in Engineering I ▪ PH 2010: Physics I	▪ CH 201: Chemistry II ▪ EN 132: Technical Composition ▪ MA 231: Calculus for Engineers III ▪ ME 191: Computer Applications for Engineering II ▪ PH 2020: Physics II
SOPHOMORE YEAR		
▪ MA 235: Differential Equations for Engineers ▪ ME 205: Engineering Statistics ▪ PH 2030: Physics III ▪ EE 201: Linear Networks	▪ EN 241: Speech ▪ MA 232: Calculus for Engineers IV ▪ ME 206: Engineering Dynamics ▪ Elective ▪ EE 253: Analysts and Control of Electromechanical Devices	▪ MA 262: Probability and Statistics ▪ ME 207: Mechanics of Materials ▪ ME 230: Dynamics of Systems ▪ Electives (2)
JUNIOR YEAR		
▪ ME 300: Modeling and Numerical Analysis ▪ ME 309: Intermediate Mechanics of Materials ▪ ME 311: Principles of Thermodynamics I ▪ ME 321: Materials Science ▪ Elective	▪ ME 314: Principles of Thermodynamics II ▪ ME 317: Fluid Mechanics ▪ ME 322: Engineering Materials ▪ ME 361: Dynamics of Machinery ▪ Elective	▪ IE 340: Project Management ▪ ME 318: Heat Transfer ▪ ME 232: Manufacturing Processes ▪ ME 363: Design of Machine Components ▪ Elective
SENIOR YEAR		
▪ ME 416: Thermodynamics Applications ▪ ME 431: Automatic Control Systems ▪ ME 460: Finite Element Methods ▪ ME 490: Senior Design I ▪ SS 461: Organizational Psychology	▪ IE 423: Engineering Economy ▪ ME 433: Electromechanical Systems ▪ ME 491: Senior Design II ▪ Electives (2)	▪ HU 432: Ethics for Professional Managers and Engineers ▪ Electives (4)

Source: Milwaukee School of Engineering Course Catalog

[27] "Course Catalog." Milwaukee School of Engineering. 2012, pp.188-191. http://www.msoe.edu/academics/course_catalog/undergrad2012-13.pdf#nameddest=BSME

[28] "Senior Design Projects." Milwaukee School of Engineering. http://www.msoe.edu/academics/academic_departments/mechanical_engineering/bsme/projects.shtml

Citing the likelihood that graduates will interact with foreign companies or cultures in their careers, MSOE's M.E. department also partners with Lübeck University in Germany to provide a **study abroad opportunity for M.E. students**. This program, undertaken during the junior year, offers M.E. courses taught in English in addition to German language and culture courses. Students who take advantage of this opportunity earn two separate degrees from each university upon graduation.[29]

MSOE states that the placement rate of its most recent graduating class of mechanical engineers was 96 percent, and that the average starting salary of its graduates was $54,720. Graduates of MSOE's M.E. program went on to positions with companies such as:

- IBM
- DaimlerChrysler
- Brady Corporation
- Caterpillar, Inc.
- Metal Tek[30]

THE UNIVERSITY OF WISCONSIN-MILWAUKEE

UW-Milwaukee offers a B.S.E. in Mechanical Engineering, which has many similarities to the M.E. programs offered by the other institutions in this report.

In order to graduate with a B.S.E. in Mechanical Engineering, students at UW-Milwaukee must complete four semesters of coursework in math, science, general education, and core and M.E. courses. Within the Mechanical Engineering major, students are allowed to pursue a **general Mechanical Engineering concentration or focus on Thermal Sciences or Mechanical Systems**.[31] Figure 3.3 on the following page lists those courses required for all students in the College of Engineering and Applied Sciences, as well as the core courses required for the Mechanical Engineering major. In addition to these courses, students must also complete 14-16 credits of Math, 5-10 credits of Chemistry, 10 credits of Physics, and general education requirements in Art, Humanities, and Social Science.[32]

[29] "Lubeck University of Applied Sciences." Milwaukee School of Engineering. http://www.msoe.edu/academics/study_abroad/lbeck.shtml
[30] "B.S. in Mechanical Engineering." Milwaukee School of Engineering. http://www.msoe.edu/academics/academic_departments/mechanical_engineering/bsme/
[31] "Mechanical Engineering Major." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/ceas/academics/undergraduate_programs/majors/me/index.cfm
[32] "Mechanical Engineering Curriculum." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/ceas/assets/curriculumME.pdf

Figure 3.3: UW-Milwaukee, Required Courses for B.S.E. in Mechanical Engineering

ENGINEERING CORE (35 CREDITS)	MECHANICAL ENGINEERING MAJOR (33 CREDITS)
▪ EAS 100: Freshman Orientation ▪ EAS 200: Professional Seminar ▪ CompSci 151: Introduction to Scientific/Computer Programming ▪ CivEng 201: Statics ▪ CivEng 202: Dynamics ▪ CivEng3 03: Strength of Materials ▪ MatlEng 201: Engineering Materials ▪ ElecEng 301: Electrical Circuits I ▪ Mech 110, 111: Engineering Fundamentals I, II ▪ MechEng 301: Basic Engineering Thermodynamics ▪ MechEng 320: Introduction to Fluid Mechanics	▪ MechEng 321: Basic Heat Transfer ▪ MechEng 323: Fluid Mechanics Lab ▪ MechEng 330: Materials and Processes in Manufacturing ▪ MechEng 360: Mechanical Design I ▪ MechEng 366: Design of Machine Elements ▪ MechEng 370: Computer Aided Engineering Lab ▪ MechEng 438: Mechanical Engineering Experimentation ▪ IndEng 467: Introductory Statistics ▪ MechEng 474: Introduction to Control Systems ▪ MechEng 479: Control and Design of Mechatronic Systems ▪ MechEng 496: Senior Design Project

Source: The University of Wisconsin-Milwaukee

Like other examined engineering programs, UW-Milwaukee allows M.E. undergraduates to participate in **cooperative education opportunities** to gain professional experience prior to graduation. UW-Milwaukee's co-op program spans an approximately 46-week period that provides students with at least three work terms with the same company.[33]

Like Marquette, UW-Milwaukee offers an **integrated B.S./M.S. program** that reduces the time, cost, and admissions requirements involved in obtaining a master's degree. This program is not a five-year master's program; rather it allows students to take up to six credits of graduate-level classes during their senior year that can be applied toward master's degree coursework.[34] **Study abroad opportunities** are also available for UW-Milwaukee M.E. students. For example, students have the opportunity to participate in the renewable energy program offered at Kassel University in Germany, which allows students to observe the operations of international producers and consumers of renewable energy.[35]

According to UW-Milwaukee, graduates of its undergraduate M.E. program earn starting salaries of $54,000. M.E. students also participate in engineering projects such as the College of Engineering and Applied Science's Baja Race Car, NASA Remotely Operated Vehicle, and Human Powered Vehicles programs.[36]

[33] "Cooperative Education." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/ceas/career_services/students/career_coop.cfm
[34] "Integrated Bachelor of Science – Master of Science Program." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/ceas/academics/undergraduate_programs/bsms/
[35] "Mechanical Engineering." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/academics/four_year/ceas/mech_eng.pdf
[36] "College of Engineering and Applied Science." The University of Wisconsin-Milwaukee. http://www4.uwm.edu/ceas/future_students/upload/CEASFactSheet.pdf

THE UNIVERSITY OF WISCONSIN-MADISON

UW-Madison offers a four-year, accredited B.S. in Mechanical Engineering through the College of Engineering. Among Wisconsin institutions, UW-Madison produces the largest number of M.E. graduates – over 50 percent more than MSOE, the next-largest program. The UW-Madison undergraduate M.E. program was ranked 15th in the nation by the *U.S. News and World Report* in 2012.[37] While the university does not provide information on the placement rates of its graduates, the median entry-level salary for its M.E. graduates is $59,172.[38]

The program's stated goals are to graduate engineers that achieve the following objectives in the years immediately following graduation:

- Exhibit a fundamental understanding of broader engineering disciplines with strong skills in mechanical engineering, problem-solving, leadership, teamwork, and communication.
- Use these skills to contribute to their organizations and communities.
- Make thoughtful, well-informed decisions in their career and life.
- Demonstrate a continuing commitment to and interest in their own and other's education.[39]

UW-Madison also seeks to cultivate engineers with a relevant, valuable skill set. The student outcomes that UW-Madison aims to produce are:

- An ability to apply knowledge of mathematics, science, and engineering;
- An ability to design and conduct experiments, as well as to analyze and interpret data;
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- An ability to function on multidisciplinary teams;
- An ability to identify, formulate, and solve engineering problems;
- An understanding of professional and ethical responsibility;
- An ability to communicate effectively;
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- A recognition of the need for, and an ability to engage in life-long learning;

[37] "Indicators of Quality." The University of Wisconsin-Madison. http://www.engr.wisc.edu/me/me-about.html
[38] "Deciding on Job Offer(s)." The University of Wisconsin-Madison. https://ecs.engr.wisc.edu/public/student/offers.php
[39] Bulleted points taken verbatim from: "Educational Objectives and Student Outcomes." The University of Wisconsin-Madison. http://www.engr.wisc.edu/me/me-objectives-and-outcomes.html

- A knowledge of contemporary issues; and
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.[40]

Graduates of the UW-Madison B.S. in Mechanical Engineering program must complete four semesters of coursework, including 15 credit hours in liberal arts subjects in addition to the core required engineering courses. Figure 3.4 below details the coursework required of M.E. graduates.[41]

Figure 3.4: UW-Madison, Required Courses for B.S. in Mechanical Engineering

SEMESTER 1	SEMESTER 2
FRESHMAN YEAR	
▪ Math 221: Calculus ▪ InterEgr 101 or 102: Contemporary Issues ▪ Comm A ▪ ME 231: Graphics ▪ Chem 103: General Chemistry	▪ Stat 224: Statistics ▪ Math 222: Calculus and Analytical Geometry ▪ EMA 201: Statics ▪ Chem 104: General Chemistry
SOPHOMORE YEAR	
▪ Math 234: Calculus – Functions ▪ Math 320: Linear Math ▪ ME 240: Dynamics ▪ CS 302: Intro to Programming ▪ MS&E 350: Material Science ▪ Elective	▪ ME 361: Thermo ▪ Physics 202: Physics II ▪ ME 306: Mechanics of Materials ▪ ME 307: Materials Lab ▪ Elective
JUNIOR YEAR	
▪ ME 363: Fluids ▪ ECE 376: Circuits ▪ ME 340: Dynamic Systems ▪ EPD 397: Technical Commune ▪ ME 331: Geometric Modeling ▪ Elective	▪ ME 364: Heat Transfer ▪ ECE 377: Power Conversion ▪ ME 368: Measurements Lab ▪ ME 313: Manufacturing Processes ▪ Elective
SENIOR YEAR	
▪ ME 342: Machine Elements ▪ ME 351: Interdisciplinary Experiential Design Projects I ▪ ME 314: Manufacturing Fundamentals ▪ Electives (3)	▪ ME 370: Energy Lab ▪ ME 349: Design Project ▪ ME 352: Interdisciplinary Experiential Design Projects I ▪ Electives (3)

Source: The University of Wisconsin-Madison

Like other M.E. programs, UW-Madison provides **co-op opportunities** for its students in addition to its required curriculum.[42]

[40] Bulleted points are taken verbatim from: Ibid.
[41] "Recommended Mechanical Engineering Curriculum Flow Chart." The University of Wisconsin-Madison. 2012. http://www.engr.wisc.edu/cmsdocuments/me-flowchart-fall-2012.pdf
[42] "Co-op and Summer Intern Programs." The University of Wisconsin-Madison. https://ecs.engr.wisc.edu/public/student/coopintern.php

Beyond the *U.S. News & World Report* rankings, the undergraduate M.E. program at UW-Madison has made headlines for student achievements. For example, one student recently received national recognition for a project he undertook while at the university. Eric Ronning, a UW-Madison M.E. junior, developed an "inexpensive, body-powered prosthetic" that can be fabricated using a 3-D printer. The invention of the "ReHand" has created an affordable alternative to more expensive, complex prosthetics. The invention has earned over $22,000 in innovation prizes and laid the foundation for Ronning's recently-established startup company that aims to develop a market-ready version of the ReHand.[43]

THE UNIVERSITY OF WISCONSIN-PLATTEVILLE

The B.S. in Mechanical Engineering at UW-Platteville is a four-year, 131-credit program offered through the College of Engineering, Mathematics, and Science. In its mission statement, UW-Platteville's M.E. program communicates its goal of providing "an open, student-friendly environment with frequent student-faculty interaction that results in a quality undergraduate mechanical engineering education and enables our graduates to practice their profession with proficiency and integrity." The department lists five educational objectives:

- Graduate proficient mechanical engineers with a strong background in the technical areas;
- Graduate mechanical engineers with strong professional skills;
- Graduate engineers who understand the need for and have the capability and motivation to pursue continual professional development;
- Graduate engineers who are familiar with ethics and professionalism; and
- Graduate engineers with a well-rounded education to become quality citizens.[44]

The University participates in collaborative programs with two of the UW System's transfer campuses, **UW-Fox Valley and UW-Rock County**, to offer a B.S. in Mechanical Engineering degree at their campuses.[45] In the case of the Fox Valley partnership, the program was established to "meet the needs of business and industry in Northeast Wisconsin" and provides degrees and continuing education for technicians, engineering professionals, and cooperative education students in addition to its body of undergraduates seeking a four-year degree. The Collaborative Program creates opportunities for students to obtain an engineering degree on a non-traditional schedule, offering part-time and evening classes.[46]

[43] Simmons, D. "On Campus: UW-Madison engineering student wins national inventors prize." *Wisconsin State Journal*. December 17, 2012. http://host.madison.com/news/local/education/on_campus/on-campus-uw-madison-engineering-student-wins-national-inventors-prize/article_c8ac89a8-4886-11e2-8636-001a4bcf887a.html?comment_form=true

[44] Bulleted points taken verbatim from: "Program Mission." The University of Wisconsin-Platteville. http://www.uwplatt.edu/meie/mission.html

[45] "Mechanical Engineering." The University of Wisconsin-Platteville. http://www.uwplatt.edu/meie/index.html

[46] "Collaborative Program." The University of Wisconsin-Fox Valley. http://www.uwfox.uwc.edu/uwplatteville/

Students pursuing the B.S. in Mechanical Engineering must complete coursework in four general areas: General Education, Math and Science, General Engineering, and Professional Engineering. Just over half of the curriculum's required credits come from the General or Professional Engineering areas. Students are required to take math courses at least to the level of Differential Equations, along with three physics courses and one engineering chemistry course. Figure 3.5 below includes the required General and Professional Engineering Courses.

Figure 3.5: UW-Platteville, Required Engineering Courses for B.S. in Mechanical Engineering

GENERAL ENGINEERING (20 CREDITS)	PROFESSIONAL ENGINEERING (49 CREDITS)
▪ GE 1000: Engineering Success Skills ▪ GE 1030: Intro to Engineering Projects ▪ GE 2030: Engineering Modeling and Design ▪ GE 2820: Engineering Economy ▪ GE 2130: Statics ▪ GE 2230: Dynamics ▪ GE 2340: Mechanics of Materials ▪ GE 2930: Applications of Electrical Engineering	▪ ME 2630: Thermodynamics ▪ ME 3030: Dynamical Systems ▪ ME 3040: Engineering Materials ▪ ME 3230: Manufacturing Processes ▪ ME 3300: Fluid Dynamics ▪ ME 3330: Design of Machine Elements ▪ ME 3630: Applied Thermodynamics ▪ ME 3640: Heat Transfer ▪ ME 3720: Mechanical Systems Lab ▪ ME 3730: Mechanical Systems Design ▪ ME 3830: Mechanisms and Machines ▪ ME 4310: Automatic Controls (+ Lab) ▪ ME 4730: Thermal Systems Design (+ Lab) ▪ ME 4930: Senior Design* ▪ Three (3) Technical Electives

* Graduating seniors are required to complete a senior design project
Source: UW-Platteville[47]

In addition to the standard curriculum, UW-Platteville offers **co-op opportunities** to its M.E. students. Students have to complete 30 credits and earn a GPA of at least a 2.5 in order to participate in the co-op program.[48]

[47] "General Requirements for a Bachelor of Science Degree in Mechanical Engineering." The University of Wisconsin-Platteville. http://www.uwplatt.edu/meie/curriculum.html
[48] "Cooperative Education." The University of Wisconsin-Platteville. http://www.uwplatt.edu/ems/coop/index.html

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Market Demand for Baccalaureate Programs in Mechanical, Electrical, and Chemical Engineering

Methodology

For the purpose of this study, the Forum included job postings that require or prefer a bachelor's degree in the following locations:

- Wisconsin counties: Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Iron, Jackson, Juneau, La Crosse, Lincoln, Marathon, Monroe, Oneida, Pepin, Pierce, Polk, Price, Rusk, Saint Croix, Sawyer, Shawano, Taylor, Trempealeau, Vilas, Washburn, and Wood
- Minneapolis-St. Paul-Bloomington metropolitan statistical area (MSA)

The Forum conducted searches for job postings in Wisconsin counties and Minneapolis-St. Paul-Bloomington MSA separately.

The Forum conducted the following two searches for each location:

- The **"occupation-based search"** included job postings only for positions with the following occupational information network (O*NET) codes:
  - Mechanical engineering (O*NET code=17214100)
  - Electrical engineering (O*NET code=17207100)
  - Chemical engineering (O*NET code=17204100).
- The **"skill-based search"** included job postings with the following skills:
  - Mechanical engineering
  - Electrical engineering
  - Chemical engineering

All graphs display data from occupation-based searches except where otherwise noted. This report includes data from online job postings in the United States across 2010, 2011, 2012, and 2013.

Table of Contents

1) Wisconsin Counties

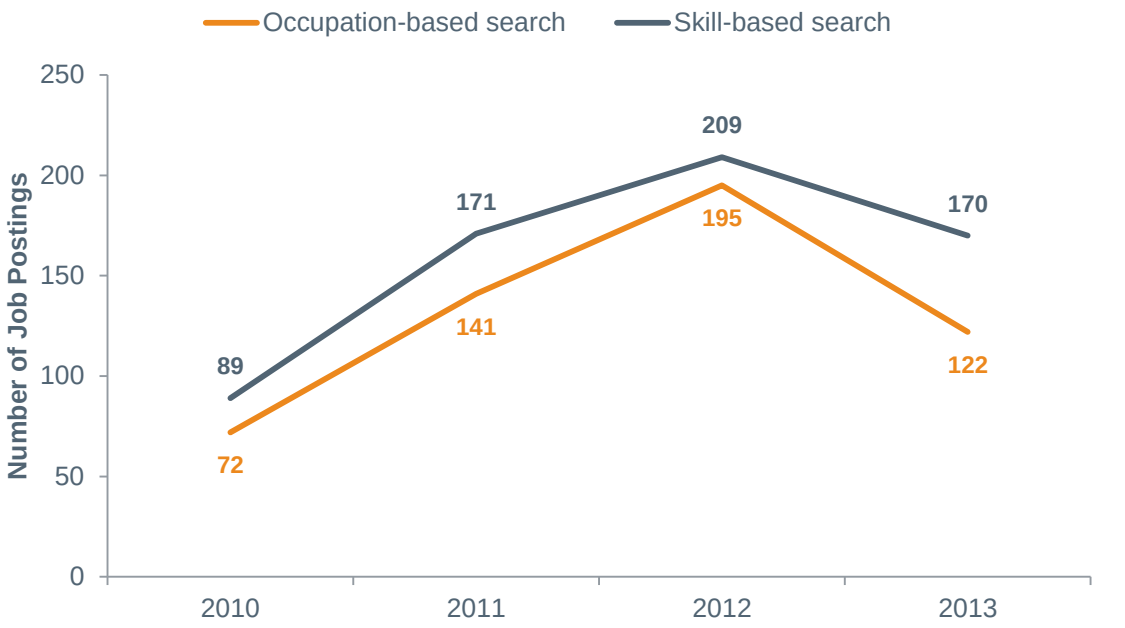
Job Demand Over Time

Mechanical Engineering Job Postings Demonstrate Increasing Demand

Employer demand for mechanical engineering positions has increased since 2010 with both occupation-based and skill-based searches.

Chart 1: Moderate Job Growth in Mechanical Engineering Positions

Wisconsin counties, January 2010 to December 2013



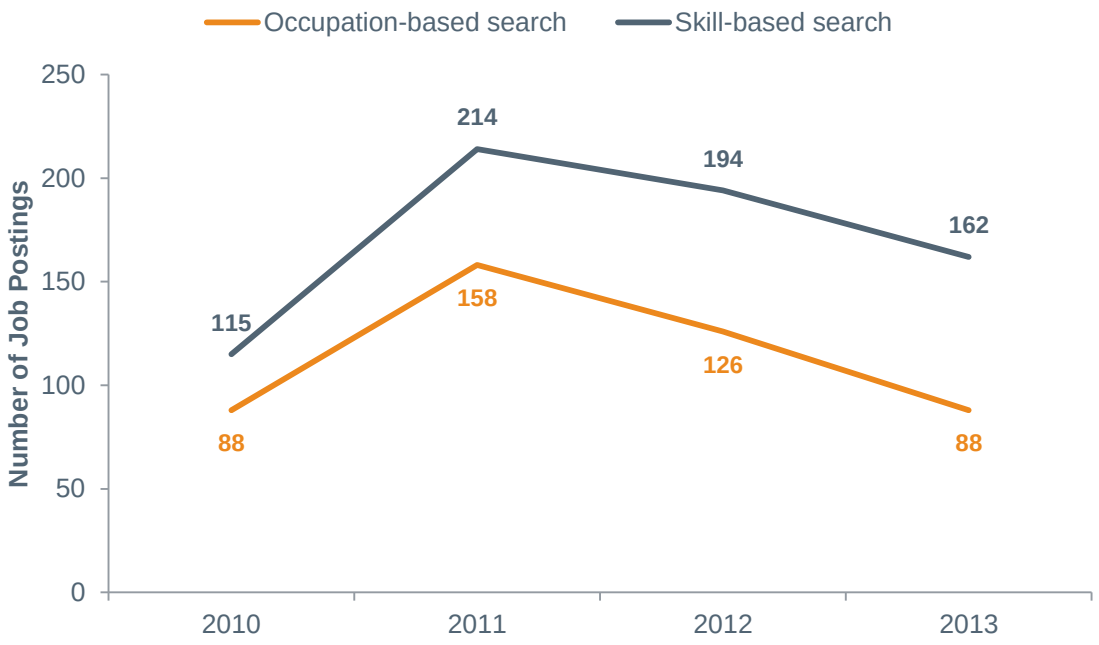
n=530 (occupation-based) and n=639 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Electrical Engineering Job Postings Remain Stable Over Time

Employer demand for electrical engineering positions increased from 2010 to 2011 but declined to near-previous numbers of postings from 2011 to 2013.

Chart 2: Modest Change in Number of Job Postings in Electrical Engineering Positions from 2010 to 2013

Wisconsin counties, January 2010 to December 2013



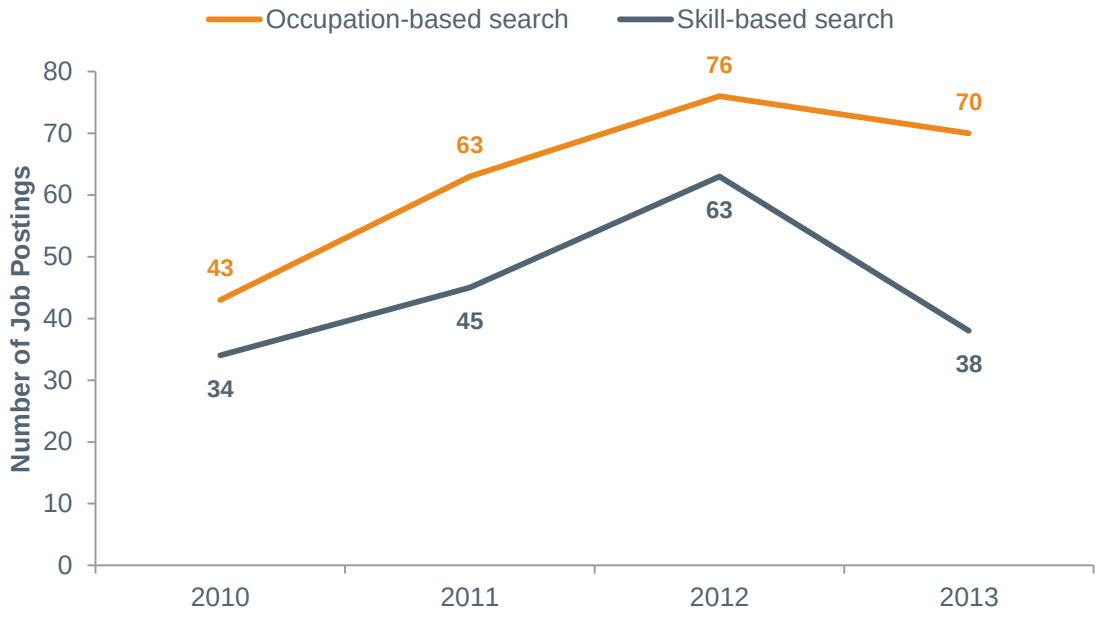
n=460 (occupation-based) and n=685 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Chemical Engineering Job Postings Remain Stable Over Time

Employer demand for chemical engineering positions increased from 2010 to 2011 but declined to near-previous numbers of postings from 2011 to 2013.

Chart 3: Modest Change in Number of Job Postings in Chemical Engineering Positions from 2010 to 2013

Wisconsin counties, January 2010 to December 2013



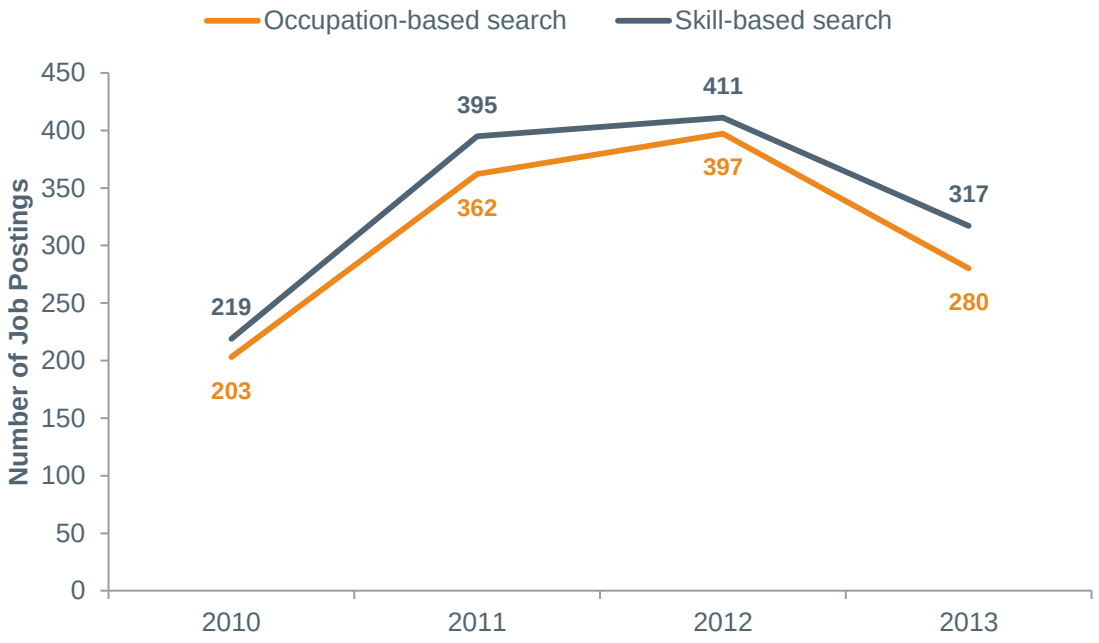
n=252 (occupation-based) and n=180 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Aggregate Mechanical, Electrical, and Chemical Engineering Job Postings Demonstrate Increasing Demand

Market demand for mechanical, electrical, and chemical engineering positions in the aggregate has increased from 2010 to 2013, with particularly high market demand in 2011 and 2012. Aggregated job postings are not cumulative because some job postings fall in more than one engineering field.

