

Quantifying the Skills Gap:

For Engineering and
Skilled Workers in NE
Ohio Manufacturing



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Primary Coordinators of Project:
ConxusNEO and MAGNET

Research provided by
Shanahan Resources, Inc.

Funded By:



*Lorain County
Community College*



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**Manufacturing
Extension Partnership**

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Labor Market Data Analytics + Employer Feedback = Strategic Intelligence for Workforce Development Leaders

I. Project

This project is a collaborative effort of community colleges and industry intermediaries acting as co-funders. The overall purpose of this investigation is to identify opportunities for greater alignment of postsecondary manufacturing technology education and training. Just as important is the need for more responsive delivery models like boot camps considering the demand for workers from manufacturers which is rapidly changing. Engineering and skilled manufacturing workers now need the knowledge, skills, and work experiences that employers reveal in online job postings. This report documents the region's skills gap for new hires, including insight into the need for upskilling industries' current, experienced workers.

Shanahan Resources, Inc., was commissioned to document the nature and nuance of current gaps between demand and supply of engineering and skilled workers in the regional labor market. From similar investigations in regions in other states, consistent findings reveal that while gaps are large:

- Not all engineering or manufacturing occupations have a gap, and some have more intense gaps than others. Gap analysis is shown at two levels of education credentials: Bachelors and above, and Associates or certificate postsecondary credential.
- Not all Engineering or Manufacturing Technology programs (CIPs) are equally effective at preparing students for every occupation in their respective career path.

Using the methodologies developed by Burning Glass Technologies, it is possible to determine which occupations are experiencing the most intense gaps and what education and training programs have the best potential to impact the gap by increasing the supply of completers with specific knowledge and skills employers now want: This varies among occupations.

This investigation applies the latest data analytics to pinpoint skill gaps by breaking them down by occupation, level of education, and prior work experience. This provides hard data with which to sharpen discussions on alternative actions for employers and educators to consider.

Funding partners are:

Community Colleges: Cuyahoga Community College; Lorain County Community College; and Stark State College

Industry Intermediaries: MAGNET, ConxusNEO, and RITE

This report is authored by Jim Shanahan, Ph.D., founder of Shanahan Resources, Inc., which was incorporated as a S-Corporation in the State of Florida January of 2012. He is available to discuss this work and can be reached at shanahan.jim.l@gmail.com or 727-631-8262.

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II. Purpose and Goal

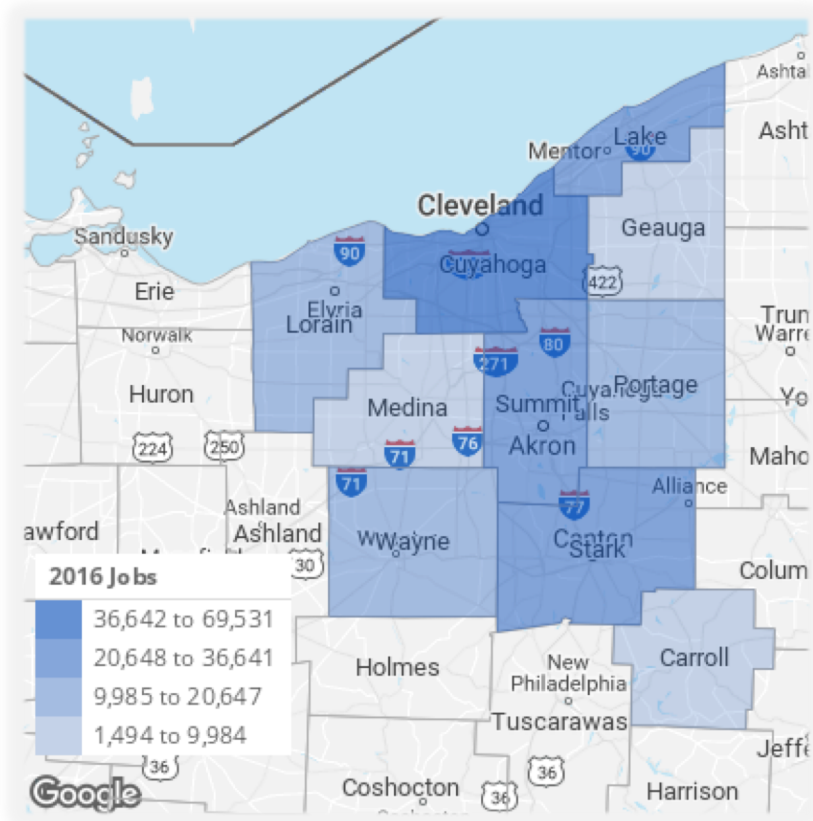
Numeric skill gaps between supply and demand results in employers recruiting outside the region. *Ideally, manufacturers should be able to