Chart 4: Moderate Job Growth in Aggregate Mechanical, Electrical, and Chemical Engineering Positions

Wisconsin counties, January 2010 to December 2013



n=1,242 (occupation-based) and n=1,342 (skill-based)
Source: Burning Glass Labor/Insight™

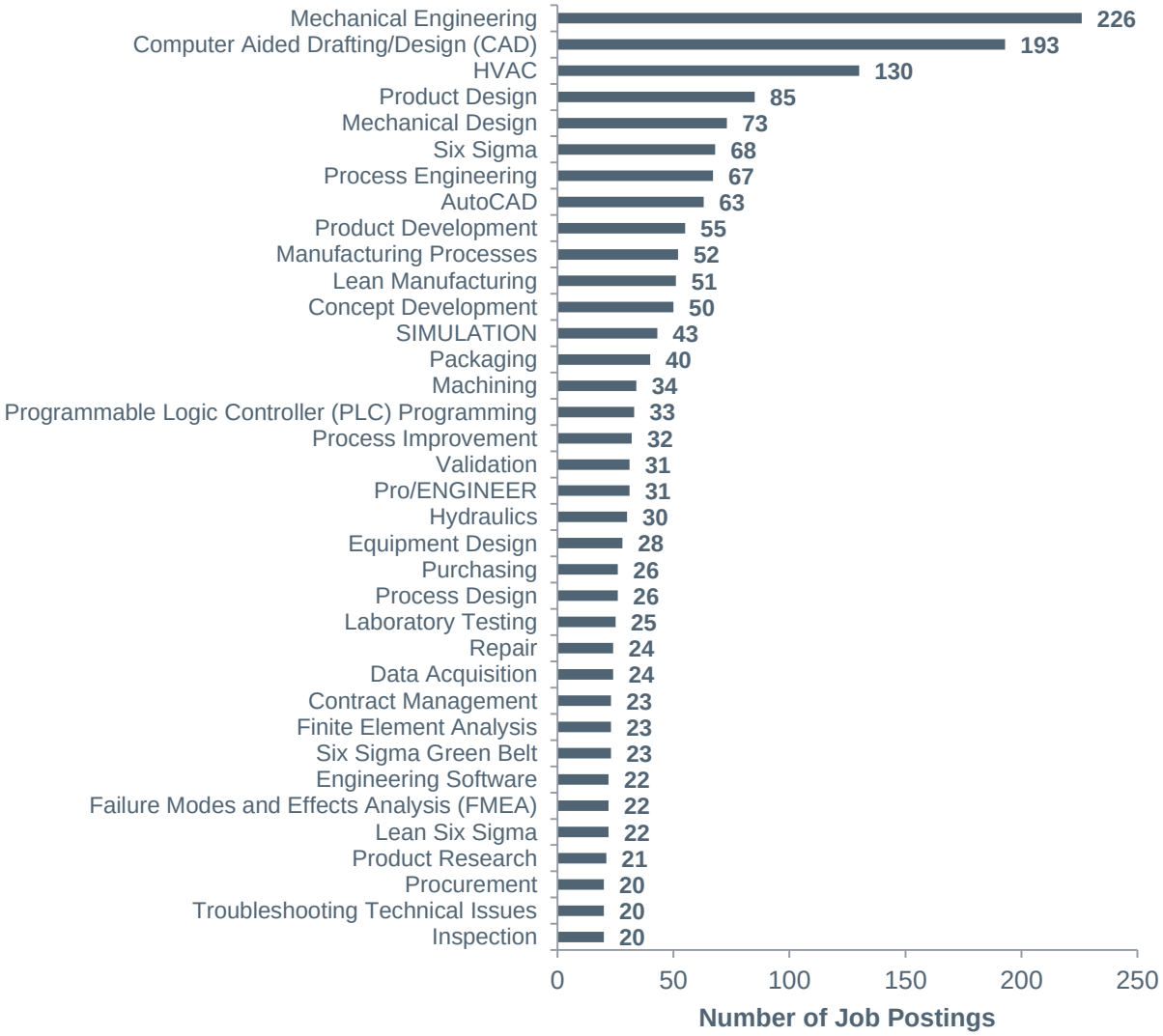
Top Skills

All Mechanical, Electrical, and Chemical Engineering Jobs Require Computer Aided Drafting/Design (CAD) and AutoCAD Skills

Top skills for all engineering job postings include CAD and AutoCAD. Notably, mechanical engineering is one of the top skills in demand for electrical engineering job postings.

Chart 5: Top Skills in Demand for Mechanical Engineering Postings

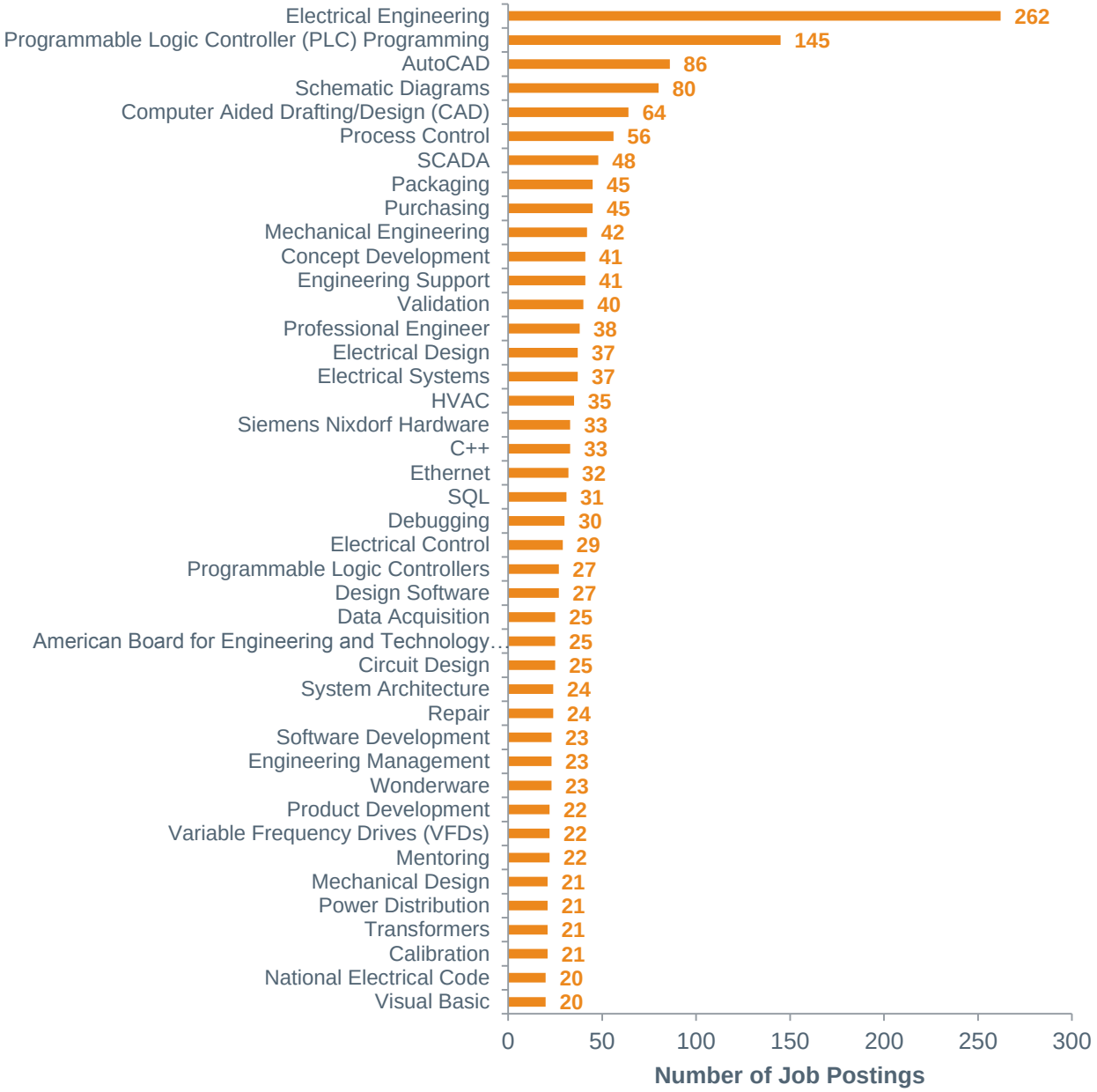
Wisconsin counties, January 2010 to December 2013



n=530 with 26 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 6: Top Skills in Demand for Electrical Engineering Postings

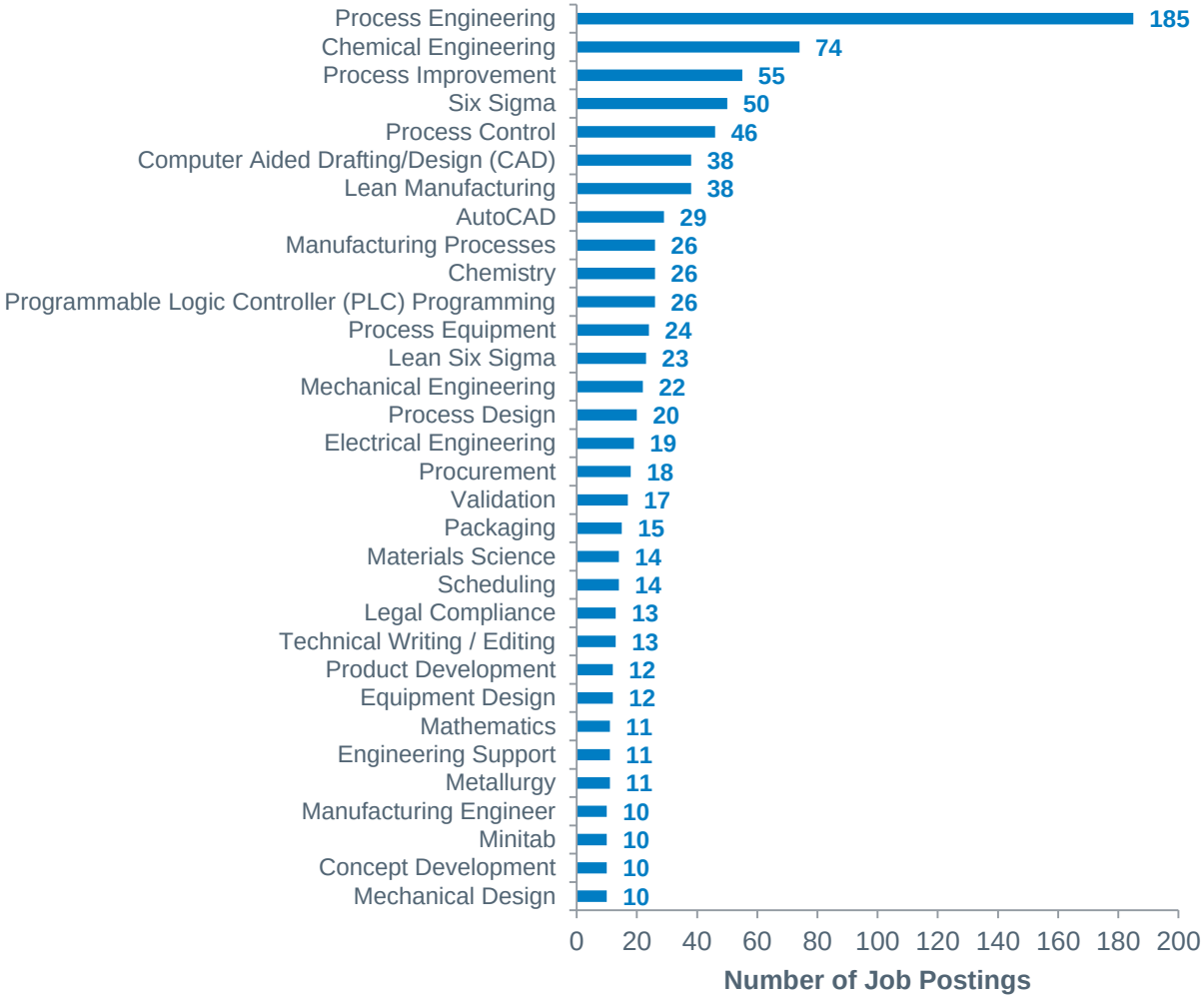
Wisconsin counties, January 2010 to December 2013



n=460 with 42 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 7: Top Skills in Demand for Chemical Engineering Postings

Wisconsin counties, January 2010 to December 2013



n=252 with 11 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

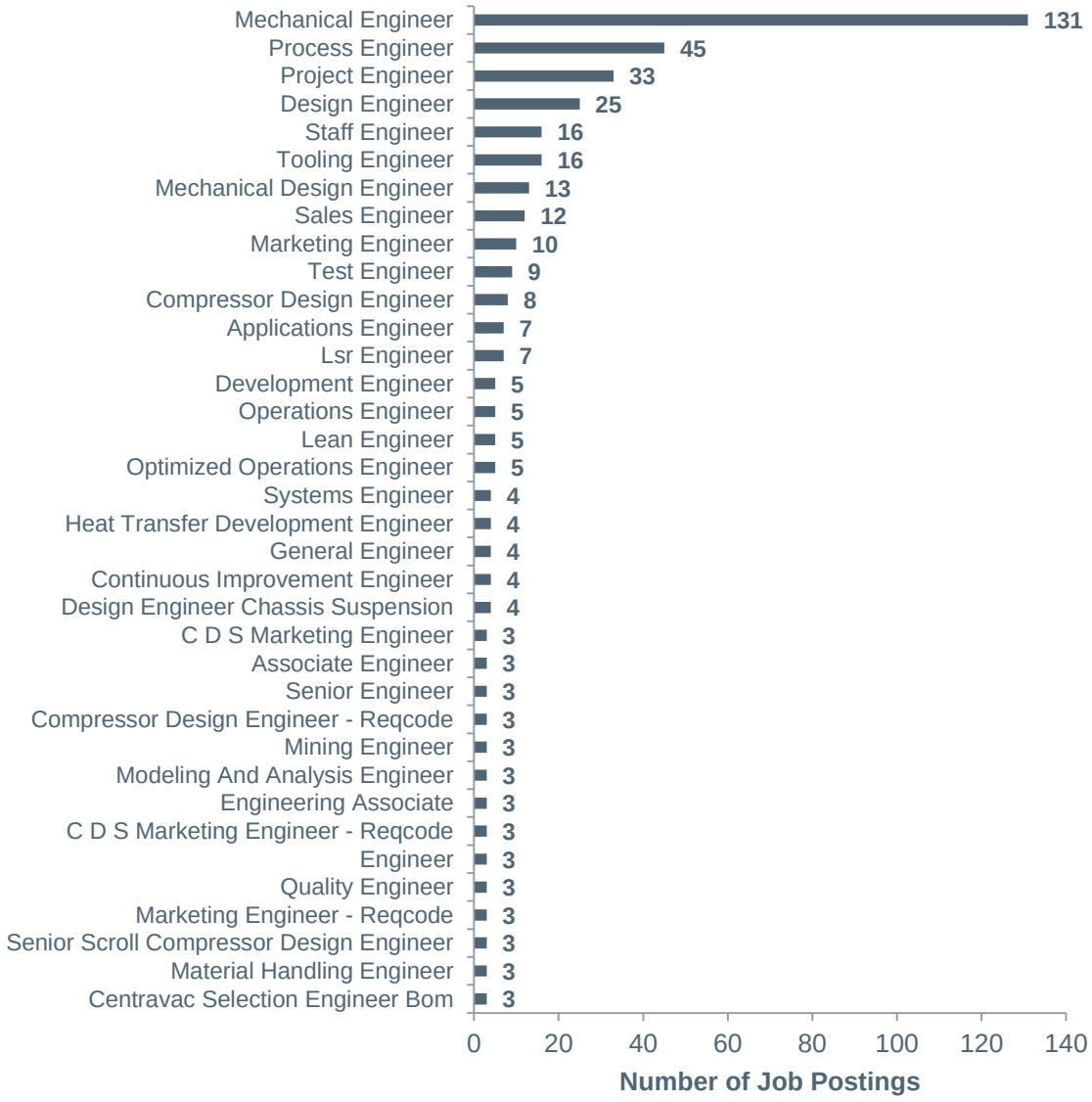
Top Job Titles

Process Engineer Job Title in High Demand Across Mechanical, Electrical, and Chemical Engineering Fields

Process engineering is by far the top title in demand for chemical engineering postings and is the second title in demand for both mechanical and electrical engineering jobs.

Chart 8: Top Titles in Demand for Mechanical Engineering Postings

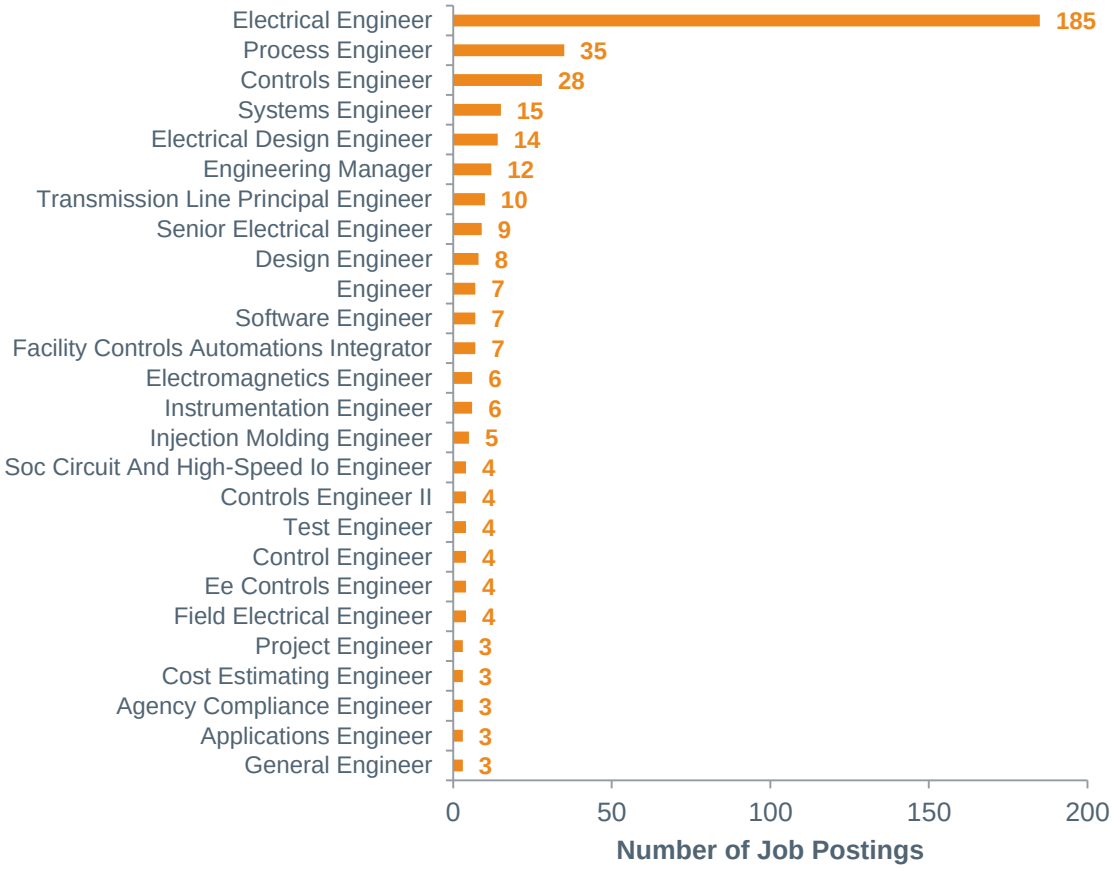
Wisconsin counties, January 2010 to December 2013



n=530 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 9: Top Titles in Demand for Electrical Engineering Postings

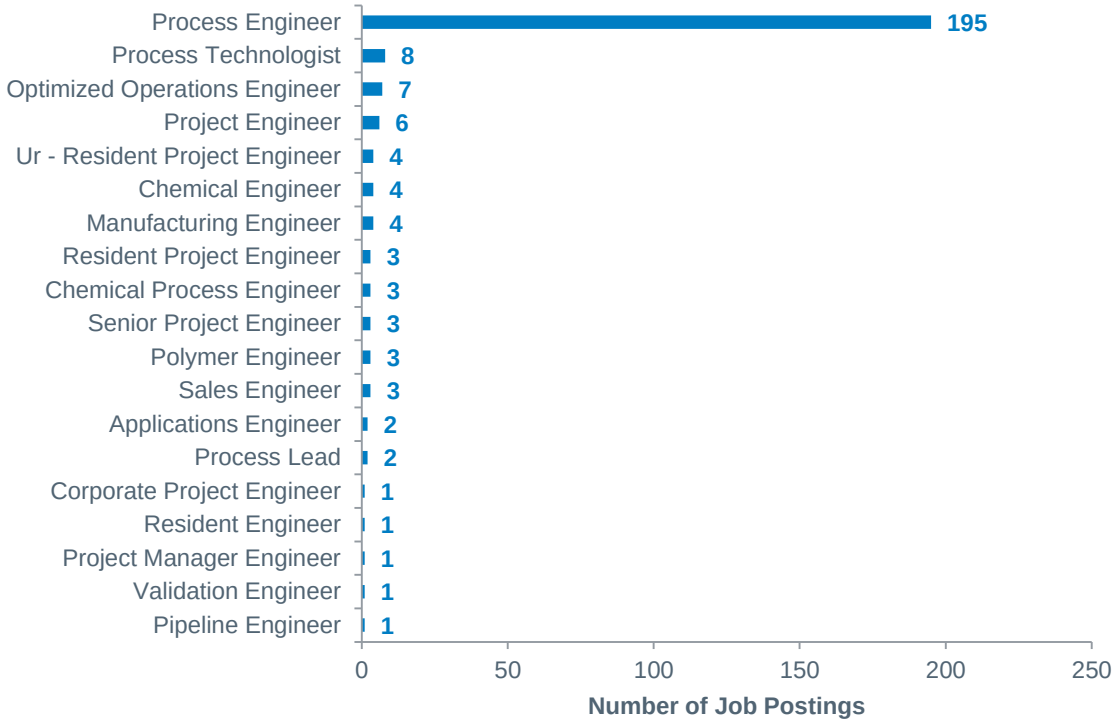
Wisconsin counties, January 2010 to December 2013



n=430 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 10: Top Titles in Demand for Chemical Engineering Postings

Wisconsin counties, January 2010 to December 2013



n=252 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

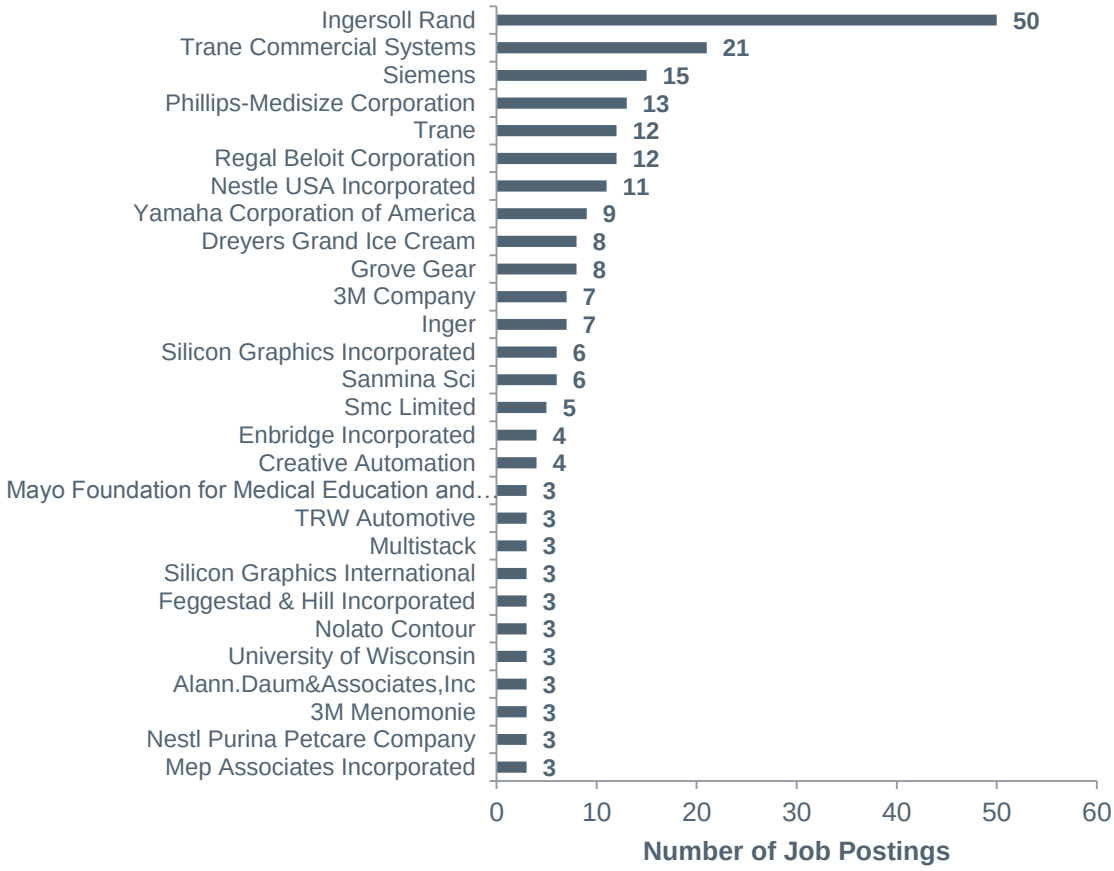
Top Employers

Ingersoll Rand Is a Top Employer for Mechanical and Electrical Engineering

Ingersoll Rand had twice as many job postings for both mechanical and electrical engineering as any other employer from January 2010 to December 2013.

Chart 11: Top Employers for Mechanical Engineering Postings

Wisconsin counties, January 2010 to December 2013



n=530 with 171 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

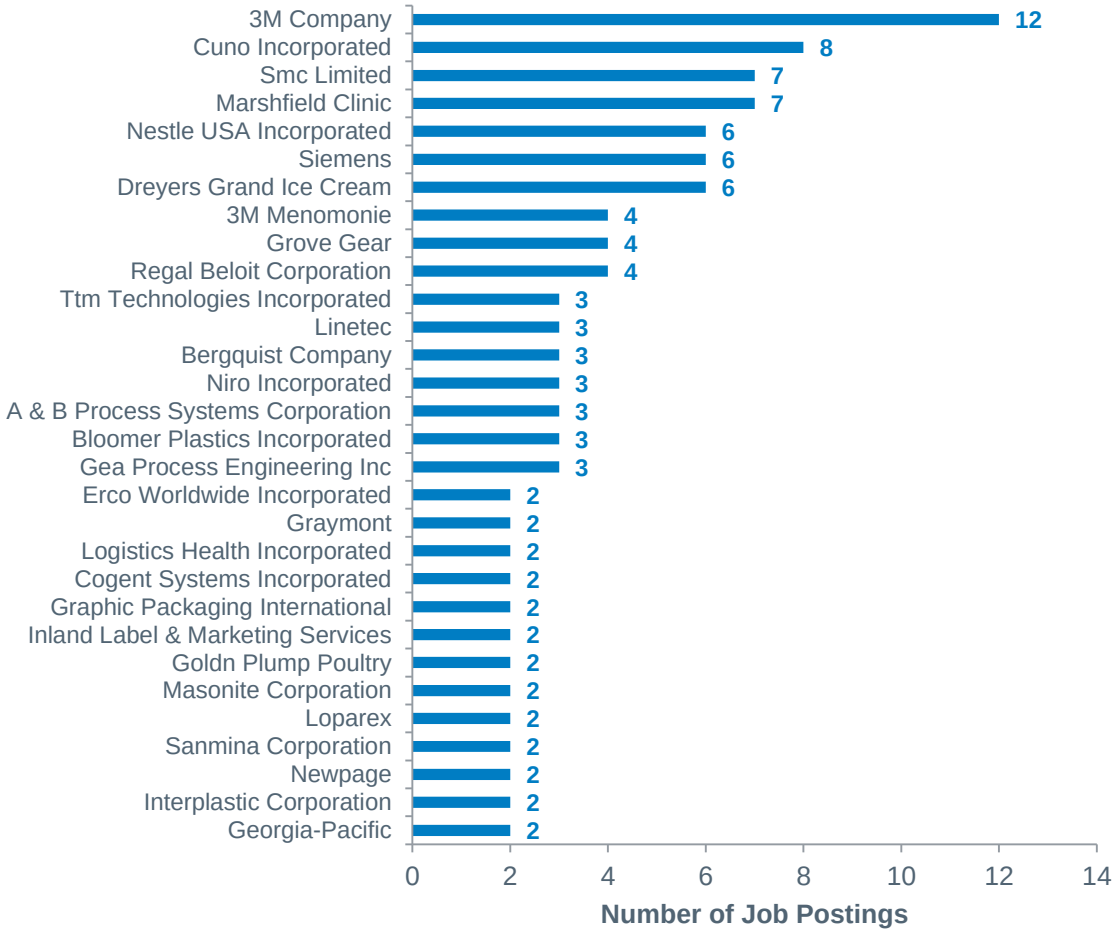
Chart 12: Top Employers for Electrical Engineering Postings

Wisconsin counties, January 2010 to December 2013

n=460 with 237 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 13: Top Employers for Chemical Engineering Postings

Wisconsin counties, January 2010 to December 2013



n=252 with 104 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

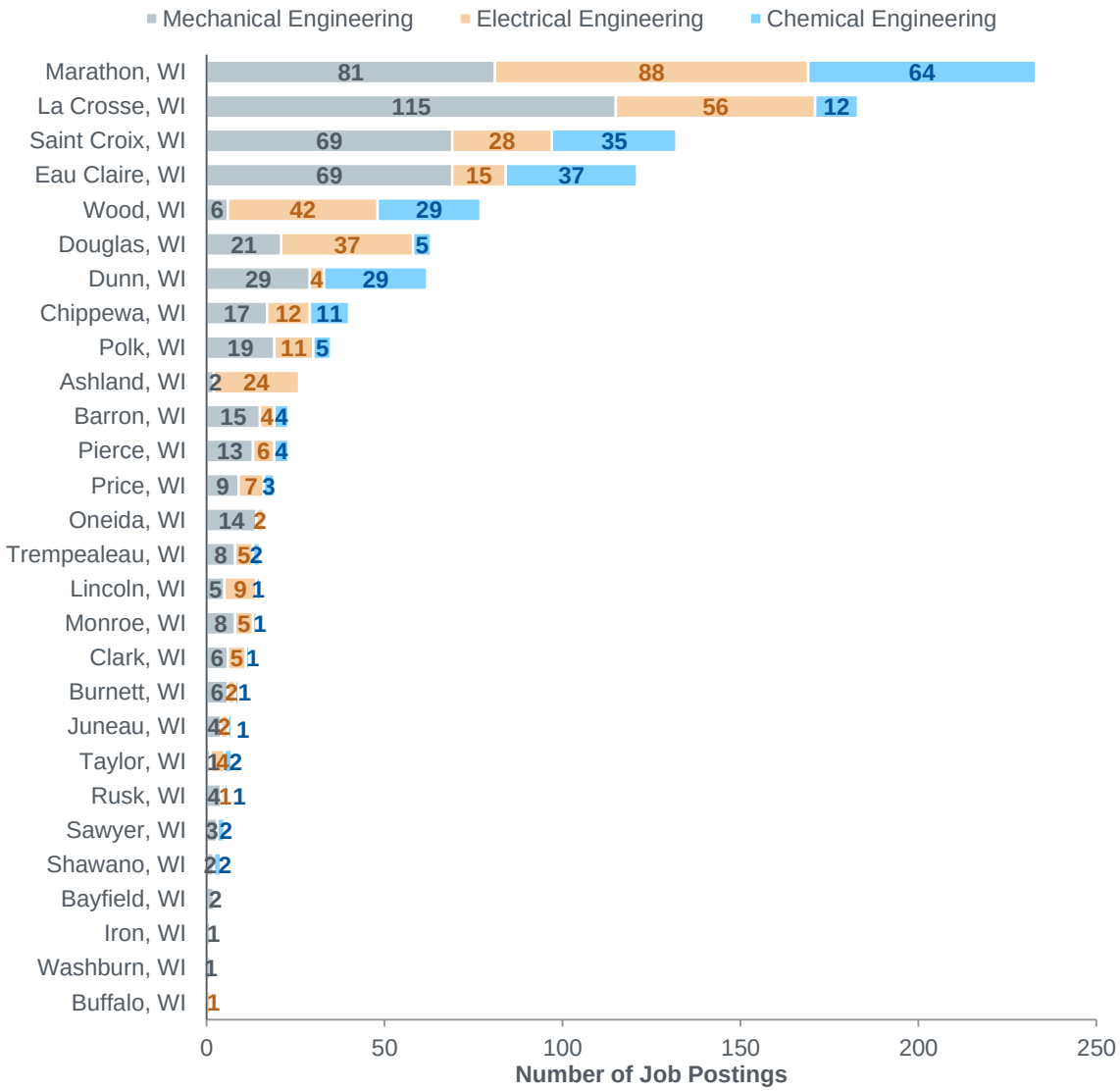
Top Locations

Marathon County, La Crosse County, Saint Croix County, and Eau Claire County Observed the Greatest Number of Job Postings Across Engineering Fields

Employer demand for engineering jobs is greatest in Marathon County, La Crosse County, Saint Croix County, and Eau Claire County; each had over 120 job postings in mechanical, electrical, and/or chemical engineering between January 2010 and December 2013.

Chart 14: Top Counties in Wisconsin with Mechanical, Electrical, and Chemical Engineering Job Postings

Wisconsin counties, January 2010 to December 2013



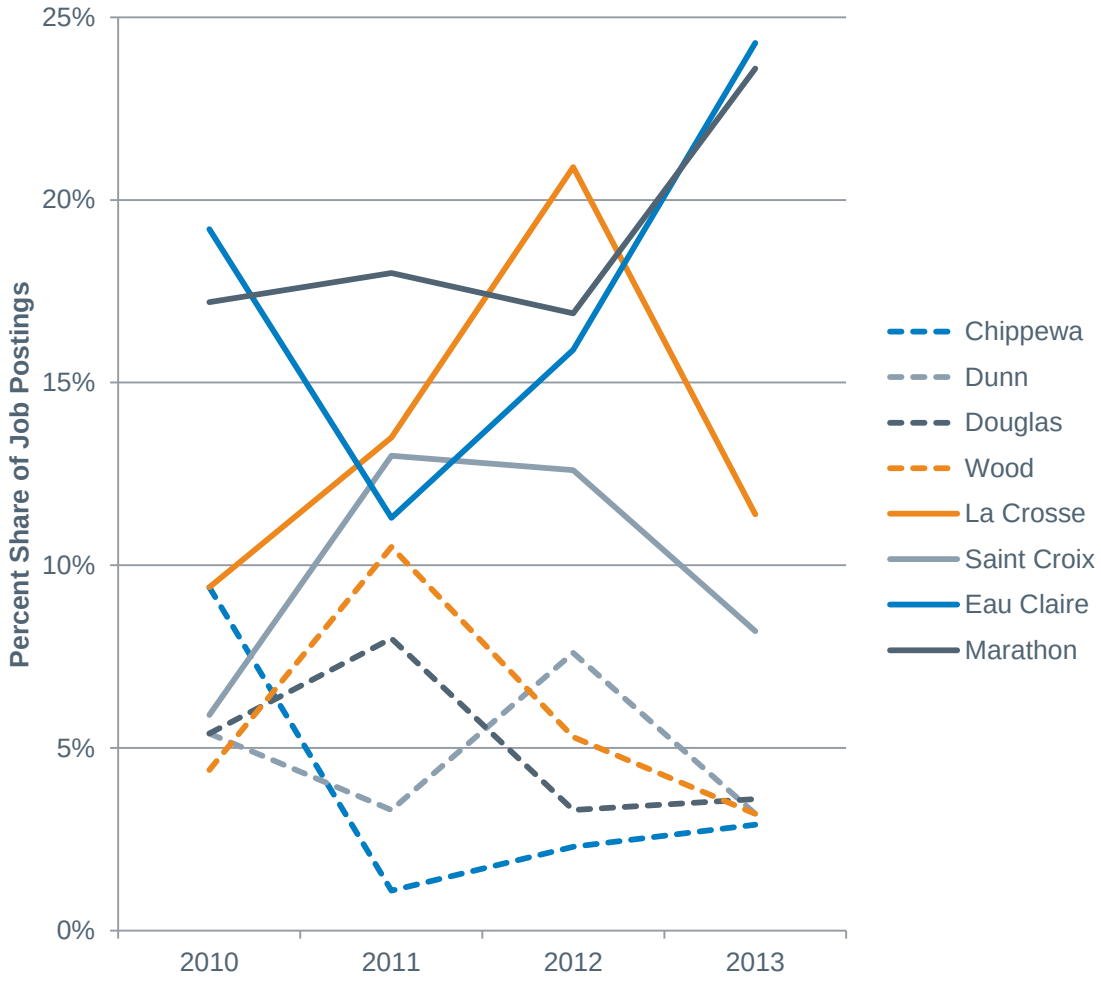
n=1,242 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Counties with Largest Number of Job Postings from 2010 to 2013 Observed Greatest Increases in Percent Share of Postings

Marathon County, Eau Claire County, and Saint Croix County, and La Crosse County observed the greatest increases in percent share of job postings in mechanical, electrical, and chemical engineering, as demonstrated by the solid lines in the following chart. Chippewa County observed the largest absolute change of all Wisconsin counties; from 2010 to 2013, the percent share of job postings in Chippewa decreased six-and-a-half percentage points. Dotted lines in the following chart represent counties that observed declines in percent share of postings from 2010 to 2013.

Chart 15: Change in Percent Share of Job Postings for Mechanical, Electrical, and Chemical Engineering in Wisconsin Counties

Wisconsin counties, January 2010 to December 2013



**Counties that never exceeded 5% share were omitted from graph*
n=1,242 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Education and Experience

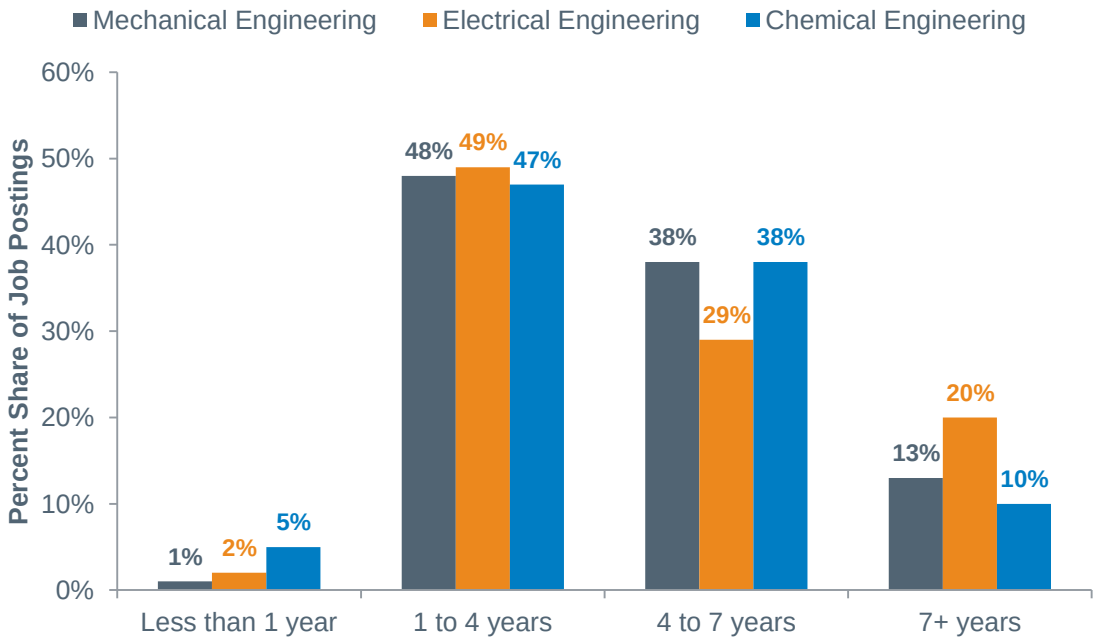
About Half of Job Postings Require 1 to 4 Years of Experience

From January 2010 to December 2013, almost half of mechanical, electrical, and chemical engineering job postings (48 percent, 49 percent, and 47 percent) require 1 to 4 years of experience. 38 percent of mechanical and chemical engineering job postings require 4 to 7 years of experience.

Between 2010 and 2013, mechanical and electrical engineering job postings increasingly required greater number of years of experience. In 2013, 37 percent of electrical engineering postings required seven or more years' experience compared with only 20 percent of all postings from 2010 through 2013. Similarly, fewer mechanical engineering job postings required one to four years' experience in 2013 versus aggregated 2010 to 2013 (42 percent versus 48 percent, respectively), and more postings required four to seven or seven or more years' experience in 2013 alone than over the aggregated time period.

Chart 16: Experience Requirements for Mechanical, Electrical, and Chemical Engineering Job Postings

Wisconsin counties, January 2010 to December 2013



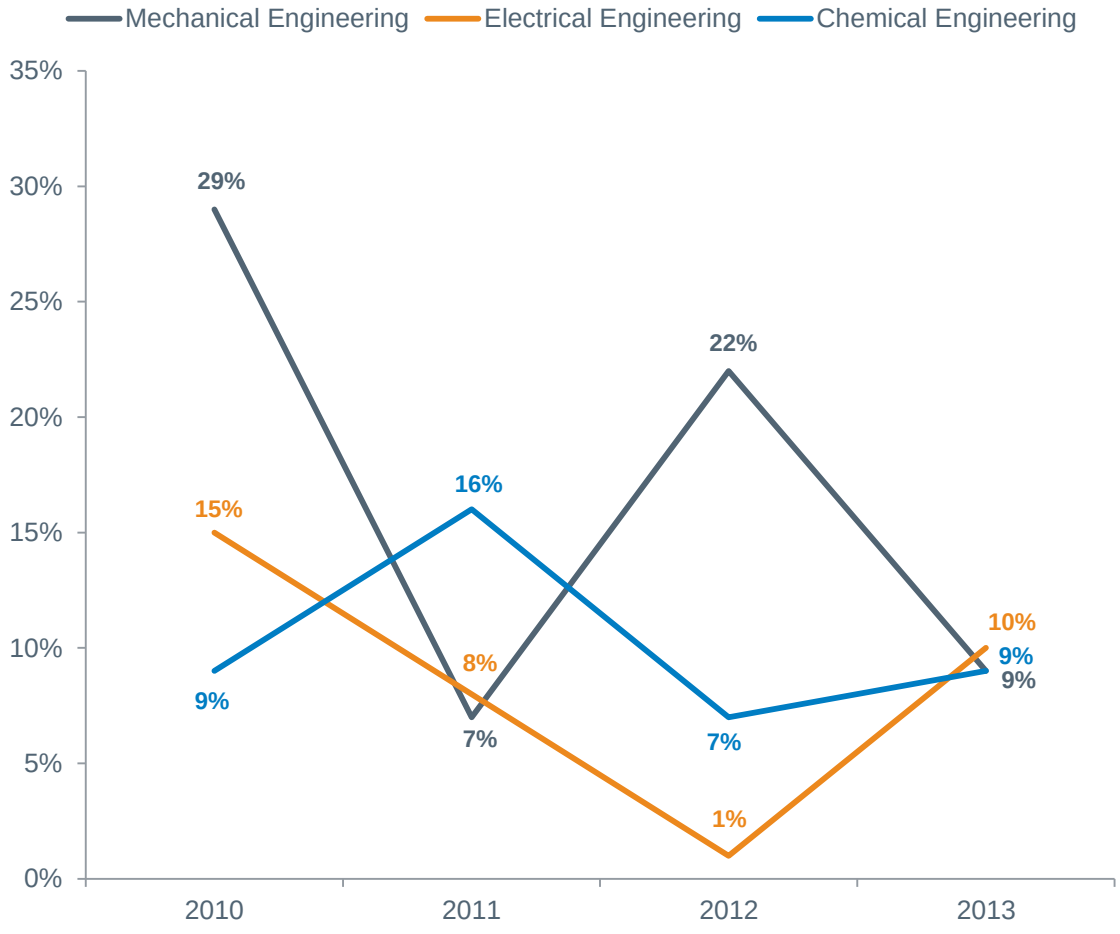
Percentages within each engineering field may not add to 100 due to rounding.
n=1,242 with 414 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

About Ten Percent of Mechanical, Electrical, and Chemical Engineering Job Postings Required a Graduate or Professional Degree in 2013

From January 2010 to December 2013, mechanical engineering had the highest average of jobs postings that require or prefer a bachelor's degree at a minimum and additionally require or prefer a graduate or professional degree compared with chemical and electrical engineering (16 percent, 10 percent, and 8 percent, respectively). Requested educational qualifications for all engineering fields' job postings varied greatly over time, as shown in the chart below.

Chart 17: Job Postings Requiring a Graduate or Professional Degree

Wisconsin counties, January 2010 to December 2013



n=1,242 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

2) Minneapolis-St. Paul-Bloomington MSA

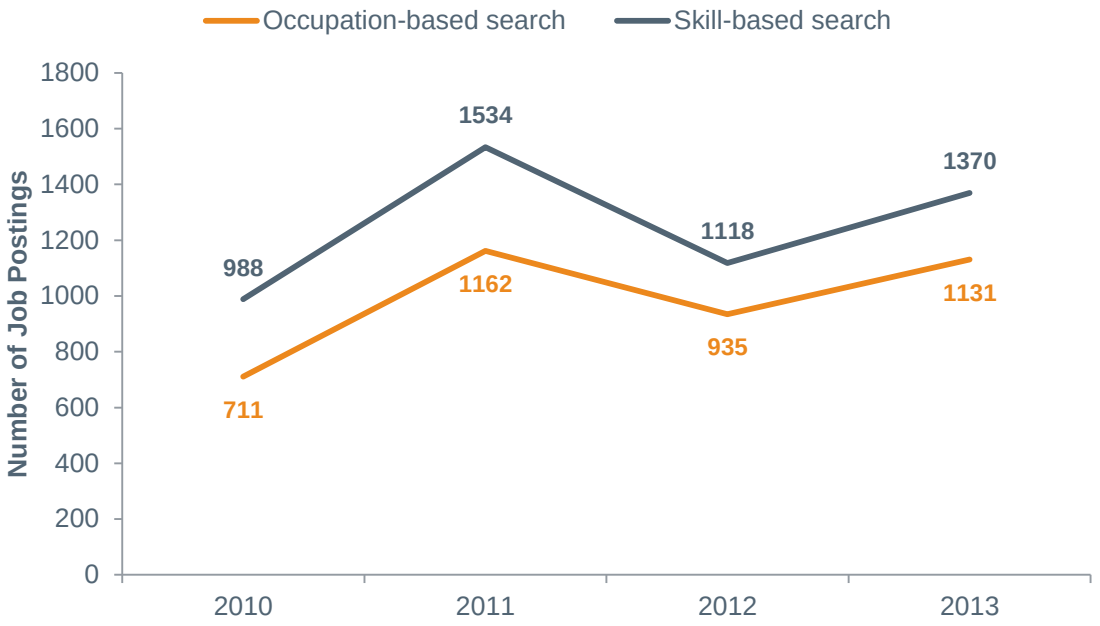
Job Demand Over Time

Mechanical Engineering Job Postings Demonstrate Increasing Demand

Employer demand for mechanical engineering positions has increased since 2010 with both occupation-based and skill-based searches.

Chart 18: Job Growth in Mechanical Engineering Positions

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



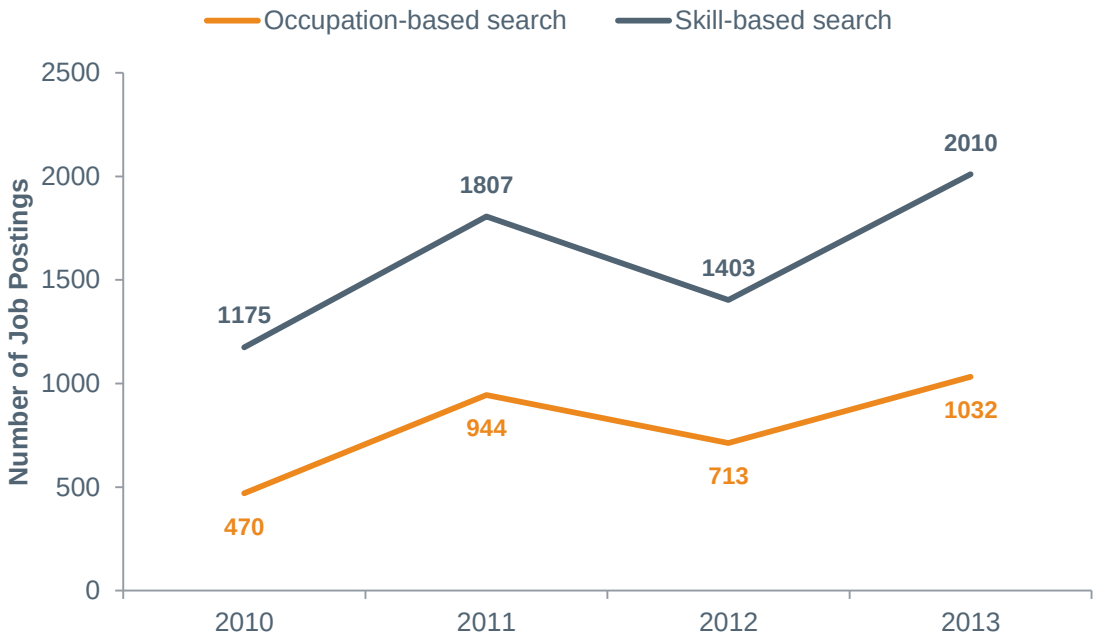
n=3,939 (occupation-based) and n=5,010 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Number of Electrical Engineering Job Postings Greatly Increased from 2010 to 2013

The number of job postings for skill-based based search for electrical engineering jobs more than doubled from 2010 to 2013, while the number of job postings for occupation-based search increased by 70 percent over the same time period.

Chart 19: Large Increase in Number of Job Postings in Electrical Engineering Positions from 2010 to 2013

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



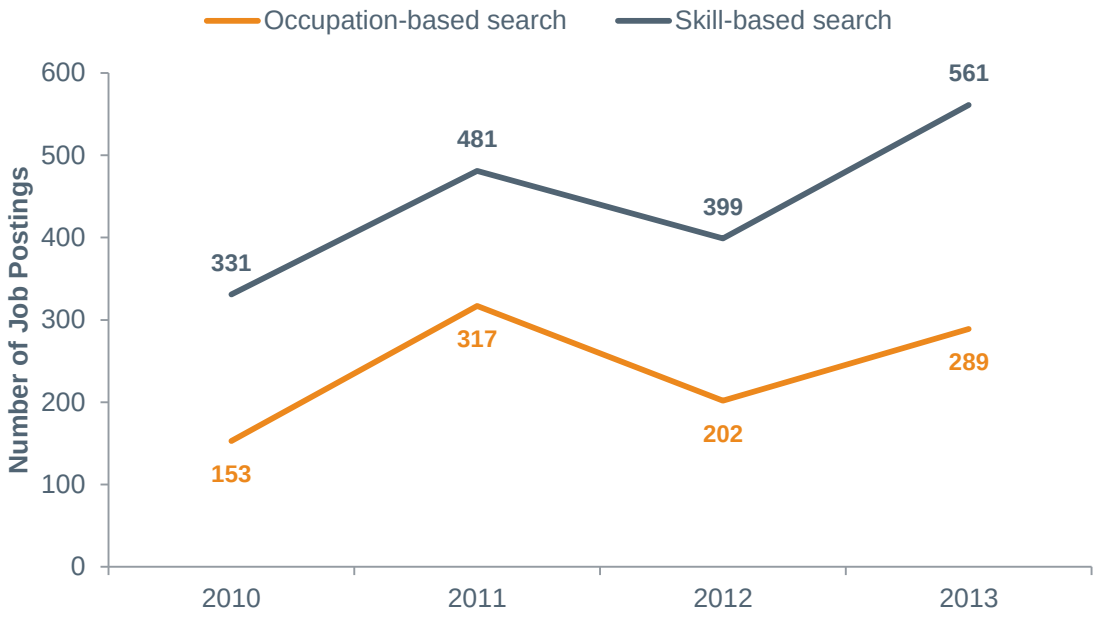
n=3,159 (occupation-based) and n=2,010 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Chemical Engineering Job Postings Remain Stable Over Time

Market demand for chemical engineering positions increased from 2010 to 2011, decreased from 2011 to 2012, and increased from 2012 to 2013, to a final number of job postings greater than 2010.

Chart 20: Increase in Number of Job Postings in Chemical Engineering Positions from 2010 to 2013

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



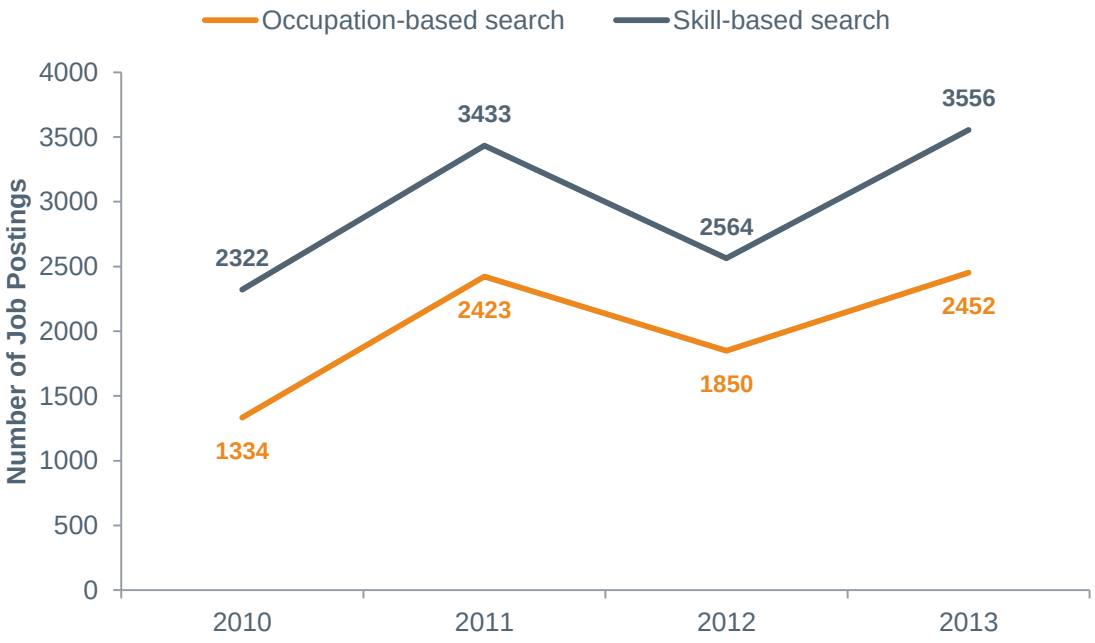
n=961 (occupation-based) and n=1,772 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Aggregate Mechanical, Electrical, and Chemical Engineering Job Postings Demonstrate Increasing Demand

Market demand for mechanical, electrical, and chemical engineering positions in the aggregate has increased from 2010 to 2013, with particularly high employer demand in 2011 and 2013. **The number of job postings in the Minneapolis-St. Paul-Bloomington MSA is much greater than the number of postings in all of observed Wisconsin counties combined.**

Chart 21: Job Growth in Aggregate Mechanical, Electrical, and Chemical Engineering Positions

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=8,059 (occupation-based) and n=11,875 (skill-based) with 0 unspecified
Source: Burning Glass Labor/Insight™

Top Skills

All Mechanical, Electrical, and Chemical Engineering Jobs Require Computer Aided Drafting/Design Skills

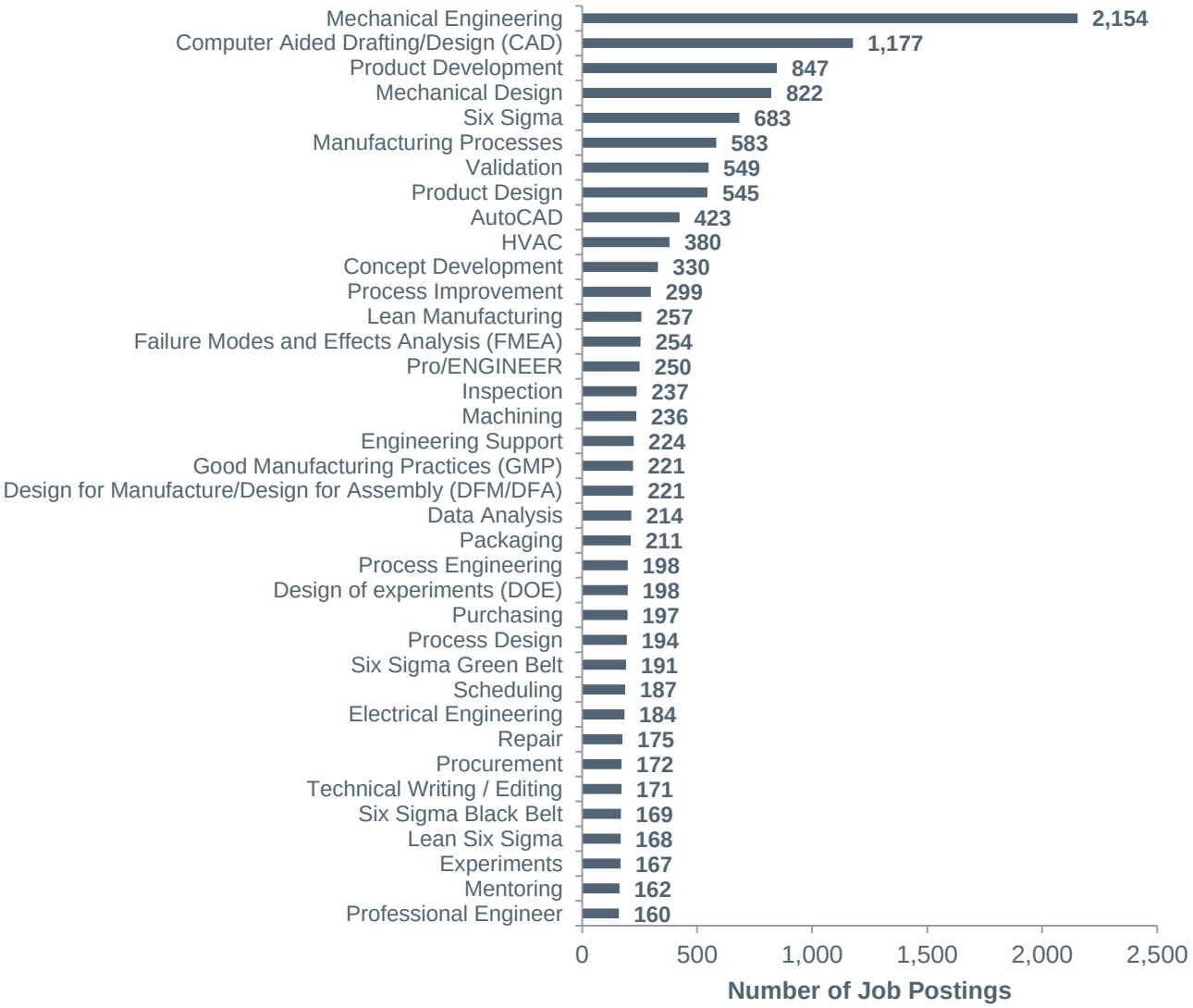
Top skills for engineering postings remain consistent between Wisconsin counties and Minneapolis MSA:

- Seven out of ten of the top skills for *mechanical engineering* postings are the same: mechanical engineering, CAD, HVAC, product design, mechanical design, six sigma, and autoCAD.

- For *electrical engineering*, these geographic areas share only five out of ten top skills: electrical engineering, programmable logic controller, autoCAD, schematic diagrams, and CAD.
- They share seven out of the ten top skills for *chemical engineering*: process engineering, chemical engineering, process improvement, six sigma, process control, manufacturing processes, and chemistry.

Chart 22: Top Skills in Demand for Mechanical Engineering Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013

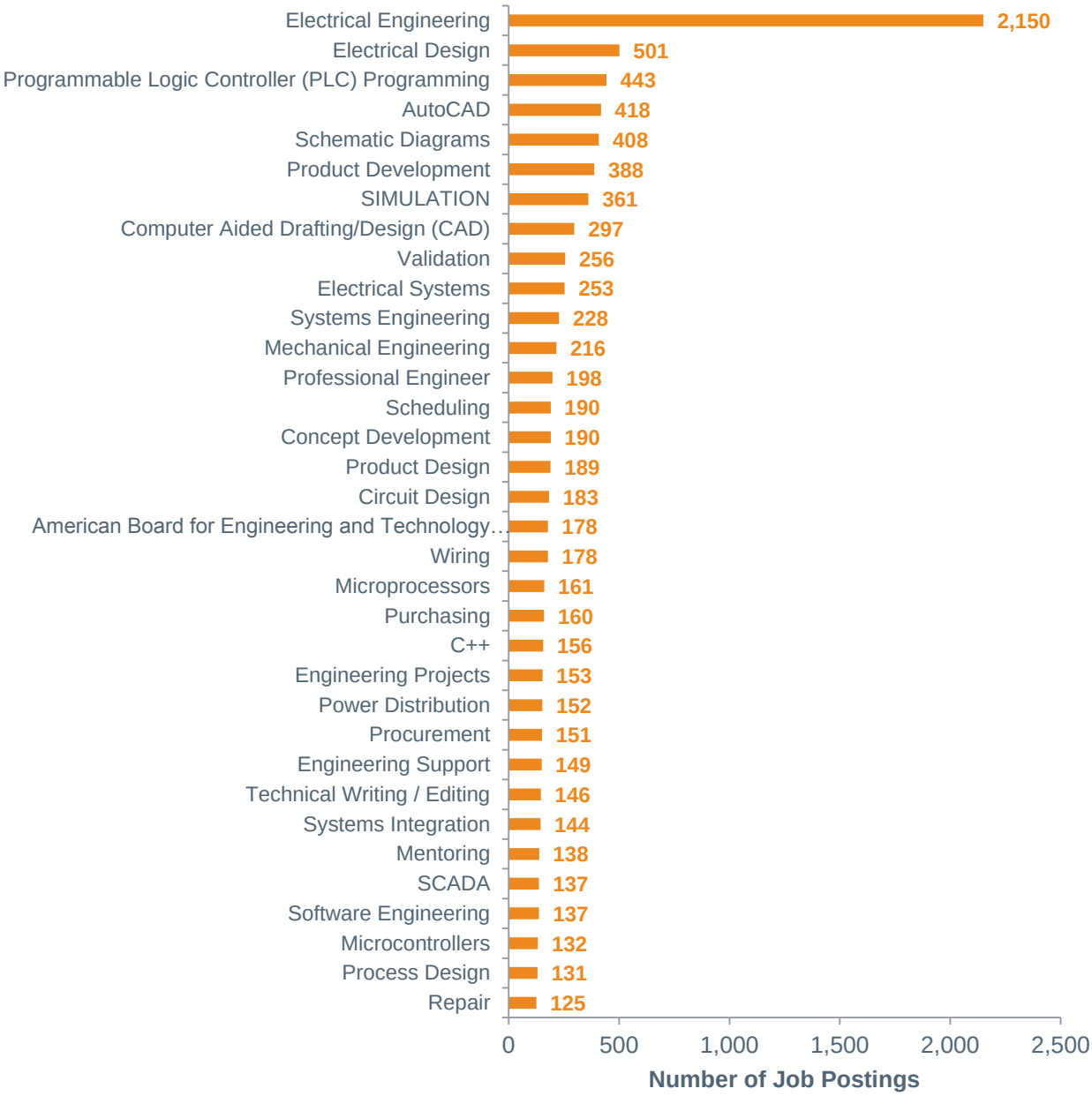


n=3,939 with 118 unspecified
Search includes postings from January 2010 to December 2013

Source: Burning Glass Labor/Insight™

Chart 23: Top Skills in Demand for Electrical Engineering Postings

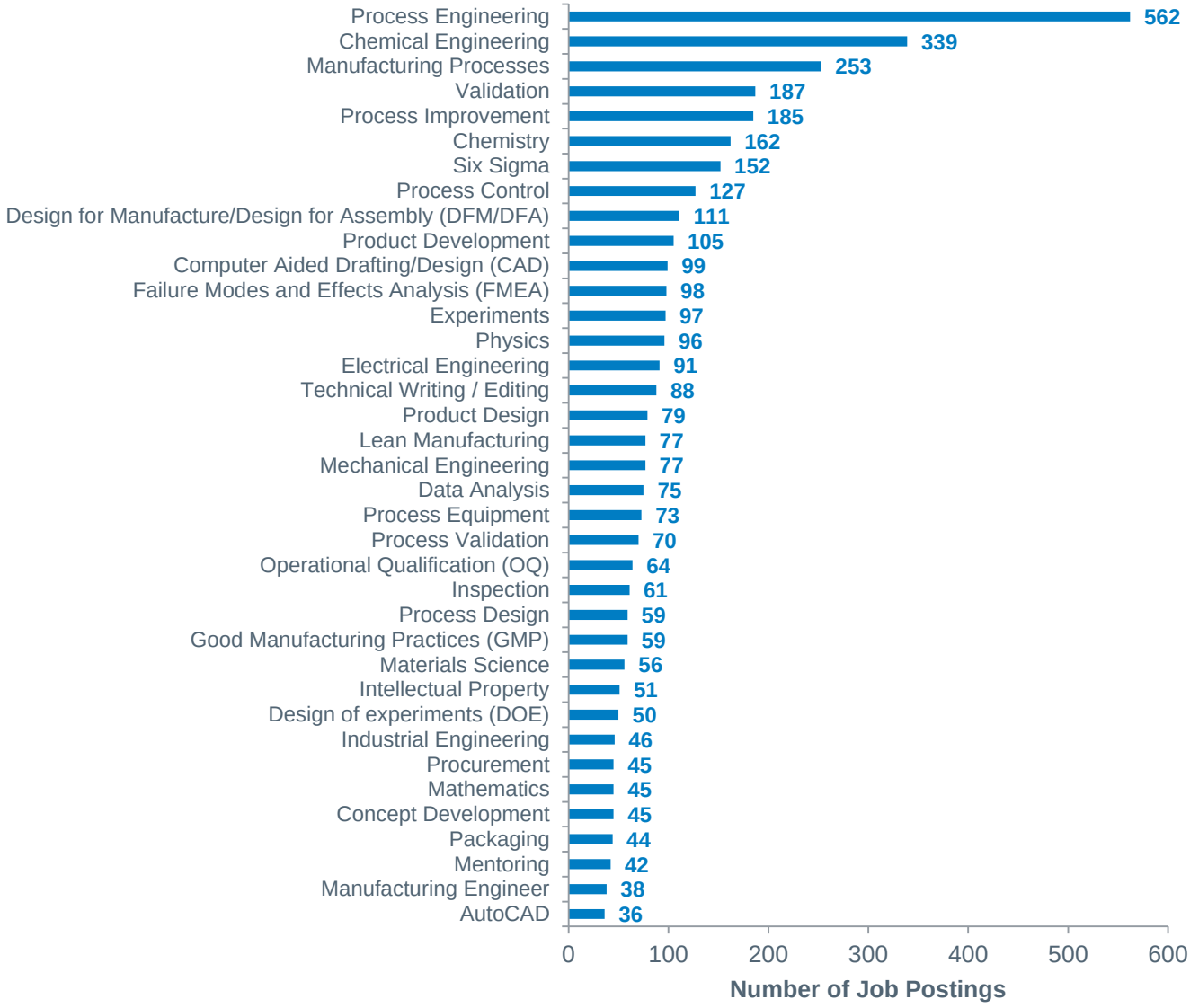
Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=3,159 with 127 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 24: Top Skills in Demand for Chemical Engineering Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=961 with 38 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

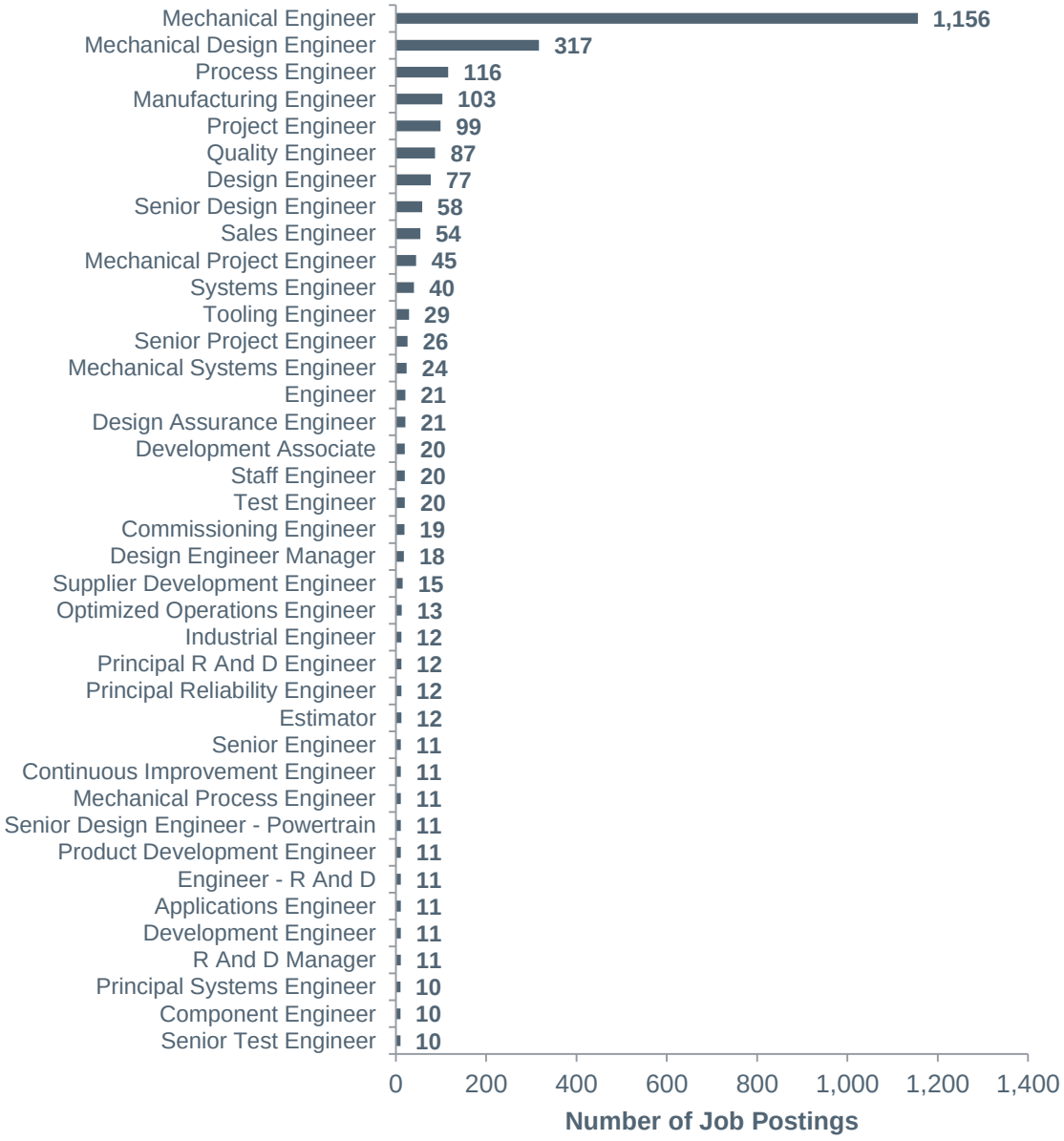
Top Job Titles

Process Engineer Job Title in High Demand Across Mechanical, Electrical, and Chemical Engineering Fields

The top job title in demand for mechanical, electrical, and chemical engineering is the same in each respective field across the Minneapolis MSA and Wisconsin counties.

Chart 25: Top Titles in Demand for Mechanical Engineering Postings

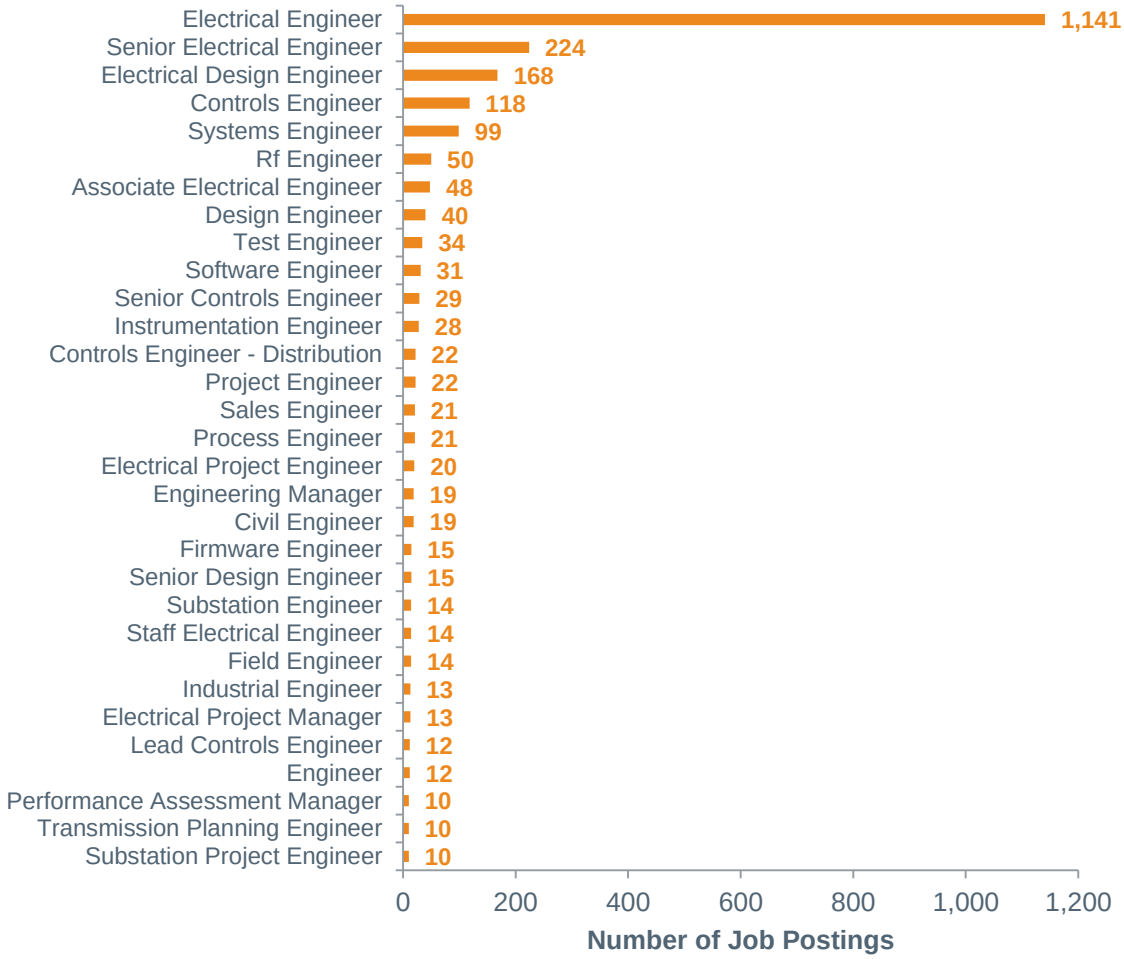
Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=3,939 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 26: Top Titles in Demand for Electrical Engineering Postings

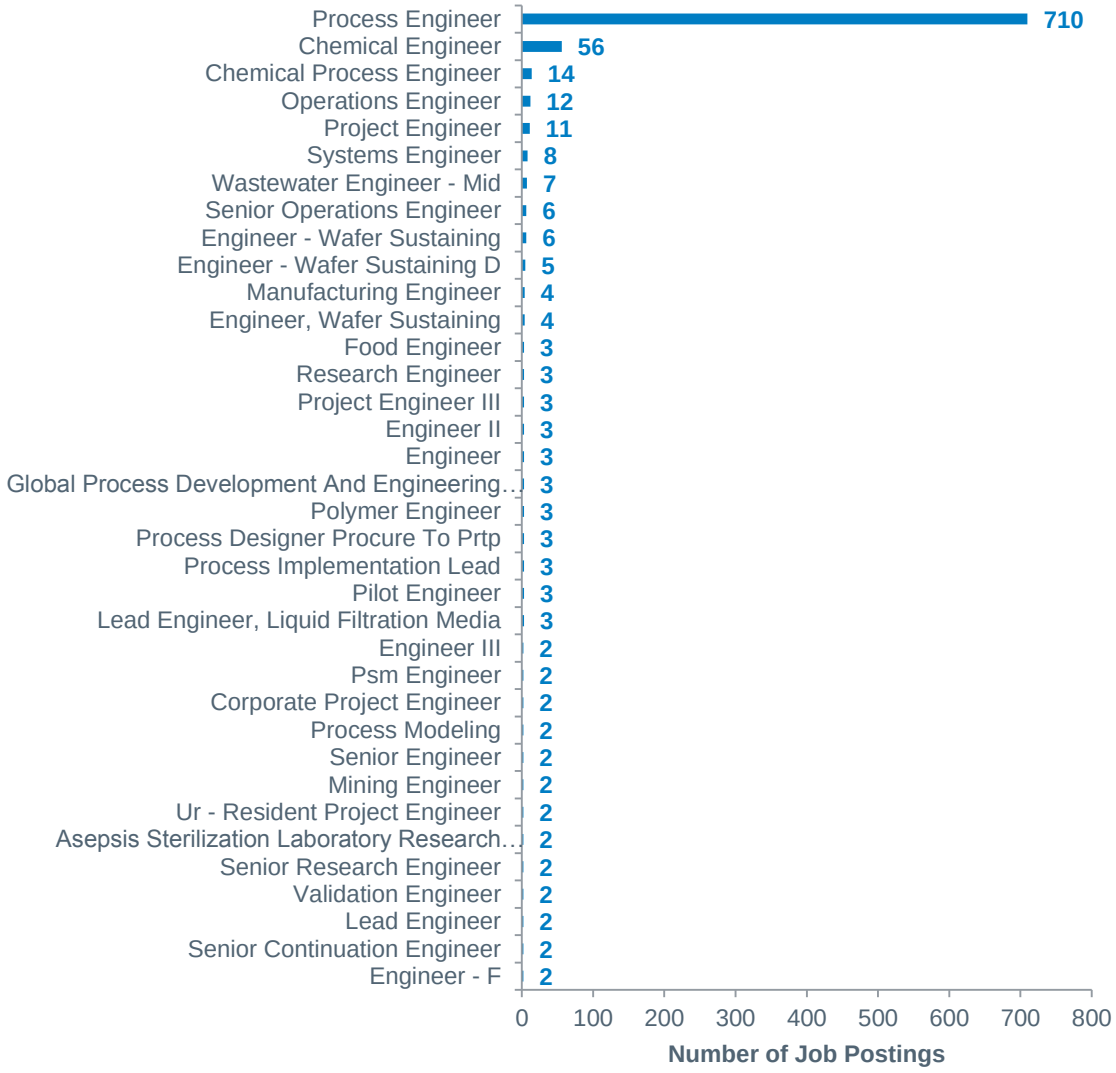
Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=3,159 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 27: Top Titles in Demand for Chemical Engineering Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=961 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

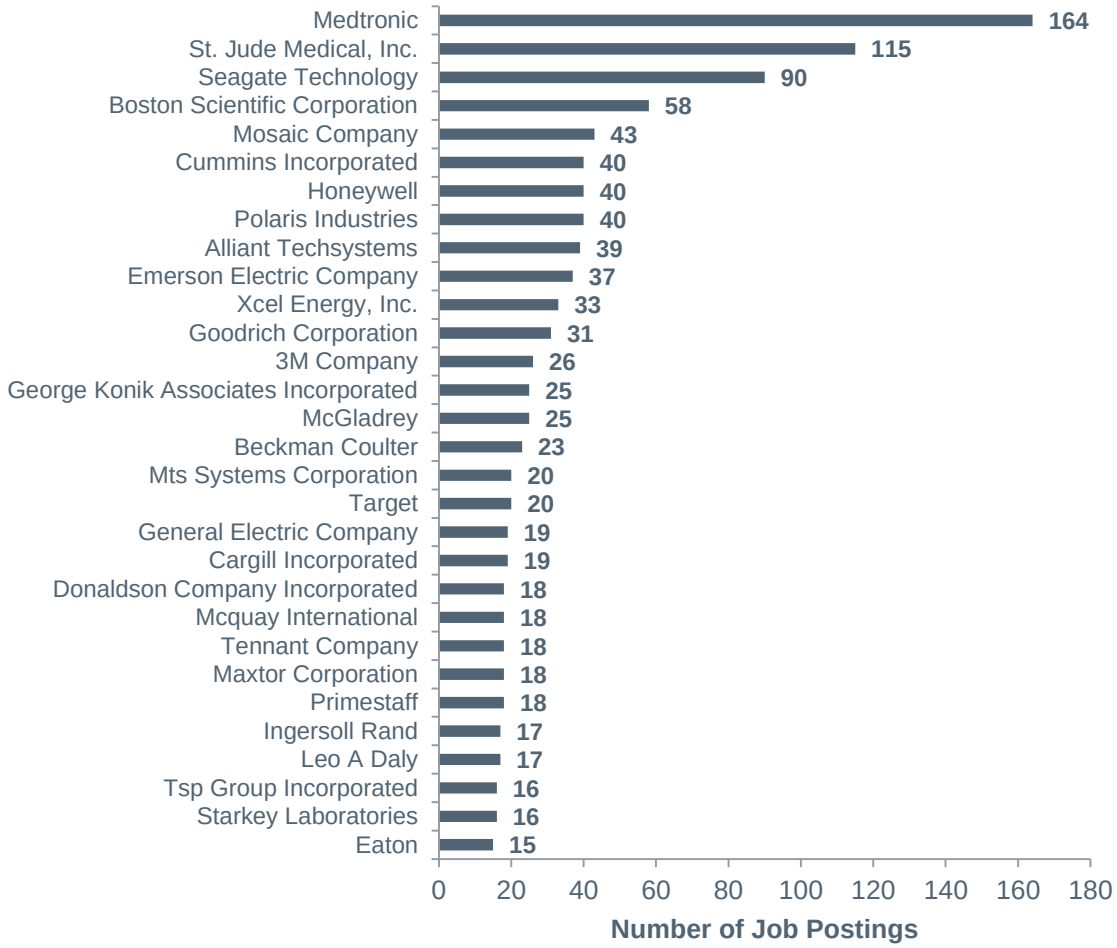
Top Employers

Mechanical, Electrical, and Chemical Engineering Postings Do Not Share Many Top Employers

St. Jude Medical, Inc. is a top employer for both mechanical and chemical engineering jobs; Medtronic is a top employer for both mechanical and electrical engineering job postings.

Chart 28: Top Employers for Mechanical Engineering Postings

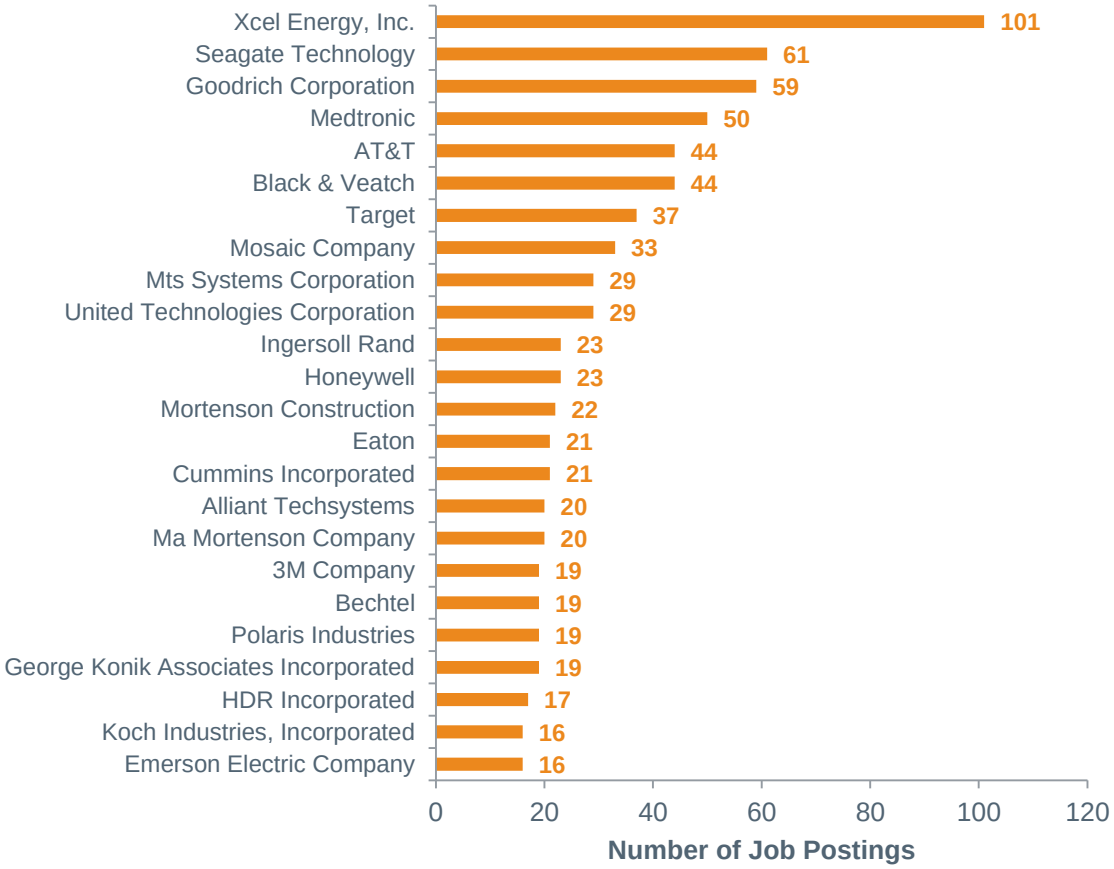
Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=3,939 with 1,620 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 29: Top Employers for Electrical Engineering Postings

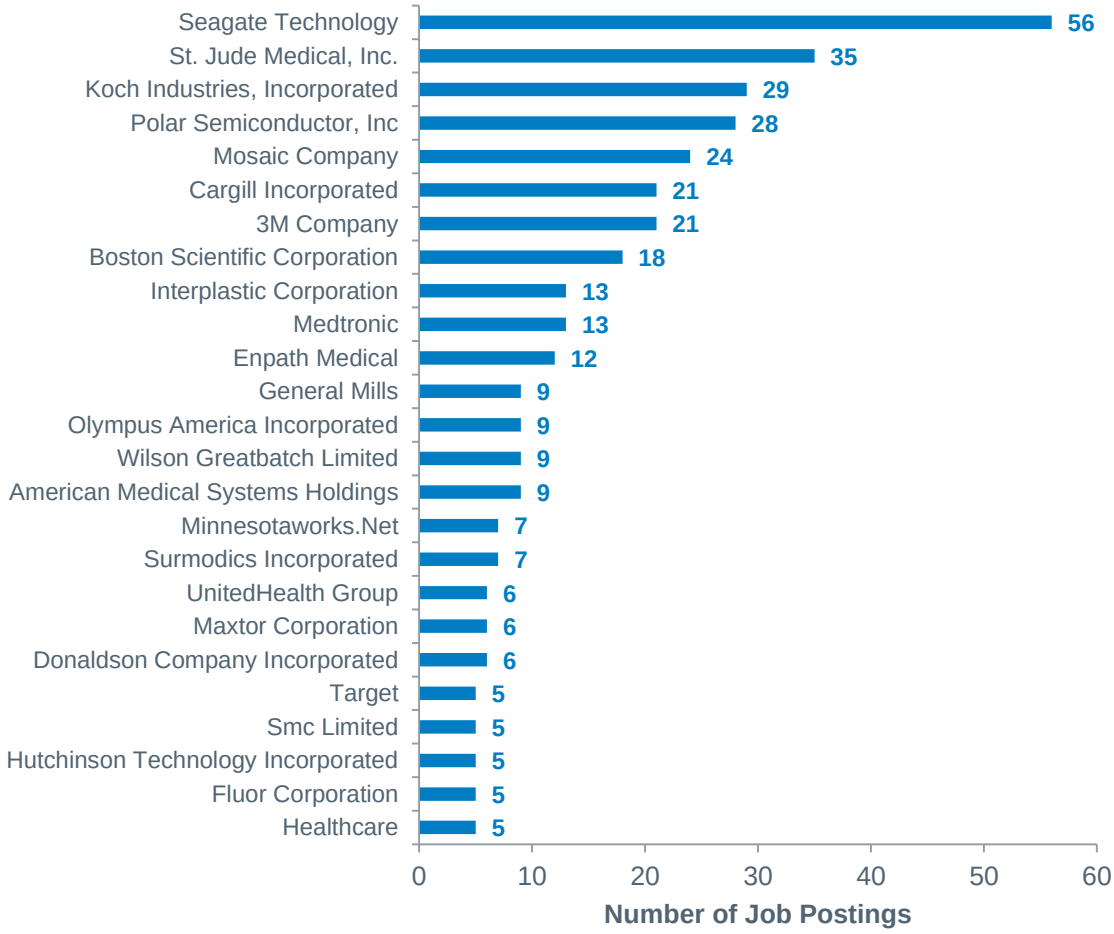
Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=3,159 with 1,273 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 30: Top Employers for Chemical Engineering Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=961 with 359 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Top Locations

Hennepin County in Minnesota Observed the Greatest Number of Job Postings Across Engineering Fields

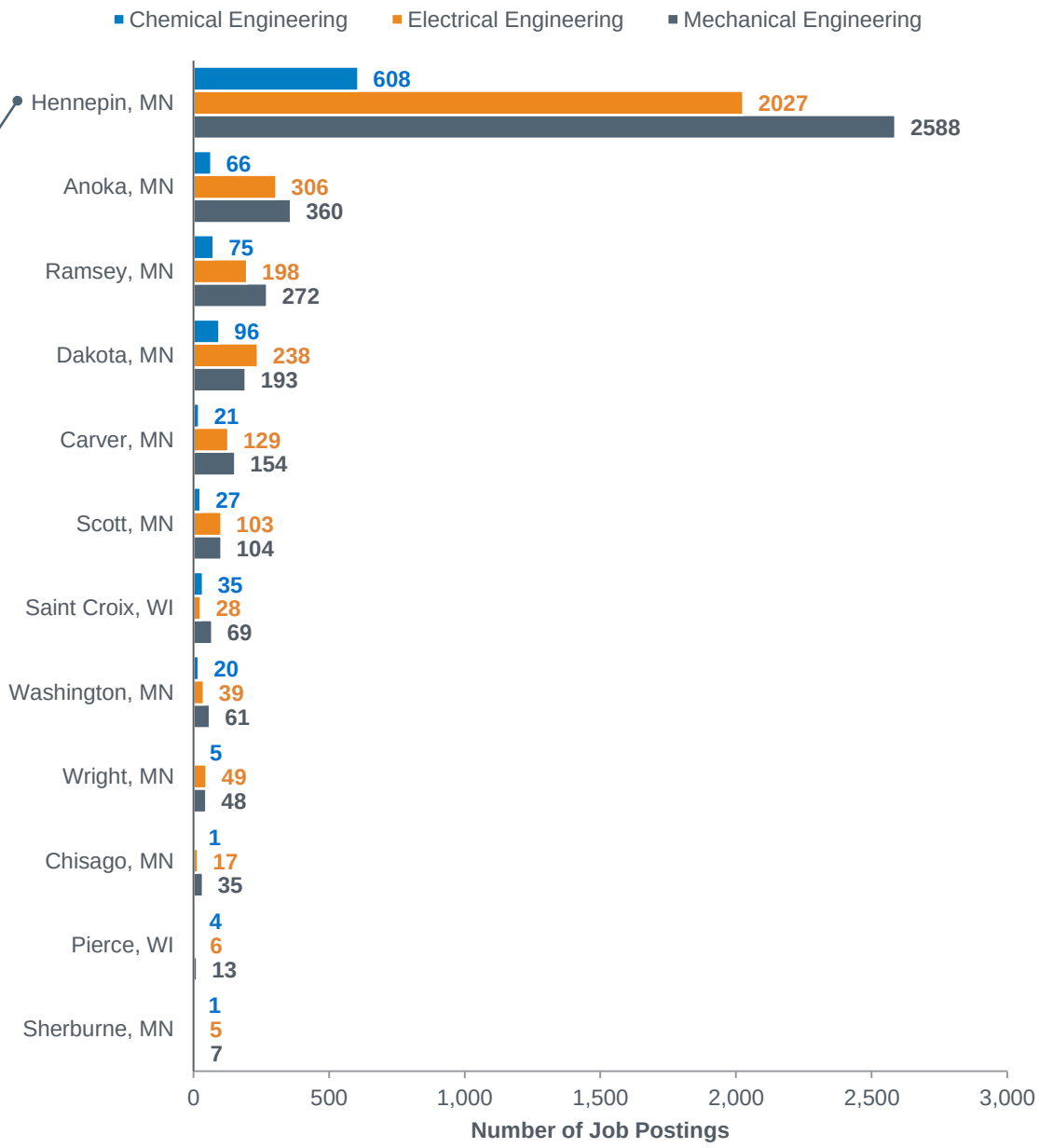
The overwhelming majority of job postings in the Minneapolis-St. Paul-Bloomington MSA were observed in Minnesota counties.

Chart 31: Top Counties in Minneapolis MSA with Mechanical, Electrical, and Chemical Engineering Job Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013

Top employers of all engineering fields posted jobs in Hennepin County, including the following and others in order of most postings to least:

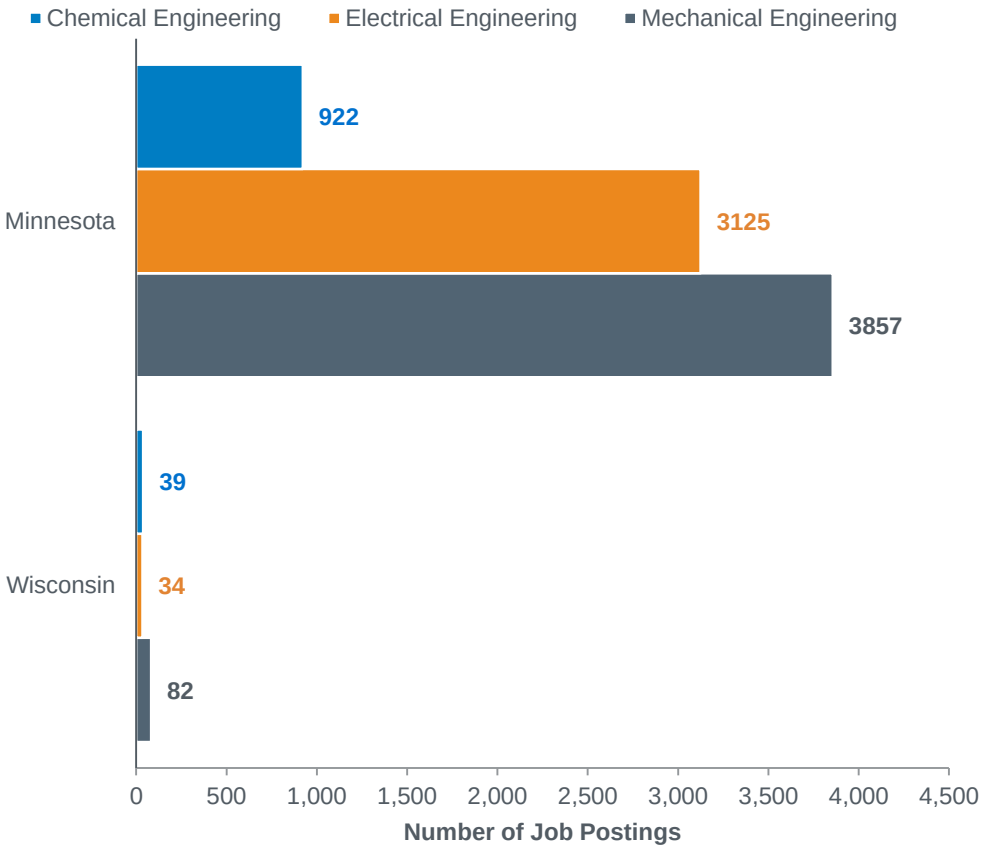
- Medtronic
- Seagate Technology
- St. Jude Medical
- Xcel Energy, Inc.
- Mosaic Company
- Goodrich Corporation
- Boston Scientific
- 3M Company



n=8,059 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Chart 32: Distribution of Mechanical, Electrical, and Chemical Engineering Job Postings by State

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=8,059 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

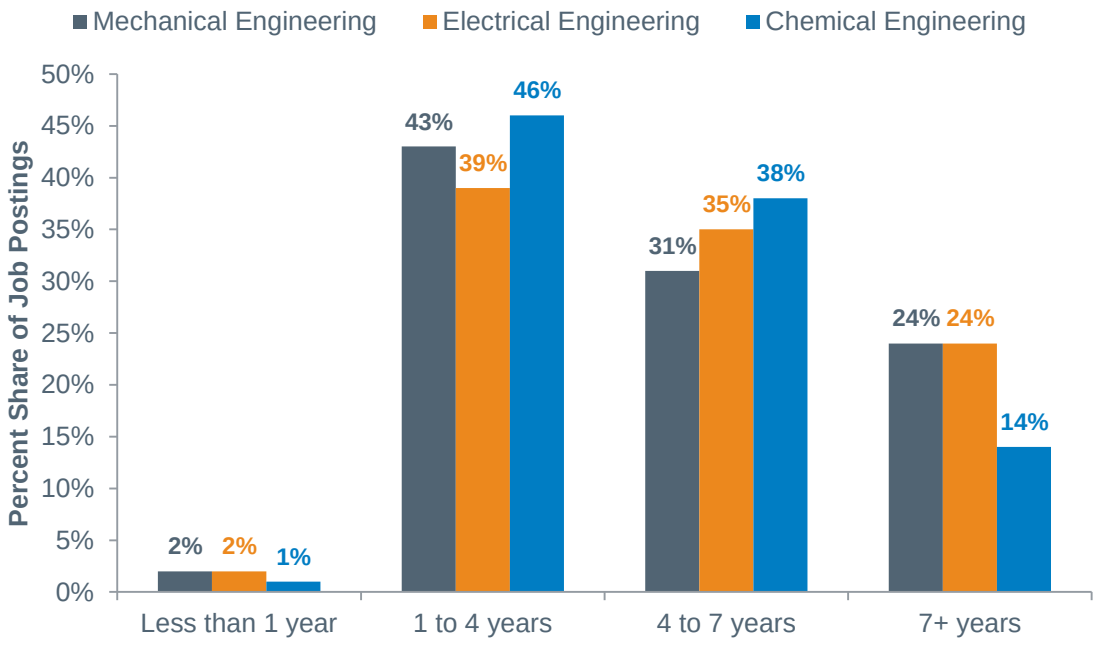
Education and Experience

About Half of Job Postings Require 1 to 4 Years of Experience

From January 2010 to December 2013, almost half of mechanical, electrical, and chemical engineering job postings (48 percent, 49 percent, and 47 percent) require 1 to 4 years of experience. 38 percent of mechanical and chemical engineering job postings require 4 to 7 years of experience. More job postings in 2013 required four to seven years' experience than in 2010 (47 percent versus 41 percent, respectively), whereas fewer job postings in electrical engineering required seven or more years' experience in 2013 than in 2010 (24 percent versus 30 percent, respectively). Experience requirements for chemical engineering job postings have remained stable over the observed time period.

Chart 33: Experience Requirements for Mechanical, Electrical, and Chemical Engineering Job Postings

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



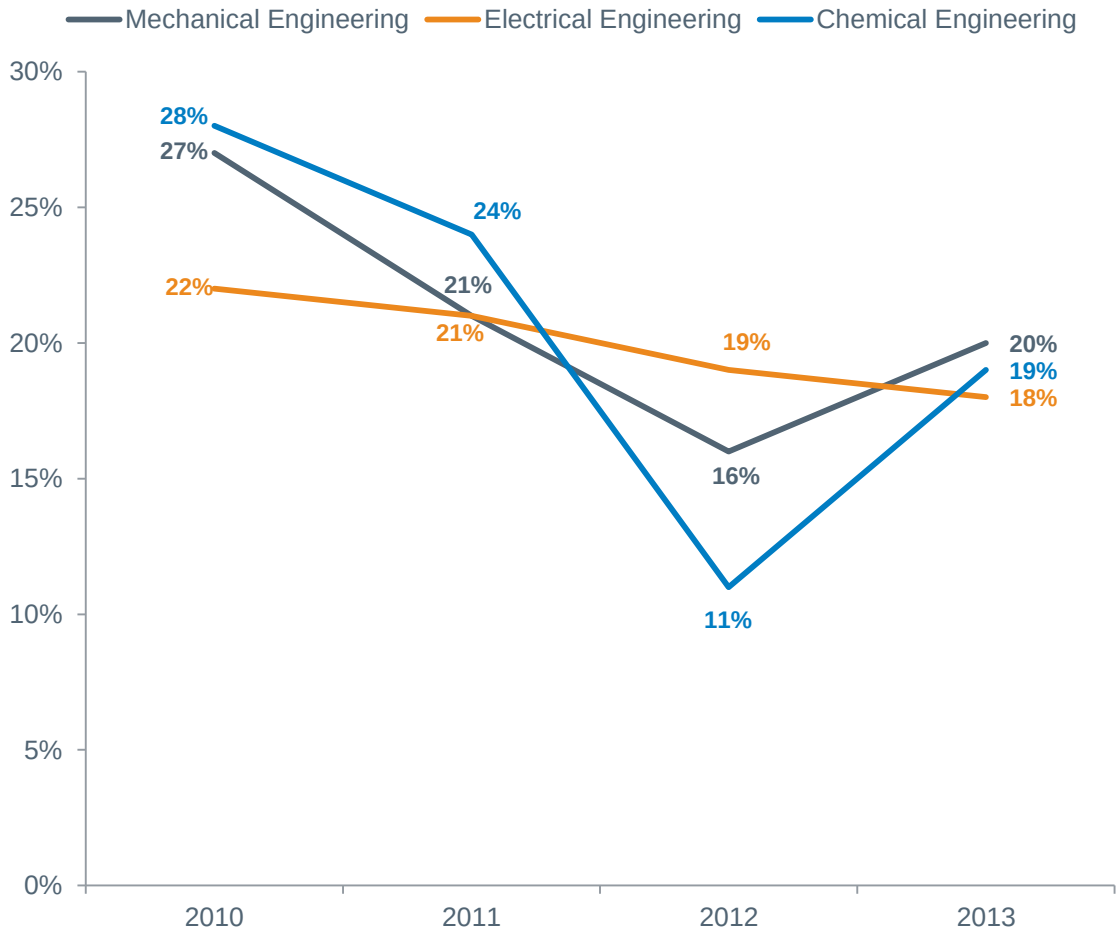
n=8,059 with 1,820 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Mechanical and Chemical Engineering Job Postings' Educational Requirements Vary Over Time While Electrical Engineering Postings Remain Fairly Stable

Fewer job postings for all engineering fields that require or prefer a bachelor's degree at a minimum additionally require or prefer a graduate or professional degree than electrical engineering jobs in 2013 compared with 2010.

Chart 34: Job Postings Requiring a Graduate or Professional Degree

Minneapolis-St. Paul-Bloomington MSA, January 2010 to December 2013



n=1,242 with 0 unspecified
Search includes postings from January 2010 to December 2013
Source: Burning Glass Labor/Insight™

Burning Glass Labor/Insight™

Burning Glass – The Education Advisory Board's Partner for Real-Time Labor Market Data

Part of the data included in this report made possible through our partnership with Burning Glass, a Boston-based firm specializing in use of web spidering technology and Artificial Intelligence engines to mine more than 80 million online job postings for real-time employer demand data. Under the partnership, the Education Advisory Board may use certain features of Burning Glass's proprietary tool called Labor/Insight™ to answer common member questions about employer demand for specific educational requirements, job titles, and competencies over time and by geography. A fuller description of the tool is available at http://www.burning-glass.com/products/labor.html.

Learn about Burning Glass and Labor/Insight™

Many Education Advisory Board member institutions subscribe to the Labor/Insight™ tool, to provide program directors and marketers desktop access to the tool's full suite of features. Burning Glass is pleased to provide Labor/Insight™ to our members at a substantial discount. For more information about the service, please contact Kelly Bailey, Business Development Manager, kbailey@burning-glass.com or 732-800-2484.

Definition of Terms

The total number of "unspecified" job postings included in a data sample is indicated below all charts and graphs in this report. Job postings are considered "unspecified" for a skill, industry, employer, geography, certification, education requirement, or major when the job posting did not advertise for one of these particular job characteristics and therefore should be subtracted from the total number (n value) of job postings analyzed in the query. Capital cities may be overrepresented in instances where job postings do not specify a location within a state.

UNIVERSITY OF WISCONSIN
PLATTEVILLE
COLLEGE OF ENGINEERING, MATHEMATICS AND SCIENCE

TO: Dennis J. Shields, Chancellor

FROM: Mesut Muslu, Interim Dean
College of Engineering, Mathematics, and Science

RE: Initial Response to NCHEMS Report on Wisconsin Engineering Assessment Report

DATE: October 23, 2014

Attached is the College of Engineering, Mathematics and Science response to NCHEMS Wisconsin Engineering Assessment Report. Overall it is a reasonable report except that it is written without understanding the role of engineering programs at UW-Platteville in providing engineers to Wisconsin industry. The report also misses the very existence of our Collaborative Engineering Program that has the goal of graduating engineers throughout Wisconsin including Region 5 (Fox Valley - Sheboygan area, as defined in the NCHEMS report).

The first page of the response highlights our observations about the NCHEMS report. The second part contains our response to the report's recommendations and the reasons why UW-Platteville is uniquely positioned to serve the perceived unmet demand in Region 5. The last part of the response provides options for collaboration between UW-Platteville and UW-Oshkosh and/or UW-Green Bay to serve the perceived unmet demand in Region 5 and compares the support necessary for each option.

Please let me know if you have any questions.

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100 Ottensman Hall | 608.342.1561 | Fax: 608.342.1561 | emsdeansoffice@uwplatt.edu
1 University Plaza | Platteville WI 53818-3099 | www.uwplatt.edu

UNIVERSITY OF WISCONSIN PLATTEVILLE
COLLEGE OF ENGINEERING, MATHEMATICS AND SCIENCE

RESPONSE TO NCHEMS WISCONSIN ENGINEERING ASSESSMENT REPORT

1. OBSERVATIONS ABOUT THE NCHEMS REPORT

The following is our observations about the report findings and its assumptions that we feel affect the recommendations by NCHEMS.

Overall, the report's findings seem to be well developed and reasonable. Also the report seems to do a good job in determining which part of the State, if any, has unmet engineering demand and which engineering disciplines are in need.

The report's finding about the compensation of engineers in Wisconsin being lower than the Border States or the National average may explain why Wisconsin is an exporter of engineers. If engineering salaries in Wisconsin were higher compared to Border States, it could improve the ability of Wisconsin to attract engineers from Border States reducing the unmet demand in Region 5.

The report does not consider where the graduates of engineering schools are placed for employment in Wisconsin. This would give a good picture of which engineering schools serve the State or specific regions of the State. For example, the graduates from UW-Platteville engineering programs are mostly placed in Wisconsin (close to 80 %) and significant portion of the graduates are placed in Region 5 (close to 30 %).

The report does not consider the current efforts by engineering schools to meet the engineering demand in Wisconsin. In fact, the report completely misses the fact that UW-Platteville already has a Collaborative Engineering Program that offers UW-Platteville electrical and mechanical engineering degrees in all regions in the State, particularly in Region 5.

The report implicitly assumes that engineering demand at a region needs to be supplied by engineering schools in the region or close to the region. UW-Platteville graduates about 300 engineers annually and only a small percentage of them (5%) are employed by companies in Region 4 where UW-Platteville is located. Most of our engineering graduates are placed in Wisconsin and a significant portion of them (29 % in 2013-14 academic year graduates) are placed in Region 5. In other words, the engineering programs at UW-Platteville serve not just the surrounding area but the whole State.

2. RESPONSE TO THE NCHEMS REPORT'S RECOMMENDATIONS

In general, we agree with the report's findings that Region 5 (as defined in the NCHEMS report) in the State is probably the only region with some unmet engineering demand.

We agree with the report's overall recommendation that priority be given to expanding the exiting capacity rather than creating new capacity in the UW-System. We also agree that the perceived unmet engineering demand in Region 5 should be met by joint effort between existing engineering programs and UW-Green Bay and UW-Oshkosh.

We, however, are deeply concerned about the report's recommendation that UW-Milwaukee or UW-Madison should be considered for capacity expansion to meet the perceived unmet demand in Region 5 without any consideration of UW-Platteville. We believe that NCHEMS staff, "not being on the ground" as indicated in the report, completely missed the fact that:

- UW-Platteville already has a Collaborative Engineering Program (established in partnership with UW-Colleges) that has served the needs of electrical and mechanical engineering in Region 5 for more than eight years.
- UW-Platteville engineering programs are already serving this region as close to 30% of all engineering graduates from UW-Platteville are placed in Region 5.

We strongly believe that UW-Platteville is uniquely positioned to serve the perceived unmet engineering demand in Region 5 effectively and most economically. The main reasons are:

a) <u>UW-Platteville Collaborative Engineering Program</u>: The Collaborative Engineering Program is established in partnership with UW-Colleges with a specific goal of workforce development in engineering fields by attracting place-bound individuals who want to further their education and receive an engineering degree. The Program started with a Mechanical Engineering (ME) program at UW-Fox Valley in 2002. In 2006, the Program was expanded by establishing an Electrical Engineering (EE) program at UW-Fox Valley, and both ME and EE programs at UW-Rock County. In 2008, the Program further expanded to serve all other UW-Colleges using streaming video technology. Expansion of the program to UW-Washington County occurred in 2010 by equipping the engineering laboratories constructed by Washington County and placing a faculty member at that location.

   Students in the Collaborative Engineering Program take their pre-engineering courses from UW-Colleges and then are admitted to UW-Platteville's EE or ME programs. Engineering courses are taught by UW-Platteville professors either using face-to-face instruction (by placing UW-Platteville professors at UW-College campuses) or by using streaming video technology (by capturing UW-Platteville faculty/staff lectures and

making it available to collaborative engineering students anywhere in the State). Students in the Collaborative Engineering Program can complete their degree requirements without coming to UW-Platteville campus.

Currently, the Collaborative Engineering Program has faculty presence and office/laboratory spaces at three locations: UW-Fox Valley; UW-Rock County; and UW-Washington County. In addition, UW-Sheboygan County broke ground for an engineering facility in October 2014 which is expected to open in Fall 2015. Table 1 provides information about faculty and facilities at these Collaborative Engineering sites.

TABLE 1: Collaborative Engineering Program faculty and Facilities at UW-Colleges

UW-College	Number of UW-Platteville faculty/staff at the UW-College Campus	Engineering Facility at the UW-College Campus
UW-Fox Valley*	2 Mechanical Engineering faculty, 1 Electrical Engineering faculty, 1 staff	Approximately 20,000 square-foot facility
UW-Rock County*	1 Mechanical Engineering faculty, 2 Electrical Engineering faculty	Approximately 4,500 square-foot facility
UW-Washington County	1 Mechanical Engineering Instructional academic staff	Approximately 5,200 square-foot facility
UW-Sheboygan	None	Approximately 7,200 square-foot facility**

* Some part-time instructional academic staff also provide face-to-face instruction at these locations.
** Expected to open in Fall 2015

As seen in Table 1, three of the four engineering facilities in our Collaborative Engineering Program are in Region 5. UW-Fox Valley has a 20,000 square–foot engineering facility with faculty offices and well-equipped EE and ME laboratories. In collaboration with UW-Oshkosh, UW-Platteville, and UW-Colleges, the existing Program at UW-Fox Valley can be expanded and the existing laboratory facilities may be shared with UW-Oshkosh. Similarly, existing UW-Platteville faculty at UW-Fox Valley could also teach at UW-Oshkosh if there are enough interested students. This will create significantly better utilization of existing facilities and personnel resulting in a more

economical way of meeting the perceived unmet engineering demand in Oshkosh and its surrounding areas. Of course, such collaboration between UW institutions and sharing facilities and personnel would result in lower cost to the State compared to establishing new programs.

Table 2 below shows the number of students in the Collaborative Engineering Program (engineering and pre-engineering) by region. Again, it is clear that Collaborative Engineering Program serves all regions in the State but Region 5 has most of the students (194 out of 365 engineering students). Our data also shows that almost all of the engineering graduates from the Collaborative Engineering Program stay in the region upon graduation. Hence, the Collaborative Engineering Program already meets its goal of developing technical workforce throughout the State, particularly in Region 5 where there is some unmet need.

TABLE 2. Total Enrollment in Collaborative Engineering Program as of Fall 2014

Program	**Region 1**	**Region 2**	**Region 3**	**Region 4**	**Region 5**	**Region 6**	**Region 7**	**Total**
Electrical Engineering	1	0	8	2	64	30	10	115
Mechanical Engineering	3	0	33	0	130	42	42	250
Total	4	0	41	2	194	72	52	365

In conclusion, UW-Platteville has the experience, expertise and infrastructure to build on while expanding its Collaborative Engineering Program to meet the engineering demand of the industry in Region 5.

a) <u>UW-Platteville is in a unique position to serve the engineering need of Wisconsin:</u>
UW-Platteville is located in the Southwest corner of the State with limited population and industry presence. At the same time, UW-Platteville College of Engineering, Mathematics and Science graduates approximately 300 students annually from its seven ABET accredited engineering programs and places less than 5% of its graduates in Region 4. The remaining 95% of graduates are placed throughout Wisconsin and out-of-state. Table 3 below shows the details of the distribution of UW-Platteville engineering

graduates in each region of the State. The data clearly shows that out of 238 graduates who reported their employment status at the end of 2013-14 academic year:

- about 80% of UW-Platteville engineering graduates stay in Wisconsin,
- less than 5 % are employed in Region 4 where UW-Platteville is located, and the
- largest portion (29%) of our engineering graduates are placed in Region 5.

The data presented in Table 3 clearly shows that UW-Platteville already serves the engineering needs in Region 5. UW-Platteville also has all the engineering disciplines (civil, electrical, industrial, and mechanical engineering) except chemical engineering identified in NCHEMS report as needed in Region 5. Hence, UW-Platteville can effectively and economically expand its existing programs in partnership with UW-Colleges and UW-Oshkosh and/or UW-Green Bay to serve the identified engineering need in that region.

Table 3. Employment Data for UW-Platteville Engineering Programs (2013-14 academic year)

Program	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Out of State	Total Reporting
Civil Eng.	5	1	4	3	11	20	9	9	53
Electrical Eng.	0	0	0	0	19	1	1	5	26
Eng. Physics	0	0	0	0	3	3	0	2	8
Environmental	2	0	0	0	0	2	1	3	8
Industrial Eng.	0	0	0	0	3	1	0	9	13
Mechanical Eng.	4	1	3	6	32	25	11	23	105
Software Eng.	0	0	0	2	0	4	9	1	16
Total placed	11	2	7	11	68	56	31	52	238
% Placement	4.6	0.8	2.9	4.6	28.6	23.5	13.0	21.8	

Table 4 below shows the number and percent of new freshmen by region. Again, the data indicates that only a small percentage of students (11 %) come from Region 4, where the largest is coming from Region 5 (23 %) confirming the reach of our engineering programs.

TABLE 4. Fall 2014 New Admits to UW-Platteville Engineering Programs

Program	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Total
Number of students	37	13	50	84	175	166	226	751
% of total students	4.9	1.7	6.7	11.2	23.3	22.1	30.1	

b) UW-Platteville is focused on quality undergraduate engineering education with the goal of graduating "industry-ready "engineers. UW-Platteville is unique with the focus on being an applied engineering school providing significant hands-on experience to its graduates. The feedback that we receive from industry consistently indicates that our graduates have the training and skillset that industry seeks.

3. WAYS TO COLLABORATE WITH UW-GREEN BAY OR UW-OSHKOSH

a) Through a variation of 2+3 type programs: In this option, students take general education and pre-engineering courses at UW-Green Bay or Oshkosh (as recommended by NCHEMS), and transfer to UW-Platteville to complete the discipline specific requirements in 2 or 3 years.

This option would be the least expensive option for the UW-System and the State as it will only require a few special advisors be hired at UW-Oshkosh and/or UW-Green Bay and maybe some expansion of the engineering programs at UW-Platteville (only when the capacity of an engineering program is reached and additional faculty/staff necessary).

b) Through the Expansion of the Collaborative Engineering Program: In this model students take general education and pre-engineering courses at UW-Green Bay or UW-Oshkosh, and discipline specific courses are taught by a combination of face-to-face or

streaming video courses taught by UW-Platteville faculty. Face-to-face instruction requires some the UW-Platteville faculty be placed at UW-Green Bay or UW-Oshkosh similar to what we currently have at UW-Fox Valley, UW-Rock County, and UW-Washington County.

This option would require significant additional funding compared to option (a) since faculty members need to be placed at UW-Green Bay and/or UW-Oshkosh. Furthermore, there may be a need for additional facilities for engineering labs or offices. However, collaborating with UW-Fox Valley and sharing the existing 20,000 square-foot engineering facility would reduce the cost and result in significant savings to the State compared to establishing such a facility at UW-Oshkosh campus.

College of Engineering
UNIVERSITY OF WISCONSIN-MADISON

David J. Ward
Interim Senior Vice President
for Academic Affairs
UW System
1730 Van Hise Hall
1220 Linden Drive
Madison, WI 53706

30 October 2014

UW-Madison College of Engineering response to NCHEMS study of "Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin"

Dear David,

In response to your request for comments on the report from the National Center for Higher Education Management Systems study of "Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin," let me start by offering, in principle, my support of the recommendations. I know that with an appropriate investment, which would be modest in comparison to building a new engineering campus or expanding program offerings at existing ones, the College of Engineering at UW-Madison can meet the demand for engineers in the identified disciplines. The College is willing to explore with Oshkosh or Green Bay the feasibility of developing a partnership to offer civil engineering and perhaps mechanical engineering degrees at their facility. The Engineering Profession Department, ranked in the top five nationally for delivery of online engineering programs, certainly has the capability to deliver degrees at a distance. However, before supporting expansion efforts, I would like to make you aware of the growth in demand for engineering degrees from UW-Madison since the study was conducted as it is pertinent to the path selected to optimize the use of resources while meeting the demand.

First, the number of applications to the College of Engineering has grown significantly in the last five years. In 2010 the number of applicants was 4239 and in 2014 it was 6238, an increase of 47.2%. Second, the number of applicants invited to attend the college in the same time period increased by 28.3%, from 2515 to 3226. Third, the number of students who matriculated in 2010 was 1135 and in 2014 it was 1479, an increase of 29.4%. Lastly, the total number of engineering undergraduates increased by 34.7% between 2010 and 2014 going from 3748 in 2010 to 5048 in 2014, with a net increase of 676 from last year alone. The disciplines experiencing the fastest growth are biomedical engineering, chemical and biological engineering, computer engineering and mechanical engineering. The growth in demand is highest in mechanical engineering with the number of students (juniors and seniors) totaling 673 today. As these students graduate, there will be a significant increase in the number of engineers seeking employment. Of course, for the college to continue to meet this level of demand, and retain the quality of education on which their reputation is based, an investment of resources is needed.

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It is also pertinent to consider the job placement of UW-Madison engineering students. The career development and job placement program in the College of Engineering is substantial and it is successful. For the last set of data, the placement rate of students was 94%, with 46% of these students employed in Wisconsin, 12% in Minnesota and 14% in Illinois. The college is expanding its career services to accommodate the increase in the student population and they would welcome the opportunity to engage companies with career opportunities on how to best work together to meet industry demand for engineers.

In summary, the growth in demand for engineering degrees that has occurred at UW-Madison over the last few years will go a long way to satisfying the demand within the State. With appropriate investment, the College can sustain and could even increase its capacity to meet any projected industry need. The demand from students is certainly there and the increased interest in UW-Madison College of Engineering is expected to continue into the foreseeable future.

Regards,

Ian M. Robertson, Dean

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

October 30, 2014

David J. Ward,
Interim Senior Vice President for Academic and Student Affairs
University of Wisconsin System
1730 Van Hise Hall
Campus

Re: NCHEMS Engineering Degree Supply and Demand in WI Study

Dear David,

Thank you for the opportunity to review the report from the National Center for Higher Education Management Systems, "Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin." We appreciate having the opportunity to review the report and comment of its findings and recommendations.

Overall, UW-Madison supports the recommendations (pgs. 20 – 21) made by NCHEMS.

We are especially supportive of the suggestion that "priority be given to expanding existing capacity at Madison and Milwaukee rather than creating new capacity at other institutions" (p. 20) for the following additional reasons not addressed in the report:

1. Engineering education is a resource-intensive educational endeavor. In the current financial landscape of higher education, most local/regional universities are not in a position to develop and accredit new engineering degree programs without significant new resources or disproportionate program reductions in other areas.

2. It will be difficult to attract and retain a strong engineering faculty in newly developed, unranked, and unaccredited engineering programs.

3. It is our observation that professionals and those students who aspire to professional positions will travel for advanced training. The notion that a large number of potential engineering students are place-bound has not been established and is inconsistent with national trends. Engineering is similar to medical, dental and pharmacy schools in that students routinely relocate to where well-known programs have been established.

Should UW System be in the position of supporting an increase in capacity within the System, we believe it is financially prudent to increase investment in the existing comprehensive accredited engineering programs at UW-Madison, UW-Milwaukee, and UW-Platteville.

Office of the Provost and Vice Chancellor for Academic Affairs
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These programs are already experiencing increased demand, and would be able to increase capacity to serve additional students with less investment than it would take to establish new engineering programs at other System institutions.

As you know, our School of Medicine and Public Health began the Wisconsin Academy for Rural Medicine (WARM) within our MD training program to address the need for the state to prepare more physicians to serve in rural areas. We believe it makes more sense to work with existing Engineering programs to develop programs that target the state needs for engineers rather than have additional System campuses attempt to establish new engineering programs. To that end, UW-Madison is supportive of the notion of develop some joint activity between UW-Madison and/or UW-Milwaukee and Platteville with Green Bay or Oshkosh, as proposed in the NCHEMS report (p. 20).

Attached please find additional information provided by Ian Robertson, Dean of the UW-Madison College of Engineering.

Thank you for the opportunity to comment on this report.

Please let me know if you have questions.

Sincerely,

Sarah C. Mangelsdorf
Provost and Vice Chancellor for Academic Affairs

Attachment

cc: Chancellor Rebecca Blank, UW-Madison
Dean Ian Robertson, College of Engineering, UW-Madison
Steve Cramer, Vice Provost for Teaching and Learning
Jocelyn Milner, Assoc. Provost and Director, Academic Planning and Institutional Research

University of Wisconsin-Stevens Point
Office of Provost and Vice Chancellor

Stevens Point WI 54481-3897
715-346-4686; Fax 715-346-4132
www.uwsp.edu/admin/acadaffairs

TO: David Ward, Interim Senior Vice President for Academic and Student Affairs
FROM: Greg Summers, Provost and Vice Chancellor for Academic Affairs
RE: Comments on NCHEMS Engineering Report
DATE: October 30, 2014

Thank you for the opportunity to provide input related to the recent report entitled "Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin" prepared by the National Center for Higher Education Management Systems (NCHEMS). Although we appreciate the intent of the report and very much support the role of UW System in managing the state's program array, we are puzzled at the narrow manner in which the report authors chose to interpret their data. More concerning still is the fact that the authors of the study requested no information from UW-Stevens Point regarding our existing resources and faculty expertise, which calls into question one of their major recommendations. Below we provide comments that explain these concerns in detail.

The supply of engineers produced by Wisconsin universities is relatively easy to determine: a total 2447 engineering degrees awarded in 2013 (from pg. 1 of the study). The demand for engineers, however, is a more complicated question. The report accounts for the migration patterns of engineers (Table 3) and the loss of engineers to retirement (Table 4). The loss of engineers to migration is estimated to be 390, and the percentage of engineers approaching retirement age is estimated as 30.8%. The total number of engineers working in Wisconsin is 30,570 (Table 6). This suggests that more than 11,500 engineers could be lost to migration and retirement in the near future. This is a gross imbalance between the supply of new engineers and the looming demand. The report's finding that there is no such problem seems to be in conflict with the actual numbers. In fact, in the paper industry (a $5.2 billion Wisconsin industry), human resource professionals worry openly about the "silver tsunami" of technical and engineering professionals approaching retirement age.

The study presents maps in its appendix purporting to illustrate the demand for various engineering disciplines by region within the state of Wisconsin. What is not clear is why the recommendations seem to suggest that any program expansion must happen only in the local regions where there is demonstrated existing "need" for a specific discipline, as though graduates are unwilling to relocate from one region to another to pursue their careers. Clearly, these narrow parameters do not reflect the reality of the job market in which engineering students are quite willing to relocate. We know, for example, that while most engineering students at UW-Stevens Point would prefer to remain in Wisconsin, they are quite willing to leave Region 3 for employment. In our opinion, this calls into question the first recommendation in the report. Moreover, the entire study seems strangely focused only on the immediate situation and does not look enough at anticipated demand. For example, NCHEM's Table 4 shows a high percentage of employed Engineers age 50 and over in both Wisconsin and neighboring states. This is most noticeable for environmental engineers. Clearly, any decisions we

make regarding our academic program array should be based on something more than just a snapshot of demand as it exists today. It should be forward-looking and strategic, so we are prepared to meet the demands of the next generation, not just the present.

The fact that NCHEMS chose not to visit any of the campuses seeking new programs is perhaps the most disappointing aspect of their study, and it clearly colors their recommendations in our opinion. UW-Stevens Point wholeheartedly agrees that UW System must manage the state's overall program array with care. We also agree that the most effective path to expansion of engineering programs is to base the expansion on existing, accredited programs. With that in mind, we are compelled to raise an obvious point that is ignored entirely in the NCHEMS report: that the engineering programs at UW-Madison and UW-Milwaukee are not the only such programs in the state, nor indeed are they necessarily the best sites for any expansion that is needed. UW-Stevens Point has an existing ABET-accredited engineering program, and we are prepared to broaden our offerings to include both chemical and environmental engineering without requesting any additional state support.

To be specific, we agree with the report's finding that there is a need for another chemical engineering program in the state. Chemical engineering programs require extensive laboratory equipment to provide an appropriate educational experience for students. Starting such a program from scratch is a very expensive undertaking, as would be the case for the report's recommendation to house a new chemical engineering program at UW-Milwaukee. The ABET-accredited Paper Science and Engineering program at UW-Stevens Point is, at its core, a chemical engineering program. Virtually 100% of the graduates from this program are employed in process engineering positions immediately after graduation, and starting salaries averaged $69,000 for the class graduating in May 2013. This program has extensive facilities already in place, and the capacity to handle more students. In addition, we know anecdotally that there are many students who would choose to study chemical engineering if there were a program located at a smaller campus than Madison or Milwaukee. This makes UW-Stevens Point a logical location for a second chemical engineering program. Graduates from such a program would certainly be willing to relocate to other regions of the state upon graduation. (See Map B3 in the report).

Map A9 in the report shows a large area designated with a "slight need" for environmental engineers. This need comes as no surprise to UW-Stevens Point. Our College of Natural Resources made several strategic decisions during the recent hiring process for three faculty positions to provide the expertise needed to develop an environmental engineering program. The proposal for this program leverages existing resources and strengths throughout the college, specifically in the Paper Science and Engineering and the existing Water Resources and Waste Management majors, to provide a solid environmental engineering education. The facilities are in place, including a Waste Education Center with extensive laboratory and pilot scale equipment.

In summary, we believe that the NCHEMS report would have contained very different recommendations if its focus on need was broadened and if the authors had taken the time to request information about the faculty and facilities at UW-Stevens Point. The two new programs we have asked permission to create build on the national and international reputation long established by our College of Natural

Resources. Equally important, because we have made strategic investments over the years to secure the appropriate facilities and faculty expertise, we can build these programs without requesting any additional financial support. These programs are essential to our strategic initiatives, and they promise to enhance our ability to secure grants, create jobs in the region, and improve the state's economy by drawing new industry into Wisconsin.

Thank you once again for the opportunity to provide this additional context and information for UW System and the Board of Regents to consider before making a decision on any potential expansion of engineering programs.

From: Lampe, Greg
Sent: Monday, October 27, 2014 7:35 AM
To: David J. Ward (dward@uwsa.edu)
Cc: Brower, Aaron; James-Byrnes, Christa; UWC-Deans 1; Mittie Nimocks Den Herder (denherderm@uwplatt.edu)
Subject: UW Colleges Feedback on the NCHEMS Engineering Report

Dear Dave,

Below are the comments I have collected to date about the Engineering Report that NCHEMS produced for UW System. This feedback comes from our deans and our UW Colleges Engineering Program Coordinator. If I receive any additional comments, I will forward them on to you later this week.

It is important to note that UW-Platteville partners with all 13 of the UW Colleges campuses and UW Colleges Online and Distance Education to offer the Mechanical and Electrical engineering degree. As you will see in the feedback below, the NCHEMS report overlooks the important role the UW Colleges play in delivering Engineering course content to students across Wisconsin and providing a clear pathway to Mechanical and Engineering degrees to students across Wisconsin. This is a highly successful, comprehensive, and thoughtfully developed program between UW Colleges and UW-Platteville.

From a UW Colleges Dean:

I noted that Region 5, which is New North, has a need for both Electrical and Mechanical engineers (and maybe others, for the moment I was focused on these two) and the comment in the document is that no engineering programs are found in that area. Should we point out that UW-Fox Valley and UW-Sheboygan offer those two degrees in collaboration with UW-Platteville? Also that UW-Washington County (West Bend) is a fourth engineering program in the Milwaukee region?

From a UW Colleges Dean:

UW-Marinette partners with UW-Platteville to offer the Bachelors in Engineering. Our collaboration with UW-Platteville was overlooked in the report.

From a UW Colleges Dean:

UW-Manitowoc has at least one student currently working with UW-Platteville (partially via the Sheboygan campus) and more potential students in the pipeline.

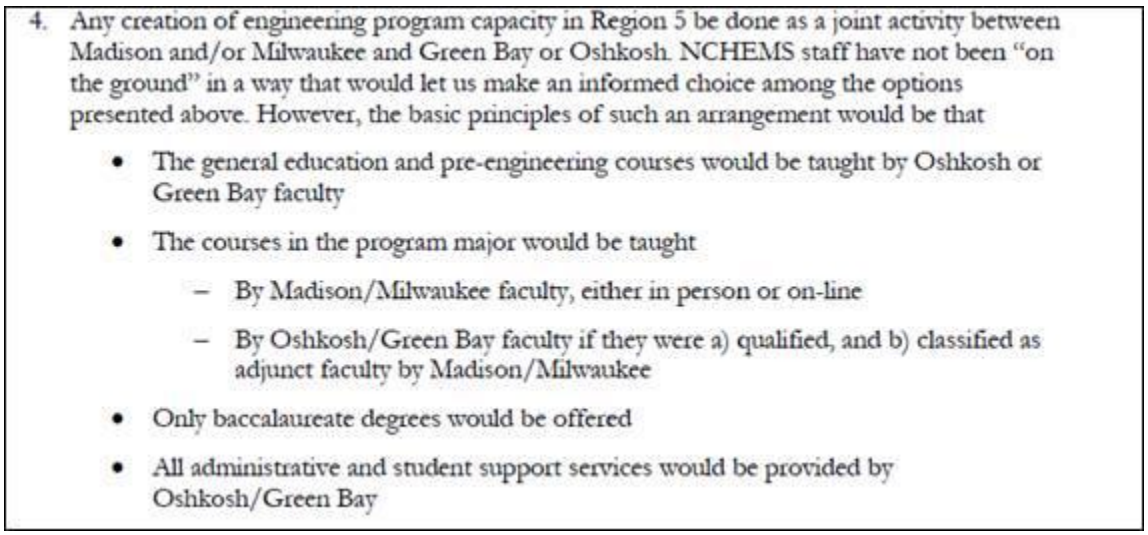
From the UW Colleges Engineering Program Coordinator:

- Since UW-Stevens Point is in a region that has a need, the UW Colleges could reach out to them to partner and offer their pre-engineering courses. Currently, UW-Stevens Point

offers Paper Science Engineering (they were only mentioned once in a table) and it would be an easy move to go to Civil Engineering. I know they are looking for an environmental engineer faculty member right now so that might be another venue for us.

- I am writing to you with my concerns regarding the NCHEMS report on the supply and demand of engineers in the state of Wisconsin. I must say I was quite taken aback by the report for several reasons.

  - In the report I could not find any reference to our partnership with UW-Platteville in the Mechanical and Electrical engineering degree programs. Nowhere in the report does it mention the ME or EE degree completion programs. It fails to recognize that we have designated facilities for engineering at UW-Fox Valley, UW-Rock County, UW-Washington County, and soon to be UW-Sheboygan County. This is especially mystifying since UW-Fox Valley is sitting squarely in the middle of Region 5 where there is a need for ME and EE engineers.
  - In the report the UW Colleges is not mentioned (Note: in the revised report, UW Colleges is mentioned; however only once). The report failed to realize that the UW Colleges offers a pre-engineering program.
    - For your information:
      - the UW Colleges has five faculty with terminal degrees teaching pre-engineering and three of these faculty are located in an areas that demonstrate a need (Fox Valley, Marathon, Waukesha). Two are located in a balanced region.
      - Two have their degrees in Civil Engineering, two in Mechanical Engineering and one in Aerospace Engineering.
      - The UW Colleges have four instructional academic staff in engineering with graduate degrees that also teach in our pre-engineering program.
      - The UW Colleges had 713 declared engineering majors in the 2012-2013 academic year
    - I believe that we are the pre-engineering program for the UW System and that we should continue to be the pipeline for engineering programs to UW Platteville and the other four engineering degree granting institutions.
  - In the report recommendation #4 is as follows:



4. Any creation of engineering program capacity in Region 5 be done as a joint activity between Madison and/or Milwaukee and Green Bay or Oshkosh. NCHEMS staff have not been "on the ground" in a way that would let us make an informed choice among the options presented above. However, the basic principles of such an arrangement would be that
   - The general education and pre-engineering courses would be taught by Oshkosh or Green Bay faculty
   - The courses in the program major would be taught
     - By Madison/Milwaukee faculty, either in person or on-line
     - By Oshkosh/Green Bay faculty if they were a) qualified, and b) classified as adjunct faculty by Madison/Milwaukee
   - Only baccalaureate degrees would be offered
   - All administrative and student support services would be provided by Oshkosh/Green Bay

- I would respond that the UW Colleges and UW-Platteville are already doing this. I feel, the UW Colleges already have the processes, the infrastructure, and the faculty and staff to do this. The UW System does not need to invest in new programs when programs are already in existence. UW System should look into methods to help expand and support the current programs we have.

- The report also failed to mention (except one table) that UW-Stevens Point has an ABET accredited program in Paper Science. They are in a region that needs engineers so there could be possible expansion in that program or others and we could be a pipeline for those programs, especially from UW-Marathon County.
- With regard to civil engineering the UW Colleges could begin to offer more Civil Engineering specific foundation courses to help the state with increasing the number of Civil engineers. This would require increased curriculum, but we could offer these courses. We could also begin exploring a collaboration or transfer agreement with UW System schools that offer Civil Engineering.

These are my opinions and concerns. If you have any questions or concerns please feel free to contact me.

From a UW Colleges Dean:

I am commenting only on the recommendations on page 20 of the revised report. Specifically, the reference to NEW ERA reveals what looks like two flaws in the report.

First, when the report recommends that gen. ed.(GE) and pre-engineering courses be offered at Green Bay and Oshkosh, in pursuit of the proposed collaborative effort with Madison and/or Milwaukee, it becomes evident that the authors have not looked at the nature of the collaboration among the NEW ERA institutions; i.e., the Colleges already offer GE and pre-engineering. Any degree-completion program regarding engineering can and should involve the Colleges (as is already done in one way with Platteville; I would not recommend that Madison and Milwaukee operate the same way, though maybe future demand will outstrip Platteville's capacity to serve the Colleges' graduates on their "home" campuses).

Second, and this may be more of a concern for Green Bay and Oshkosh than for us, though it could affect our recruiting, as well. The report, when calling for a collaboration with Madison and Milwaukee, notes that a "full" engineering program could be offered in our region if Madison and/or Milwaukee were involved. The implication is that the engineering tech programs offered through the NEW ERA collaborative initiative are not "real" engineering programs, or are "engineering lite," rather than addressing an industry demand for technicians. The NCHEMS authors seem to have missed the point to the engineering tech program entirely; i.e., it was established to address a need that was not being filled with existing engineering programs, of which there are plenty already in Wisconsin, rather than because that's all Green Bay and Oshkosh could do.

On page 20 of the report, the authors note that they had not been "on the ground." I suspect that this may have led to what looks like a lack of understanding of A) what role the Colleges play in the UW System and B) the engineering tech programs at Green Bay and Oshkosh.

Gregory P. Lampe, Ph.D.
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From: Ford, Deborah L
Sent: Saturday, November 01, 2014 5:52 PM
To: David Ward
Cc: Ebeid, Fred J; Otu, Emmanuel O; Wood, Gary M; Kristy Gorman (kgorman@uwsa.edu) (kgorman@uwsa.edu)
Subject: RE: Revised Engineering Report - please provide feedback

David,

Thank you for providing time for us to review the Engineering report. The only suggestion I have is to add information about the new articulation agreement (signed in May 2014) between UW-Milwaukee and UW-Parkside for an engineering partnership. I noted that NCHEMS included information about the Kentucky partnerships and we have evidence of a similar program in Wisconsin.

I have copied Dean Otu so he can share the articulation agreement and a summary of the new engineering pathway for inclusion in the report. Many of our regional employers have asked about engineering at UW-Parkside and the optimal pathway was to develop a 2+2 agreement with UW-Milwaukee. The program launched in the fall with great interest from students, and we received new funding from Snap-on for engineering scholarships.

I appreciate the level of detail provided by NCHEMS and hope that additional studies may be conducted for high-demand fields. Information like this provides us with greater clarity of where to focus our limited resources and also allows us to share specific needs with business leaders.

Let us know if you have questions or need additional information from us.

Thanks,
Debbie

Pre-Engineering / Engineering Articulation Agreement

University of Wisconsin - Parkside
College of Natural and Health Sciences
and

University of Wisconsin- Milwaukee
College of Engineering and Applied Science

EFFECTIVE Fall 2014

Overview

The agreement creates a curriculum plan so that students at the University of Wisconsin-Parkside (UWP) may complete and transfer coursework applicable to the first two years of the University of Wisconsin-Milwaukee (UWM) Electrical and Mechanical engineering majors in the College of Engineering and Applied Science (CEAS), and provides guaranteed transfer to students who complete all of the articulated pre-engineering courses and UWM admission requirements.

Terms and Conditions

The terms of this agreement establishes a guaranteed admission into UWM CEAS with Junior Standing, upon completion of the agreed upon program outlined in this agreement.

II. **Admission requirements**

A. All UWP standard university admission requirements apply. Admission to the pre-engineering program requires placement into Calculus I or successful completion of math course sequence leading to Calculus I.

B. All UWM and specific CEAS admission requirements apply to students under this agreement. http://www4.uwm.edu/ceas/future_students/student_admission.cfm
Guaranteed admission requires successful completion of agreement upon UWP pre-engineering program as outlined in the agreement and a 3.0 cumulative GPA.

II. **Provisions**:

1. **Recruitment**. UW-Parkside will recruit students into the pre-engineering (61-75 credits) phase.

2. **Marketing**. Any marketing of this agreement will be subject to the prior approval of both parties and will adhere to each institution's standards for the use of its name and logo. Each institution may provide a link to this agreement and/or the other institution at its website, with notice to

the other party. UW-Parkside will provide materials, catalogs, and other information to UWM counselors to facilitate their understanding of the requirements of this articulation.

3. **Advising**. During the first 61-75 credits of study (typically years one and two), students will receive primary academic advising at UWP. Students will also be assigned co-advisors from UWM during these years to ensure continuity upon transitioning to UWM. When students are taking courses at UWM (typically years three and four), they will be advised solely by UWM advisors. UWP will convey to its students the requirements needed to successfully transition to UWM CEAS with a Junior Standing.

4. **Tracking**: UWP will provide the UWM CEAS Advisor(s) with the names of students who are at UWP under this articulation agreement. This will allow UWM to plan for their transition and advising. Prospective student applicant names will reside at UWP.

5. **Tuition**: Students pay tuition and appropriate fees to the university at which they are enrolled.

6. **Term**. This articulated program will be available to students beginning in the Fall Semester of 2014. This Agreement shall remain and continue in full force and effect unless written notice of a need for modification or termination is received by one party from the other party at least 6 months in advance of the next academic year. In the event the program is terminated, any student already in the program will be allowed to finish it as long as academic standards are met.

7. **Periodic Review**. This agreement will be reviewed every two years prior to the publication of the UWP catalog, or earlier if curricular or institutional policy changes warrant. Each institution agrees to notify the other of significant curricular or policy changes in a timely manner.

8. **Courses**. In the event that UWP does not offer specific courses, UWM and UWP will work collaboratively to find alternative ways of delivering these courses (e.g. UWP students could be offered enrollment in CEAS as guest students for these courses while they enroll in other courses at UWP). Current courses include: CivEng-201 (Statics), CivEng-202 (Dynamics) and ElecEng-301 (Electrical Circuits I).

9. **Program and Course changes**: In the event that academic program requirements and/or course curricula of either institution undergo revision or change it is the responsibility of that partner institution to inform the other partner institution of the change(s) within 120 days of the change. Each partner institution should provide contact person information to facilitate this requirement. The UWP contact is the Dr. Penny Lyter, Associate Dean, College of Natural and Health Sciences (email: lyter@uwp.edu; telephone 262-595-2494). The UWM contact is Dr. Ronald Perez, Associate Dean-Academic and Administrative Affairs, College of Engineering and Applied Science (email: perez@uwm.edu; telephone 414-229-6543).

10. Students admitted under this agreement will be guided by UWM and UWP catalogue year of their admission to UWP.

11. **Failure to complete the program**: Students enrolled under this UWP/UWM CEAS articulation agreement who voluntarily withdraw or do not meet the requirement to continue in the program may transfer any earned UWP/UWM credits eligible under this agreement back to UWP or UWM into another degree program of their choice, in accordance with the institution/academic program credit transfer equivalencies and requirements.

IN WITNESS WHEREOF the parties hereto have executed two copies of this instrument, each of which shall be considered an original.

UNIVERSITY OF WISCONSIN – MILWAUKEE

Brett A. Peters — Dec. 11, 2013

Dean, University of Wisconsin - Milwaukee College of Engineering and Applied Science — Date

Provost, UW-Milwaukee — Dec. 19, 2013 — Date

UNIVERSITY OF WISCONSIN - PARKSIDE

Jan 7, 2014

Dean, College of Natural and Health Sciences University of Wisconsin - Parkside — Date

Jan. 7, 2014

Provost, University of Wisconsin - Parkside — Date

Jan, 7, 2014

Chancellor, University of Wisconsin - Parkside — Date

UW-Parkside / UW-Milwaukee BSc Mechanical Engineering Agreement
4-Year Plan

Year 1 – UW-Parkside pre-Mechanical Engineering @ UWM					
Fall Semester			*Spring Semester*		
MATH 221	Calc. & Analytic Geometry I	5	MATH 222	Calc. & Analytic Geometry II	5
PHYS 201	Physics I	5	PHYS 202	Physics II	5
CHEM 101	General Chemistry I	5	PHYS 241		3
			Civ Eng 201 (or equivalent)		3
		15			**16**
Winterim Semester			*Summer semester*		
Gen Ed	ART or HUM or SOC	3	Gen Ed	ART or HUM or SOC	3
Foreign Lang*		4	Foreign Lang*		3
		7			**6**
Year 2 – UW-Parkside pre-Mechanical Engineering @ UWM					
Fall Semester			*Spring Semester*		
MATH 223	Calc. & Analytic Geometry III	5	PHYS 303 or MATH 368		3
MATH 317	Diff Equations & Applications	4	PHYS 403	Thermo & Statistical Physics	4
Civ Eng 202 (or equivalent)		3	CHEM 102	General Chemistry II	5
Gen Ed	ART or HUM or SOC	3	Elec Eng 301 (or equivalent)		3
		15			**15**
Winterim Semester			*Summer semester*		
ENGL	English Competency Req.	3	Gen Ed	SOC	3
			ENGL	English Competency Requirement	3
		3			**6**

*If required, refer to UWM foreign language requirement

Year 3 – UWM Mechanical Engineering					
Fall Semester			Spring Semester		
MechEng 110	Engineering Fundamentals I	4	MechEng 111	Engineering Fundamentals II	4
Civ Eng 303	Strength of Materials	4	MechEng 320	Intro to Fluid Mechanics	3
MatlEng 201	Engineering Materials	4	MatlEng 330	Materials & Processes in Manuf	3
MechEng 321	Basic Heat Transfer	4	Ind Eng 467	Intro Statistics/Phy Sci & Engr	3
EAS 200	Professional Seminar	1	MechEng 474	Intro to Control Systems	4
		17			17
Year 4 – UWM Mechanical Engineering					
Fall Semester			Spring Semester		
MechEng 323	Fluid Mechanics Laboratory	1	MechEng 438	Mech Eng Experimentation	3
MechEng 360	Mechanical Design I	3	MechEng 479	Mechatronics	3
MechEng 366	Design of Machine Elements	4	MechEng 496	Senior Design	3
MechEng 370	Comp Aided Engineer Lab	2	MechEng XXX	Technical Electives	8
MechEng XXX	Technical Elective	3			
Commun XXX	Part B Oral & Written	3			
		16			17

UW-Parkside / UW-Milwaukee BSc Electrical Engineering Agreement
4-Year Plan

Year 1 – UW-Parkside pre-Electrical Engineering @ UWM					
Fall Semester			*Spring Semester*		
MATH 221	Calc. & Analytic Geometry I	5	MATH 222	Calc. & Analytic Geometry II	5
PHYS 201	Physics I	5	PHYS 202	Physics II	5
CHEM 101	General Chemistry I	5	PHYS 241		3
			Civ Eng 201 (or equivalent)	Statics	3
		15			**16**
Winterim Semester			*Summer semester*		
Gen Ed	ART or HUM or SOC	3	Gen Ed	ART or HUM or SOC	3
Foreign Lang*		4	Foreign Lang*		3
		7			**6**
Year 2 – UW-Parkside pre-Electrical Engineering @ UWM					
Fall Semester			*Spring Semester*		
MATH 223	Calc. & Analytic Geometry III	5	PHYS 303 or MATH 368		3
MATH 317	Diff Equations & Applications	4	PHYS 403	Thermo & Statistical Physics	4
PHYS 302	Electricity & Magnetism	4	CHEM 102	General Chemistry II	5
Civ Eng 202 (or equivalent)	Dynamics	3	Elec Eng 301 (or equivalent)	Electrical Circuits	3
		16			**15**
Winterim Semester			*Summer semester*		
Gen Ed	ART or HUM or SOC	3	Gen Ed	SOC	3
ENGL	English Competency Req.	3	ENGL	English Competency Requirement	3
		6			**6**

*If required, refer to UWM foreign language requirement

Year 3 – UWM Electrical Engineering					
Fall Semester			Spring Semester		
MatlEng 201	Engineering Materials	4	ElecEng 330	Electronics I	4
ElecEng 305	Electrical Circuits II	4	ElecEng 310	Signals and Systems	3
ElecEng 354	Digital Logic	3	ElecEng 362	Electromechanical Energ Conv	4
Commun XXX	Part B Oral & Written	3	ElecEng 367	Intro to Microprocessors	4
EAS 200	Professional Seminar	1			
		15			15
Year 4 – UWM Electrical Engineering					
Fall Semester			Spring Semester		
ElecEng 335	Electronics II	4	ElecEng 595	Senior Design	4
ElecEng 420	Random Signals & Systems	3	ElecEng XXX	Technical Electives	9
ElecEng XXX	Technical Electives	9			
		16			13

UNIVERSITY of WISCONSIN
UWMILWAUKEE

Academic Affairs
Provost and Vice Chancellor

Chapman 215
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Milwaukee, WI
53201-0413
414 229-4501 *phone*
414 229-2481 *fax*

DATE: October 31, 2014

TO: David J. Ward, Interim Senior Vice President for Academic & Student Affairs

FROM: Johannes Britz, Provost & Vice Chancellor,
University of WI-Milwaukee

SUBJECT: Response to Revised NCHEMS Engineering Report prepared for the UW System

UWM response to Revised Engineering Report:

1. It is difficult for us to comment on the data on demand and supply presented in the report, as we have not had the opportunity to examine the source data. Assuming these are good data, the conclusions drawn in the report seem reasonable.

2. One correction that needs to be made in Table 15. UW-Milwaukee has no Manufacturing Engineering degree. The number 16 assigned to this should indeed be reflected on the previous row (Industrial Engineering). Our degree is BSE in Industrial Engineering.

3. The recommendations seem reasonable to UWM. We would welcome a discussion with the UW System Office on the program array at UWM (Recommendation 3) and on the expansion of existing programs to serve Region 5 (Recommendation 4).

JJB/eak

Cc: Dev Venugopalan, Associate Vice Chancellor, UW-Milwaukee
Brett Peters, Dean, College of Engineering & Applied Science, UW-Milwaukee

UNIVERSITY OF WISCONSIN SYSTEM

Office of the President

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e-mail: rcross@uwsa.edu
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DATE: October 31, 2014

TO: Wisconsin Economic Development Organizations, Wisconsin Companies, and State Agencies

FR: Ray Cross

RE: Engineering needs in the State of Wisconsin

As part of the strategic planning for UW System, I am writing to you to seek your input on engineering workforce needs of the State of Wisconsin in the next 10 years. We also need your input on how the University of Wisconsin System can address these needs. Several studies and articles have mentioned the need for more engineering graduates in the state. For example, the *Be Bold 2* study cites engineering as one of the top talent needs for businesses in the state.

We are seeking more information and insight on the demand for engineers in Wisconsin going forward. We would value your organization's input on this matter. The attached documents summarize the current UW offerings in engineering by campus and 2013-14 graduates of those programs. Please also comment on specific areas of engineering need.

From your organization's perspective:

1. What is the long term workforce need for more baccalaureate-trained engineers in the State of Wisconsin? What is your organization's workforce need for more baccalaureate-trained engineers?

2. What specific engineering specialties are now or will be in short supply? Please explain.

3. What engineering schools (public and private) does your firm (or region) draw on to recruit new engineering talent?

4. What would you like the University of Wisconsin System to do in the Engineering field to help your company or organization address its Engineering workforce needs?

Please feel free to share this brief survey with members of your industry trade group or individual businesses and let us know what you are hearing from your organizations' members or other companies.

Thank you for taking the time to respond to this survey. We would like to have responses by November 14, 2014 if at all possible. Please direct your responses to my office or to Interim Senior Vice President for Academic Affairs David J. Ward at dward@uwsa.edu.

HEARTH & HOME technologies®
The Hearth Experts™

To: Ray Cross, President, UW System
David J. Ward, Interim Provost, UW System
CC: Michael Falbo, President, UW system Board of Regents

Date: November 20, 2014

I am writing to express deep support for the proposal by UW Stout to add mechanical, electrical and chemical engineering to their existing engineering program.

Our business is located approximately 50 miles from UW Stout which has been an essential institution to the success of our business. We currently employ 19 engineering graduates in various engineering competencies from UW Stout. Many of these graduates have worked their way into management positions due to their unique ability to have practical hands on experience that transition immediately to our business results and needs. In addition, we typically will have 2 UW Stout Co-Op students on site at any given time.

It has been our experience that those joining our company from UW Stout have both local and rural roots to Northwest WI and Southeast MN and are looking to stay in the region. Historically, we have found it much more difficult to entice graduates from outside this region. Because of the propensity for these students to want to stay local with both their schooling and careers, we see extreme value in enhancing the UW Stout engineering programs with a stronger background in areas identified by the Northwest Wisconsin Engineering Consortium.

We are requesting full support of the UW System and its Board of Regents to move forward with the recommendations of the NWEC and in particular the requested adds to the UW Stout engineering program. We believe this is vital to our business and Northwest WI and Southeast MN if we are to remain competitive in an increasingly challenging and global environment.

Sincerely,

Greg Radtke
Vice President and General Manager
Hearth and Home Technologies

7571 215th Street West | Lakeville, Minnesota 55044 | P: 952-985-6000 | F: 952-985-6001 | www.fireplaces.com

From: Chad Meyer [mailto:chad.meyer@meyermfg.com]
Sent: Thursday, November 20, 2014 8:34 AM
To: Jill Hassenfelt
Cc: dmeyer@meyermfg.com
Subject: FW: Engineering Needs in the State of Wisconsin

Jill,

I am a UW-Stout alumni, and I graduated in Production and Operations Management 14 years ago. We have hired and currently have students from the UW system with engineering degrees. Here at Meyer Manufacturing we have been adding degreed engineers now the last 8-10 years, and we are looking to add another individual to our staff. This time we are looking for a seasoned engineer. We want real life problems solved and an understanding of how to solve those problems. Not by guessing, but by knowing how to quickly and properly make the calculations. At times quick math numbers are enough, other times FEA analysis will need to be done. Understanding how metal stresses in real life and how to strengthen problem areas while looking at the cost of the options to provide the strength. I envision our engineering staff to grow over the years. Engineering is the backbone of the company, in both providing new ideas in our products and solving problems quickly in response to customer issues in the field.

Engineers that understand the Agriculture Industry are the ones that we feel are in short supply to us. The agriculture industry has been very strong over the last few years and Farm Equipment Manufacturers are growing with them. Along with Engineers come a support staff of Drafters and B.O.M. writers. I think that we will be looking for hydraulic and electrical engineers in the near future as well.

We like to see local talent. We have seen that when we draw people from a distance, that they are usually short-term employees. The schools locally are usually the schools that will provide engineers for our company for that same reason. We are located right in the center of the state, so schools like Madison, Green Bay, Eau Claire, Stout, Marshfield, and others are ones we currently look to.

I would like to see more results from UW alumni that have solved numerous real life problems that professors have brought back from various manufacturers for the students to solve, and then for the students to see how the manufacturers solved the problem. This is different than trying to solve the problem for the manufacturers, which is what I saw when I was a student at UW-Stout which I do not believe is as effective. I would like to see students understand the trade of welding, metal forming, and machining metal better. They need to see more failures and understand why failures occur. Run the calculations to back what they are seeing. I think if asked, most companies can give examples of different problems they have faced and the solutions they chose and why. What can happen when there is a bad weld. What happens when you weld in stress areas. Help students see how different structural metals work better than others. How bending metal into certain shapes can increase strength and reduce cost. How designing parts differently can impact cost. I think drawing on the experts out in the field can help tremendously.

With all of this said, I am not stating that you are not providing some or all of this. We currently have only a small sampling of students from the UW system including myself that have worked for Meyer over the years. This is what we want to come from the degree so they get a fast start for companies like ours.

I hope that helps. Thanks for your inquiry.

Best Regards,

Chad Meyer

Parts Manager
Meyer Manufacturing Corporation
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Dorchester, WI
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From: Cristiano Spina <cristiano.spina@bonduelle.com>
Sent: Monday, November 17, 2014 11:58 AM
To: David Ward
Subject: Engineering needs in the state of Wisconsin

Good morning mr. Ward,
I received your Survey and I think it is a great idea gathering opinion from the market to better design and build the education for the future.
Following the answer to your questions:

1. My organization works in the Frozen and canned vegetable business we are actually the largest world's organization for processed vegetables, so we need Mechanical Engineers for our maintenance departments and for Design and New Project management; Chemical Engineers for Continuous Process Improvement and Floor Supervision; Agricultural Engineers for our Fields Departments.
2. We are currently looking for 1 Mechanical Engineer as Maintenance Supervisor/possible future Maintenance Manager; 1 Mechanical/Chemical Engineer as Process/Project Engineer; 1 Mechanical/Chemical Engineer as Production Supervisor. In the next 2 years we will need additional 2 Engineers as production Supervisor. We want to introduce new talented people in our organization to guarantee the right succession plan for our and the other plants of our company.
3. We recruited 1 Mechanical Engineer from Madison UW and we tried to get in touch with Madison UW and Milwaukee UW again for our current needs without luck.

4. Introduce internship in food processing industry to have the future engineers exposed to the environment and the needs of this kind of industry; introduce 1 or more courses in Refrigeration Engineering (unless you already have it); Introduce concept of Lean Manufacturing (unless you already have it).

Please don't hesitate to contact me for any further information. I would also like to take advantage of this opportunity to ask you a few names of people I can contact to be able to recruit some talents from your University.

Best Regards

Cristiano Spina
Bonduelle Americas
Fairwater Plant Manager
Tel:9203462218

Please note that my email address has changed to cristiano.spina@bonduelle.com

Momentum West
NanoRite Innovation Center | 2322 Alpine Road | Suite 7 | Eau Claire, WI 54703
Email | info@momentumwest.org
Phone | 715-874-4673
Fax | 715-874-4683

November 13, 2014

Ray Cross, President
University of Wisconsin System
1700 Van Hise Hall
1220 Linden Drive
Madison, WI 53706-1559

Dear President Cross,

Please accept the following input from Momentum West, the Regional Economic Development Organization representing the ten counties of West Central Wisconsin. This input is submitted in response to your October 31, 2014 solicitation regarding the engineering employment needs of the State of Wisconsin. Additionally, please accept this as a letter of support for the engineering initiative being proposed by the Northwest Wisconsin Engineering Consortium that is designed to address the challenges employers of the Momentum West region are experiencing in meeting their engineering talent demands.

1. What is the long term workforce need for more baccalaureate-trained engineers in the State of Wisconsin? What is your organization's workforce need for more baccalaureate-trained engineers?

Momentum West fully supports the contention presented by the Engineering Consortium that employers in our region face serious shortages in attracting and retaining the engineering talent necessary to support the full potential for regional employment and economic growth. Our local economic development and workforce development partners hear about the impact of the shortage of engineering talent almost daily as they work to address business expansion, retention, and attraction and as well as talent attraction, retention and preparation needs in the region.

We endorse the data analysis provided by the Engineering Consortium in support of regional demand and, given sufficient time, would be happy to assist in providing even more data in support of this initiative. Additionally, we have reviewed the NCHEMS study of Baccalaureate and Master's Engineering Degree Supply and Demand in Wisconsin commissioned by the UW System and support the preponderance of its research and demand analysis. However, we draw considerably different conclusions as to the supply analysis and the solution to regional engineering shortages. Experience has clearly shown that the contention that West Central Wisconsin regional demand can be met through supply from the Minneapolis Metro area is a false premise. We will address that matter more fully in the response to question #3.

West Central Wisconsin is one of the primary centers for manufacturing growth in Wisconsin and the Midwest. The nine county West Central Wisconsin Workforce Development Area is projected to experience a 13% growth in manufacturing over the next 10 years compared to 5%

for Wisconsin and 1% nationally. The next highest growth rate in Wisconsin is 10 % in Fox Valley and 9% in neighboring Northwest Wisconsin and Southwest Wisconsin.

Engineering talent supply is critical to the manufacturing sector which is the largest employment sector in the region. The lack of engineering talent is currently retarding growth of area manufacturers and limiting their hiring of other employees. A substantial number of area manufacturers have reported turning away work since and foregoing new market development due to the current engineering shortage. This shortage is projected to worsen in the next decade. This restraint on economic growth has the ripple effect of limiting hiring of the entire array of production, support industry and broader community employment that accompanies such economic growth.

Momentum has identified the engineering talent shortage as an economic imperative that must be addressed for the region to achieve its full growth potential. Wisconsin must recognize that supporting manufacturing growth in West Central Wisconsin is critical to the state's overall economic health. While this region's current and future growth is significantly influenced by its' immediate proximity to the 3.5 million person Twin Cities metro area, the solution to this engineering talent shortage is not to be found in the theory that engineering talent trained in the Metro area will migrate back to West Central Wisconsin. This region is a net exporter of talent to the Metro area and by failing to provide adequate regional engineering training and requiring students interested in engineering to migrate outside the area to obtain such training only exacerbates talent out-migration.

Commensurately, by equipping the region with sufficient engineering preparation capabilities, the region will attract young engineering talent from the Metro area. Equipping the region with expanded engineering training capabilities will undoubtedly attract Minnesota students to the three institutions based on well-established enrollment patterns. This will provide regional employers with the opportunity to partner with the institutions on practicums and internships that will expose these students to opportunities in the region and increase the likelihood of retaining this talent for the regional economy.

2. What specific engineering specialties are now or will be in short supply? Please explain.

Areas of specific engineering need are directly related to the diverse economic structure of the region. We deeply appreciate the past UW System support for the development of manufacturing, computer and plastics engineering in the region, however, more remains to be done. Workforce and economic development officials continue to be bombarded by requests from area business to address their Electrical, Chemical, Industrial and Mechanical Engineering needs. This is driven by the strong representation in our robust advanced manufacturing sector of metal fabrication, plastics, medical device and computer manufacturing. The region's longstanding prominence in agribusiness supports the need for Agricultural and Environmental Engineering as do the emerging mining and biotech industries of the region.

3. What engineering schools (public and private) does your firm (or region) draw on to recruit new engineering talent?

Typical recruitment efforts have centered at those educational institutions with the greatest access, Minneapolis Metro, UW-Stout, Madison, Platteville, Milwaukee and Michigan Tech. Many employers have cast even wider nets with only limited success.

These are also the traditional areas to which students from the region migrate to when seeking engineering education. However, West Central and Northwest Wisconsin tend to be net exporters of STEM talent, which is supported by the NCHEMS study. Students that migrate to those areas are then exposed to opportunities associated with those regions, are not exposed to opportunities in this region and as a result are lost to their home region. The lack of regional access also causes those students who are not inclined to seek education outside of the West Central/Northwest region to select alternative career paths and move away from the pursuit of engineering disciplines.

The lack of availability of engineering training options also limits employers in supporting career advancement of incumbent workers desiring to attain engineering credentials. This lack of access impeded employers and employees who wish to maintain the employment relationship while pursuing advanced training.

Additionally, employers are constrained in their ability to host and benefit from internships, practicums and other forms of business education partnerships due to the distance from the training institutions. This includes limitations on tech-transfer opportunities and other business-higher education economic and innovation synergies that tend to arise where business and industry are in close proximity.

Contrary to the conclusion of the NCHEMS study indicating that investment would be best placed elsewhere, we strongly disagree. Wisconsin would achieve its best return on engineering investment in West Central Wisconsin where these investments would support the region with the strongest potential for growth and strongly documented need. This is also the area with the greatest potential for both talent loss due to the lack of engineering investments and the greatest potential for talent gain from the adjacent Metro area if the engineering capacity is enhanced as recommended by the Northwest Engineering Consortium and Momentum West.

4. What would you like the University of Wisconsin System to do in the Engineering field to help your company or organization address its Engineering workforce needs?

Momentum West strongly recommends that the UW System adopt the initiative proposed by the Northwest Engineering Consortium. Momentum would gladly provide additional data and documentation of business and institutional support for this initiative, should you desire. Absent that additional effort, be assured that Momentum West, its business and institutional members, its Economic Development and Workforce Development partners and its area employers strongly encourage UW System to support the request of the Northwest Engineering Consortium to proceed to plan.

Momentum West has been in the forefront of efforts to secure resources to address the needs for local engineering talent for many years. We strongly endorse this unique effort of our three regional universities to work collaboratively to address this demand in a comprehensive manner that will assist the West Central and Northwest Wisconsin economies to achieve their full potential to lead Wisconsin's industrial renaissance.

Respectfully

James Hanke, President
Momentum West

Stratasys
ADVANCED MATERIALS CENTER

November 10, 2014

University of Wisconsin Board of Regents
President Ray Cross
1700 Van Hise Hall
1220 Linden Drive
Madison, WI 53706

Ray,

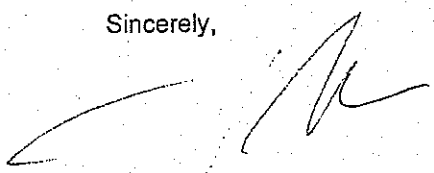
I wanted to reach out to you to indicate my strong support for the efforts that the Chancellors of UW-River Falls, UW-Stout and UW-Eau Claire are making to increase the number and availability of hard-core engineering programs at their respective institutions. My former business, Interfacial Solutions, had a staff of nearly 20 scientists and engineers, primarily in the chemical field. The 3D Printing firm Stratasys acquired interfacial Solutions last April. Stratasys has doubled their staff from 1500 to nearly 3000 employees in the past two years. They expect to double their staff again in the next two years. Stratasys, like Interfacial, is an engineering heavy firm. They have an option on 8 acres of land in the River Falls industrial park. I fully expect them to build a facility there in the next 5 years. During due diligence, one of the key questions they asked was whether or not engineering talent either exists or can be enticed to locate to Western WI. I firmly believe that the best long-term strategy to address this question is to cultivate and create the talent locally. The plan that the UWRF, UWEC and Stout Chancellors (and the Northwest Wisconsin Engineering Consortium) have to add engineering programs locally aligns directly with my beliefs.

I know that to some others in the UW System may view this concept more negatively. There may be concern that these three campuses will be "stealing" potential students that would otherwise have attended their institutions. This is completely misguided in my opinion. I believe that creating these programs in Western WI will provide our high school students with additional options to study engineering locally. I think that the creation of additional engineering programs at UWRF, UWEC and Stout is a larger threat to the University of Minnesota's Institute of Technology than it is to UW Madison, Platteville or Milwaukee.

If all goes well with the Stratasys acquisition and my future endeavors, I see no reason why there will not be hundreds of engineering jobs created in Western WI over the next two decades. Let's develop, train and recruit local kids for these exciting future positions! I have two young boys at home (7 and 9) that could be beneficiaries of such a program...

Please do not hesitate to reach out to me with any questions.

Sincerely,



Dr. Jeffrey Cernohous

General Manager

Stratasys Advanced Materials Center (formerly Interfacial Solutions)

2007 Engineering Education Task Force Report

EXECUTIVE SUMMARY

BACKGROUND

The 2007 Engineering Education Task Force was formed in February 2007, and was charged by Senior Vice President of Academic Affairs Rebecca Martin to study the current and projected supply and demand of engineering graduates in Wisconsin in the various disciplines of engineering. The Task Force was charged to formulate recommendations on steps that need to be taken by the UW System to ensure that the state's emerging public higher education needs in engineering over the next decade are effectively and efficiently met.

The Task Force completed its report in November 2007. The Report is presented to the Board of Regents Education Committee for discussion at its April 2008 meeting.

REQUESTED ACTION

This item is presented for information only; no action is required.

DISCUSSION

Current and Projected Supply

Overall enrollments in UW System engineering programs have remained steady in the last ten years. Engineering programs that saw growth in this timeframe were typically new subfields such as computer engineering and biomedical engineering – areas that were offshoots from existing engineering programs. A margin of additional capacity is present in almost all of the UW System engineering programs. This capacity margin serves as an important balancing factor that can be used to address the cyclical nature of demand for engineers and enrollment in engineering programs, and appears to be adequate to meet current engineering needs.

Future capacity building may be necessary to accommodate cutting-edge, emerging scholarly disciplines, or subfields in engineering. It remains to be seen whether such new branches in engineering will stand the test of time to survive as independent majors, or whether they are better accommodated in existing programs, as concentrations or minors. The *Wisconsin Engineering Occupation Outlook Summary* prepared by the Wisconsin Department of Workforce Development in April 2004, along with updated engineering employment projections provided in 2007, forecast an increase in new engineering jobs in Wisconsin in the period 2004 through 2014. Growth was predicted in the emerging fields of environmental, biomedical, computer, and health/safety engineering. While the situation may vary in specific subfields and in different regions, overall the Task Force saw no evidence in the report of a significant unmet need for engineers in the state.

Recruitment and Retention of Qualified Students in Engineering

Retention rates for students in UW System engineering programs range from 56% to 77%. Retention rates in engineering education nationally are identified as in need of improvement. UW System institutions do not currently enroll and retain significant numbers of women and students of color, and both groups are underrepresented in UW System engineering programs. The percentage of females and people of color in the UW System engineering student and teaching body has remained constant for the past decade. Also consistent over the past decade, is the relatively small proportion (15%) of those enrolled in undergraduate engineering programs as part-time students. As the numbers of high school graduates in Wisconsin declines, and as the UW System addresses the challenge of increasing the percentage of Wisconsin residents with baccalaureate degrees in general and in technical fields in particular, the needs of part-time and place-bound students, women, and students of color become paramount. Another matter of concern is the significant number of Wisconsin engineering graduates who leave the state. In a 2002 study, it was found that 70% of the state's engineering graduates were employed in Wisconsin one year following graduation, but by 20 years following graduation that percentage had dropped to only 40%. This pattern of migration, and ways to reduce it, must be considered when looking at how the UW System can help ensure the supply of engineering graduates that the state needs.

Key Recommendations

1. Periodically assess potential regional and state-wide demand for engineering graduates;
2. Utilize existing resources to the extent possible to meet potential unmet regional and state need. The Task Force recommends that such unmet need be initially served, where possible, through collaboration between UW institutions with existing engineering programs and UW institutions in the region(s) of need;
3. Develop strategies for accommodating part-time and place-bound students in existing engineering programs;
4. Develop strategies for attracting more students in general, and women and students of color in particular;
5. Work with K-12 and pre-college programs to nurture interest and ensure academic readiness for engineering study; and
6. Periodically assess capacity and demand while maintaining quality through adequate investment of resources and pursuit of Accreditation Board for Engineering and Technology (ABET) accreditation.

REPORT OF THE UW SYSTEM ENGINEERING EDUCATION TASK FORCE

I. INTRODUCTION

The 2007 Engineering Education Task Force was formed in February 2007, and was charged by Senior Vice President of Academic Affairs Rebecca Martin to study the current and projected supply and demand of engineering graduates in the state in the various disciplines of engineering. The Task Force was charged to formulate recommendations on steps that need to be taken by the UW System to ensure that the state's emerging public higher education needs in engineering over the next decade are effectively and efficiently met. For a list of Task Force members, see Appendix A.

1. Background

This report contains the results of a study conducted by the Engineering Education Task Force in 2007. This background section provides a short history of engineering education in the UW System and at private universities in Wisconsin. A complete list of all engineering programs and degrees currently offered in the state of Wisconsin by both UW System and the private institutions is included in Appendix B.

Engineering programs seek to provide students with the needed skills and talents to meet the demands of Wisconsin's changing industrial, postindustrial and technological needs. Programs, especially those with a major research mission, also serve supra-regional, national, and international demand for engineering professionals at all levels. The mission of engineering schools and programs is to develop vigorous programs of teaching, to conduct and publish research, and to work closely with industry and the community. Typically, engineering programs create learning environments that establish strong foundations in scientific and engineering principles along with practical applications in order to solve broad industrial and community problems. The UW System includes three institutions with a particularly long and rich history of engineering education: UW-Madison, UW-Milwaukee, and UW-Platteville. UW-Stout and UW-Stevens Point offer selected engineering or engineering technology-related programs.

Civil, Mechanical, Railway, Metallurgical, Mining and Electrical Engineering were among the earliest engineering disciplines established at what is now UW-Madison, starting in 1857. Adapting to scientific innovation and changing market demands, numerous subfields and consolidations of engineering fields emerged out of this initial disciplinary cluster over the next century and beyond. Today, UW-Madison's College of Engineering is home to an array of engineering options with faculty providing nationally-recognized expertise through teaching, research and service that includes a wide variety of interactions with state and local entities. Traditionally, engineering education at Madison has focused on close interactions with the community. In 1903, for instance, a general engineering course was established to meet the needs of business and industry. The course provided "fundamental principles and practices of some of the ordinary applications of science to modern industry." In 2002, funded by the National Science

Foundation, the Women in Science and Engineering Leadership Institute (WISELI) was established at the UW-Madison College of Engineering to enhance the advancement of women in science and engineering. In addition, the Wisconsin Alliance for Minority Participation works to boost the number of underrepresented students in science, technology, engineering and mathematics. Today, approximately 60 different centers and consortia provide technical support to regional and national industries.

UW-Extension courses and professional development serving a broad community became a mainstay and grew parallel to the College of Engineering's course offerings leading to bachelors, master's and Ph.D. degrees. In 1985, Extension's Department of Engineering and Applied Science became a department within the College of Engineering and was renamed the Department of Engineering Professional Development. In 1989, it transmitted its first live satellite course. In 2001, the Master of Engineering in Professional Practice program, the university's first internet-delivered degree, graduated its first class.

Collaboration between UW institutions also boasts a long and illustrious history. In the 1930's, the UW-Madison initiated a two-year undergraduate engineering program and a master of science program in various engineering disciplines offered on the Milwaukee Civic Center campus. The undergraduate program served as a direct transfer program to the College of Engineering in Madison and was taught by faculty hired by that college to teach on the "Milwaukee campus." Graduate courses were primarily taught by Madison faculty until the merger of the Milwaukee State Teachers College and the Milwaukee Extension Division formed the UW-Milwaukee in 1956. In 1964, the UW Board of Regents approved the "College of Applied Science and Engineering" at UW-Milwaukee, and the first freshmen class was admitted to the college in September 1965. In 1971, the college's name was changed to the current "College of Engineering and Applied Science (CEAS)." Experiencing continued growth and demand, UW-Milwaukee implemented a new major in Computer Engineering in July 2007.

> UW-Platteville's engineering tradition dates back to 1907 when a mining college was founded. In 1959 the teacher's and the mining colleges merged, and in 1966 they formed the Wisconsin Institute of Technology, which later joined the UW System. In 1971 the institution officially changed its name to UW-Platteville. Starting in the late 1960s, UW-Platteville expanded its academic programs and founded other colleges. The engineering college originally encompassed mining, electrical, mechanical, and civil engineering. In the late 1980s the mining engineering degree was gradually phased out due to declining enrollment. Engineering is one of UW-Platteville's "mission programs" and it offers additional capacity at off-site programs in the Fox Valley and Rock County.

Throughout its history, UW-Stout has developed technical programs to meet the needs of industry. These programs focus on the direct application of technical knowledge to the solution of practical problems. In 1974 the Board of Regents defined UW-Stout as a special mission university with a select array of programs leading to professional careers and serving the needs of society. UW-Stout offers an undergraduate degree in

Manufacturing Engineering and received entitlement to plan programs in Polymer as well as Computer/Electrical Engineering in 2007. The Regents approved UW-Stout's designation as Wisconsin's Polytechnic University in the spring of 2007.

Stevens Point Normal opened its doors in 1894 as a teacher's college. The curriculum continued to expand and in 1927 Stevens Point Normal became Central State Teachers College with the right to grant four-year teaching degrees. In 1951 it became a Wisconsin State College authorized to grant liberal arts bachelor's degrees, and emerged as UW-Stevens Point after the merger of Wisconsin's university and state college systems. Early 20th century course offerings in conservation education eventually grew into today's College of Natural Resources, offering a variety of scientific and technological majors. Today, part of the select mission of UW-Stevens Point's College of Natural Resources is to offer a major in Paper Science, for which it currently seeks accreditation from the Accreditation Board of Engineering and Technology (ABET).

All UW System institutions are successful in creating learning environments that establish strong foundations in scientific and engineering principles along with practical applications in order to solve broad industrial and community problems. A majority of the engineering programs currently offered by UW System institutions are accredited by ABET.

The Milwaukee School of Engineering (MSOE) and Marquette University are the two private institutions in Wisconsin offering undergraduate education in engineering and produce 30% of the total of engineering graduates in the state.

2. Review of Previous System Wide State Engineering Studies

In order to get a historical overview and to learn from previous long range planning efforts conducted by the UW System, the Task Force reviewed the 1974 *Report of the System Task Force on Engineering/Technology* and the 1988 Report of the Steering Task Force for Strategic Planning in Engineering and Technology within the UW System, entitled *Better Living through Technology: Wisconsin at Risk*. Both reports provided some directions for program planning that were instructive and useful in formulating the recommendations of the 2007 Task Force. A continuity of interpretations, concerns, and action agendas emerges from a cross-historical analysis of these documents. In creating long range planning tools for the next decade, it is important to take the lessons of the past into account.

The 1974 report contained a number of principal and subsidiary recommendations relating to "long-range planning, establishment of criteria for program evaluation, extension of educational opportunity to the nontraditional student, efforts to increase the technological awareness of the public, program articulation to facilitate student transfer from technician to technology program, continuing and open education, professional development of the faculty and cooperative efforts between the UW System schools/colleges of engineering/technology." The central conclusion of this comprehensive report was that "there appears to be little need for development of new

schools/colleges of engineering/technology within Wisconsin" (p.1). Further, the Task Force recommended:

- expansion of programs only at institutions already operating a college of engineering/technology;
- development of separate engineering technology programs;
- improvement of the financial stability of existing programs in engineering/technology;
- continuing assessment of existing programs;
- recruitment of a diverse student body; and
- co-operation among institutions.

The 1988 *Better Living Through Technology* report by a steering committee that included industry representatives and faculty leaders, and was assisted by representatives from UW System Administration, was charged with creating a broader vision for general technology education at all levels of the educational system. The Task Force acknowledged the need to provide lifelong learning opportunities and to provide state of the art knowledge to practicing engineers. The report articulated six major objectives and numerous recommendations arising from those central goals. The major objective of this Task Force was to improve the coordination of engineering and technology programs in order to make the UW System more responsive to state and national needs, more cost effective, and to improve the quality of existing programs. Expansion priorities were tied to access, research and industry linkages. A permanent advisory Task Force and the appointment of a senior executive for engineering education were recommended. Among the specific recommendations of the 1988 report, the following conclusions and recommendations are particularly noteworthy:

- engineering and technology programs are more expensive both in capital needs and in ongoing commitments;
- no convincing case can be made that more undergraduate engineering and technology majors must be served than the existing programs can educate;
- using telecommunications (now often referred to as distance education) can increase the capacities of existing programs and distribute educational opportunities throughout the state;
- cooperative, inter-institutional delivery programs between UW institutions can meet local educational needs and are a cost effective means of expanding capacities of existing engineering/technology programs; and
- expansion decisions must weigh start-up costs, continuing costs, and available support capacity, as well as long term demand. New programs should be created only if the above alternatives cannot meet state needs.

Other reports examined as examples of regional needs assessment efforts were a focus group research project entitled *Engineering and Technology Needs in the Chippewa Valley Area,* prepared by the former UW System Market Research office in February 2001. The purpose of this focus group project was a needs assessment based on a small sample of area employers.

A follow-up report detailing research findings was published in August 2001, also by the former UW System Market Research Office, entitled *Survey of Organizations Employing Engineers in the Chippewa Valley*. This informal report gathered information regarding plans of area companies for hiring engineers with specific specializations. One of the conclusions of the study was that the data "does not indicate a great need to hire engineers either in the long-term or the short-term" (p.8). This summarizing statement was qualified by allowing for variation in needs among individual companies.

A March 2001 report, entitled *Market Analysis for Engineering Professionals in Wisconsin, Minnesota, and Illinois*, explored the potential job market for graduates of four-year engineering degree programs by examining supply and demand. Among the key findings was that a small pipeline of two-year technical college graduates existed and that in "Wisconsin, Electrical and Mechanical Engineering have the largest annual growth." In Illinois and Minnesota, potential job openings in a subset of engineering fields were not projected to be met with Illinois and Minnesota graduates.

Further sources reviewed by the Task Force were the *Wisconsin Engineering Occupation Outlook Summary* (April 2004) and updated engineering employment projections provided in 2007 for the period 2004 through 2014 (Appendix C) prepared by the Wisconsin Department of Workforce Development. The projections regarding estimated employment and estimated average annual openings for new jobs and replacement were:

- the number of Wisconsin's engineering jobs was projected to increase by a net of 3,300 total jobs between 2004 and 2014. The report projected that in some areas of engineering workforce needs would remain constant while in others there would be new employment opportunities;
- the projected demand for replacement engineers between 2004 and 2014 averages 610 for each year;
- the average annual number of new jobs created and replacement needed account for a projected combined total of 940 openings each year; and
- Wisconsin's largest employing engineering fields in 2014 will continue to be mechanical, industrial, civil and electrical engineering.

II. ENROLLMENTS, DEGREES GRANTED, AND CAPACITY

Junior/Senior level enrollments in UW System engineering programs have remained steady in the last ten years. In fall 1996, junior/senior level engineering enrollments totaled 3,262 students compared to 3,331 in fall 2006 (Appendix D). Since, in some cases, students are not enrolled in a specific engineering program until their junior year, junior/senior level enrollments were used for comparison. Similarly, the number of bachelor's degrees awarded by UW System engineering programs remained steady over the last ten years with 983 degrees awarded in 1995-96 and 1,014 degrees awarded in 2005-06 (Appendix B). Engineering programs that saw growth in this timeframe were typically new subfields such as computer engineering and biomedical engineering – areas that were offshoots from existing engineering programs.

A capacity margin is present in almost all of the UW System engineering programs (Appendix D). In comparing fall 2006 junior/senior level enrollments to the potential capacity, the capacity margin is over 930 slots or 22% of the total capacity. This capacity margin serves as a balancing factor that can be used to address the cyclical nature of demand for engineers and enrollment in engineering programs. The capacity margin appears to be adequate to meet current engineering needs.

The Task Force also examined data on engineering degrees awarded by Wisconsin private institutions (Marquette and Milwaukee School of Engineering). In 1995-96 a total of 1,437 bachelor's degrees in engineering were awarded in Wisconsin, compared to 1,449 in 2005-06 (Appendix B). In 2005-06 UW System institutions awarded 70 percent of the engineering Bachelor's degrees while Wisconsin private institutions awarded the remaining 30 percent. Engineering degree production in Wisconsin has been steady for the last ten years with the UW System share of degrees awarded ranging between 68 percent and 73 percent of the total.

Future capacity building may be necessary to accommodate cutting edge, emerging scholarly disciplines, or subfields in engineering. It remains to be assessed whether such new branches in engineering will stand the test of time to survive as independent majors or whether they are better accommodated in existing programs, as concentrations or minors. Among the promising new subfields, it appears that Nano-Engineering may be a viable program offering although it has been a component of some traditional engineering fields at some institutions. Research and education at the nano-scale is becoming more critical each year as research and development focus on nano-scale phenomena, ultra fine structures and interfaces between matter.

III. DEMAND

Sources of demand data reviewed by the Task Force were the *Wisconsin Engineering Occupation Outlook Summary* (April 2004) and updated engineering employment projections (2007), prepared by the Wisconsin Department of Workforce Development. Overall, these projections forecast an increase in new engineering jobs in Wisconsin in the period 2004 through 2014 (Appendix C). Growth was predicted in the emerging fields of environmental, biomedical, computer, and health/safety engineering. When factoring in replacement needs due to retirements, career advancement, or other reasons, the report projected a total of 940 engineering job openings each year. The job opening projections can be compared to the annual engineering bachelor's degree production in Wisconsin of over 1,400 degrees.

Wisconsin demand data in the 2001 *Market Analysis for Engineering Professionals in Wisconsin, Minnesota, and Illinois* report was also reviewed. While a need for computer engineers was identified in the market analysis, two mitigating factors since 2001 may have affected this demand – changes in UW campus program and changes in the industry. UW-Madison's computer engineering program has grown since its

implementation in 2000 and UW-Milwaukee's computer engineering program will be implemented in fall 2007. UW-Stout was granted an entitlement to plan a program in Electrical/Computer Engineering. While the situation may vary in specific subfields and in different regions, overall the Task Force saw no evidence in the report of a significant unmet need for engineers in the state.

IV. RECRUITMENT AND RETENTION OF QUALIFIED STUDENTS IN ENGINEERING

In the UW System engineering programs, retention rates for students range from 56% to 77% (Appendix E). Retention rates in engineering education nationally are identified as in need of improvement. According to an August 2007 *Chronicle of Higher Education* article on science education, "about 30 percent of entering freshmen plan to earn bachelor's degrees in science, mathematics, or engineering, but only about 15 percent of all baccalaureate degrees are awarded in those fields." The percentages of degrees are even lower among women and students of color. UW System institutions do not currently enroll and retain a significant number of students from these underrepresented groups. Models for best practices could be identified and recommendations for improving an adequate pipeline are addressed in the Recommendations section of this report.

1. Women in Engineering

Despite local campus efforts in recruitment—such as "Women in Engineering" programs, career days for prospective students, as well as the research and professional development provided particularly by Women in Science & Engineering Leadership Institute (WISELI), a system-wide institute housed on the UW-Madison campus—the number of UW System women students in engineering remains low for most fields. Although efforts to recruit a greater number of female students are under way, the percentage of females in the UW System engineering student body has remained constant for the past decade. In 2006, the year for which the most recent data is available, 15% of all engineering students in the UW System were women (Appendix F). For comparison, in 2006 nationally 18% of bachelor's degrees were awarded to women (Appendix H).

It appears that certain fields in engineering attract or recruit more women students. In Biomedical Engineering at UW-Madison 41% of the students are female; in Chemical Engineering 34%, and in Geological Engineering 28% are female. Industrial Engineering at UW-Madison, UW-Milwaukee, and UW-Platteville enrolled 36% women. These disciplines nationally have similar levels of enrollment of women students (Appendix G).

The low number of female students has been correlated with the low number of female engineering faculty. System wide, 12% of the engineering faculty is female, which, while marginally higher than the 11.3% female nationally, may contribute to the gender imbalance among students (Appendix E).

2. Racial and Ethnic Diversity

Eight percent of UW System students in engineering are people of color (Appendices F and G). This percentage has remained constant in the last decade despite efforts by engineering programs to increase diversity. Particular engineering programs, for instance biomedical engineering at UW-Madison and electrical engineering at UW-Milwaukee, attract and retain a greater than average percentage of students of color (both 18%). Traditional engineering fields such as mechanical and civil engineering do not attract a significant number of students of color relative to the total UW System student population. In comparison, nationally students of color represent 25% of all engineering degree recipients (Appendix H).

Twelve percent of all System engineering faculty members are people of color. Nationally, people of color still comprise only 4.8 percent of the more than 23,000 faculty members nationwide. Both African-American and Hispanic engineering professors have equal shares at 2.4 percent. However, one-quarter of the African-American faculty members are located at just 7 of the country's historically black colleges and universities. Asian faculty make up 22.2% of the engineering faculty ranks nationally. According to the American Society for Engineering Education (ASEE), research indicates that one of the factors that impacts retention of diverse students is the role model function faculty from underrepresented groups fulfill.

3. Part Time and Place Bound Students

Over the past decade, a consistent 15% of those in undergraduate engineering programs enrolled as part time students. This percentage includes students who are participating in mandatory and voluntary internships and cooperatives, and so overstates the percentage of students actually pursuing their engineering education part time. (Appendix I).

As the numbers of high school graduates in Wisconsin decline, and as the UW System addresses the challenge of increasing the percentage of Wisconsin residents with baccalaureate degrees, the needs of part time and place bound students become paramount. They are a vital source for filling the state's need for engineering graduates. Focus groups of employers in the Chippewa Valley conducted by the former UW System Office of Market Research indicated an interest in local engineering programs to serve as engineering bachelor's degree completion opportunities for employees in that region. Students who are place bound and employed are more likely to stay in Wisconsin following their graduation.

4. Migration

Wisconsin produces a significant number of engineering graduates who leave the state. According to a study conducted by UW System's Office of Policy Analysis and Research in 2002, 70% of Wisconsin engineering graduates were employed in Wisconsin one year following graduation. However, only 40% were employed in Wisconsin 20 years after graduation. Engineering graduates seem to be particularly susceptible to taking up employment elsewhere, especially in comparison to other fields of study, among them business, education, nursing, liberal studies, and social science, which displayed much lower percentages of out-migration.

While graduates have personal and professional reasons for relocating, the state would be better served if it could retain its engineering graduates longer. The pattern of migration, and ways to reduce it, must be considered as we assess the UW System's role in providing the supply of engineering graduates that the state needs.

V. RECOMMENDATIONS

Serving Regional Need

1. Periodically assess potential regional demand for engineering graduates.

The Task Force examined data from the Department of Workforce development and some regional data from the former UW System Office of Market Research. With the exception of limited programming at UW-Stout, UW-Stevens Point and UW-Platteville programs in the Fox Valley and Rock County, all engineering education in the state of Wisconsin is offered south of a line from Milwaukee to Madison. The Task Force recommends that more in depth analysis be undertaken of potential unmet need for engineers in parts of the state not currently served by a distance delivery or on site engineering program. A common tool for assessment should be developed and utilized for periodic review of regional needs to guide future program development.

2. Utilize existing resources to the extent possible to meet potential unmet regional need.

Engineering education is relatively expensive to deliver. For that reason, Wisconsin has a history of utilizing existing programs to serve students at a distance. Engineering education at UW-Milwaukee began with the delivery of UW-Madison programs by professors who traveled to serve a need in the Milwaukee area. When it became clear that the need was sustainable, UW-Milwaukee developed its own programs. UW-Platteville has continued that tradition with its initiatives in the Fox Valley and Rock County, offering mechanical and electrical engineering in collaboration with the UW Colleges campuses in those areas. The 1988 study, *Better Living Through Technology, Wisconsin at Risk* stressed the need for "cooperative delivery of existing programs between UW institutions to meet local educational needs" and that such efforts should be pursued before implementing new programs. Should further study of regional

needs and systematic market research indicate that there are areas of the state with unmet demand for engineering graduates, the Task Force recommends that such unmet need be initially served, where possible, through collaboration between UW institutions with existing engineering programs and UW institutions in the region(s) of demonstrated need before new programs are developed.

Student Pipeline

A major challenge for UW engineering programs in preparing sufficient numbers of graduates to serve the needs of Wisconsin employers is attracting qualified and interested students into these programs. This challenge has three parts: nurturing interest on the part of students to pursue engineering education, building a pipeline of students with the necessary preparation to pursue engineering education, and serving the needs of underserved populations.

As indicated above, the pool of students pursuing engineering education, with some exceptions, is not well represented by part time, female or students of color. With the projected decline in state high school graduates (traditional student pool), and increases in their diversity, part time students and students of color will make up a greater portion of the potential pool of students in the future. In addition, women's participation in engineering programs does not match their representation in the UW System. If UW engineering programs are to attract sufficient numbers of students in the future, they will need to attract more part time, female and students of color. This gives rise to three recommendations:

3. Develop strategies for accommodating part time and place bound students in existing engineering programs.

Since existing engineering programs are clustered in the southern part of the state, efforts must be made to provide access to place bound students who are not within commuting distance of an engineering program. These may include the use of distance technology to provide instruction to students at remote locations, and expansion of the UW-Platteville model of collaboration with local UW Colleges and universities to offer engineering education in parts of the state in which there are no programs readily available. Further, these strategies may also include assessing and addressing the barriers that part time and place bound students perceive to exist in their pursuit of engineering education.

4. Develop strategies for attracting more students in general, and students of color and women in particular.

With few exceptions, women and students of color are not well represented in existing UW engineering programs. Given the current representation of women among college students, and future demographic trends that show Wisconsin's population becoming increasingly racially and ethnically diverse, strategies must be developed to attract more women and students of color into engineering. The challenge to recruit students into engineering is not limited to women and students of color. Engineering programs need to

more effectively compete for the decreasing percentage of students who enter college with the math and science preparation appropriate for engineering study. There are models for effective recruitment of students into engineering that can serve to address this challenge.

5. Work with K-12 and pre-college programs to nurture interest and ensure academic readiness for engineering study.

Career interests need to be nurtured at an early age as students pursue K-12 education. The engineering professions suffer from stereotypes that can dissuade students in general and female students in particular from pursuing engineering careers. Programs that reach out to K-12 students can spur interest in engineering fields. There are a number of such programs, e.g., the UW-Madison Engineering Summer Programs, UW-Platteville's Women in Engineering Fall Career Day, and UW-Stout's (Science, Technology and Engineering Preview) STEPS program. Other programs focus on skills development for minority and disadvantaged students. These are also critical in ensuring a pipeline of high school graduates prepared to pursue the rigors of engineering education. UW campuses that offer engineering programs should work together and learn from each other in offering programs that reach as many K-12 students as possible, attracting and preparing them for careers in engineering.

Periodic Assessment and Program Quality

6. Periodic assessment of capacity and demand.

The fields of engineering are changing at an ever increasing pace. Demand for engineering graduates ebbs and flows, and rapidly changing technology gives rise to the emergence of new fields. Because of this rapid change, the planning horizon for assessment of supply and demand is relatively short. It is not possible to look out more than a few years with any degree of reliability. This calls for periodic assessment of statewide supply and demand to ensure that UW institutions continue to meet the needs of Wisconsin's employers for engineering graduates and potential needs for new fields of study. The Task Force recommends that such an assessment be done at least every five years.

7. Safeguard excellence in teaching and research both in existing and in new engineering programs.

It is important to ensure that new and continuing programs are of high quality in preparing engineering graduates. Developing criteria for program quality assessment was beyond the scope of the charge to the Task Force and would require considerable effort dedicated to that task. However, it was generally acknowledged that an external review of each program and resources allocated to it is one useful input into assessing program quality. A necessary, but not necessarily sufficient condition is an adequate investment of resources, evidenced by all undergraduate engineering programs being ABET accredited within a reasonable time frame after implementation.

VI. CONCLUSION

The Task Force successfully addressed the questions posed at the beginning of its study. One of the results of studying the current and projected supply and demand of engineering graduates in the state in the various disciplines of engineering is the conclusion that long-term predictions cannot definitively be made and that a focus on a smaller time-frame is necessary. Periodic assessment of supply and demand has therefore been recommended. The Task Force's recommendations reflect the steps that need to be taken by the UW System and its constituents to ensure that the state's engineering education addresses the state's needs and remains high quality.

The significance of the Task Force's findings lies in the affirmation of cooperation among System institutions and the demonstration of continued service of UW System institutions to the State of Wisconsin. Most importantly, the results of careful engineering program planning and review will be a strengthened statewide engineering curriculum and well-educated engineers within the framework set by market demands, equity in access to engineering education, regional and national job and occupation forecasts in diverse engineering fields, as well as alignment between K-12 and college math and science skills.

OEM FABRICATORS, INC.

November 26, 2014

President Ray Cross
University of Wisconsin
1720 Van Hise Hall
1220 Linden Drive
Madison, WI 53706

Dear Ray:

I am writing in support of the regional campuses efforts to address our regional engineering needs. As I expressed in my presentation to the Regents, my leadership team is made up entirely of UW grads with ten of twelve graduating from River Falls, Stout, or Eau Claire. When given the opportunity, these institutions perform and my company and companies in our region benefit from their outstanding performance. Even with their stellar performance in meeting the needs of businesses and the broader economy, they are constrained in their ability to meet all of needs of the region. Over the last several years, you and I have had many conversations about the challenges that our campuses face. Often it is the bureaucracy of state oversight that limits flexibility, or politics within the institution itself that slows progress. I am confident that you are the right person to lead the organization to the best and most productive solution. I said once before that you are uniquely qualified to stir the pot while oiling the waters. So this is your next challenge; in a long line of challenges that need to be addressed to continue the University of Wisconsin in its' quest to live The Wisconsin Promise.

OEM Fabricators has served original equipment manufacturers since our founding in 1986. We deliver a suite of services to our customers that are focused on helping them achieve success and bring work to Wisconsin. Over the years, we have been asked repeatedly by our customers to assist in providing mechanical and other engineering support to their companies. We have scratched the surface of helping them with a primary focus on engineering for manufacturability and cost reduction. This is not what they are looking for. They would like us as the manufacturer of their components to take the responsibility to design, prototype, and transition into production these components. We have never attempted to address this need because of our inability to attract engineers into our area. From a strategic point of view, this approach makes total sense. If we design the products for them, the likelihood that we will own the manufacturing of the product is substantially higher. When we have studied this in the past, we have always come to the conclusion that we would need to locate an engineering center elsewhere (like Minnesota) if we were to add this to our service offering. So far we have decided to just not address the need because of the inability to hire engineers.

OEM FABRICATORS, INC.

OEM is not the only company facing these issues. I serve as a director for Engineered Propulsion Systems. EPS is developing a general aviation engine that is the first clean-sheet, purpose designed engine in more than fifty years. EPS' current engineering staff is substantially European and efforts to recruit additional engineers are being undertaken in Europe instead of the US because of the challenges with recruiting here.

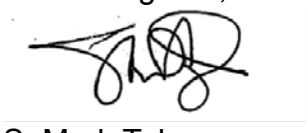
I shared information in the Regent presentation that demonstrates how far behind the US is in training engineers compared with other countries. As a leading university in the US, I would hope that we look to help solve not only the regional needs here in Northwestern Wisconsin, but take a larger view as well.

Why a regional approach? First I would point to the leadership changes that have occurred in our region in higher education. There is an unprecedented spirit of collaboration among Chancellors Van Galen, Meyer, and Schmidt. And included in this collaboration are our Technical College presidents Will and Barker. I am delighted that these relationships are formed and becoming stronger. In my tenure of relations with these institutions, I have never seen the level of cooperation that exists today. This must be rewarded and encouraged and a collaborative approach to dealing with our regions need for expanded engineering program array is a great way to support and encourage that progress.

Engineers, like Advanced Machinists bring a unique component to manufacturers like OEM. Each Advanced Machinist in our organization has direct revenues related to their activity of over $300,000. If we consider the materials, other supporting direct labor, supporting indirect labor, overhead and markups, each Advanced Machinist brings over a million dollars of economic activity to our company. Engineers are the same. For each Engineer, there are designers, detailers, programmers, tool makers and other indirect support staff. In our world each Engineer brings as many as ten additional roles as a result of their activity. So if each of these positions brings a million dollars to the company. Common economic development data would indicate that the multiplier effect in the broader economy is three times that number. This is an opportunity that we must not let pass.

Please support the Northwest Wisconsin Engineering Consortium.

Warm Regards,



S. Mark Tyler
President

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City of RIVER FALLS

November 21, 2014

President Ray Cross
University of Wisconsin Board of Regents
1700 Van Hise Hall
1220 Linden Drive
Madison, WI 543706

Dear President Cross:

I have been blessed to work in local economic development in four different regions of this great State serving as City Administrator for the City of River Falls for the past five years after time in Lancaster, Janesville, and Waukesha.

I am writing in support of the Northwest Wisconsin Engineering Consortium (NWEC).

It may be seen as counter to other programs in the system but adding programs of this nature in Western Wisconsin campuses increase the amount of students from the region and from neighboring states. It is no coincidence that you meet a lot of civil engineers from Dodgeville, Livingston, and Lancaster having grown up near UW-Platteville. We are missing the boat when it comes to offering our students convenient, regional options for engineering degrees in fields with a bright future. In addition, the mere presence of quality engineering programs enhances the region's focus and development of STEM interest at an early level in the K-12 setting. It is unlikely that UW-Platteville will be partnering with the River Falls School District like they do with those in the Southwest part of the state. Proximity matters; even in this digital world.

River Falls is home to several companies that have made the Wisconsin Companies to Watch and INC 500 lists. Many of these companies were started by graduates of River Falls, Stout, or Eau Claire. In an era where the emphasis in economic development seems ready to rightfully focus on developing local talent who can launch their own companies or add their talents to existing home-grown firms, it seems inconceivable that the UW System would not take every opportunity to offer programs locally. I believe the proposal for the region's three campuses to work together makes sense for the region and for the State.

Small and mid-size companies are the future of the State's economic life. Seeding, then feeding them with the talent they need is vital. I believe the NWEC proposal will be successful in doing just that.

Sincerely,

Scot Simpson
City Administrator

222 Lewis St. River Falls, WI 54022 ~ 715•425•0900 Fax: 715•425•0915

The Chamber
100th Anniversary
Eau Claire Area Chamber of Commerce

ACCREDITED

November 18, 2014

Ray Cross, President
University of Wisconsin System
1720 Van Hise Hall
1220 Linden Drive
Madison, WI 53706

Dear President Cross:

The Eau Claire Area Chamber of Commerce supports the Northwest Wisconsin Engineering Consortium (NWEC) and its efforts to cooperatively develop engineering programs at Northwest Wisconsin UW campuses, including agricultural, chemical, electrical, environmental, material science and mechanical engineering.

Representing our Chamber membership of over 1,200 local businesses and organizations, which employ 30,000 people, we are acutely aware of the challenges local and regional employers are facing in today's tightening labor market. A recent survey of Chippewa Valley employers found engineers are among the most challenging positions to fill, particularly in mechanical, electrical and industrial/process engineering.

The failure to act in this area could have significant negative ramifications to continued economic growth in Northwest Wisconsin. Our employers know from experience that graduates of local institutions of higher learning are more likely to consider career opportunities in the local area, where they earn their degrees, than those educated at more distant locations. Some companies have already reported that their ability to grow has been hampered by difficulty in recruiting for key positions. Adding these degrees, in our area, would be an important step in ensuring the economic competitiveness of our region.

We appreciate the collaborative efforts of UW-Eau Claire, UW-River Falls and UW-Stout to identify the needs and develop educational solutions and align with higher education institutions in our area to meet the talent needs of our local economy.

Sincerely yours,

Paul Kohler
Chair of the Board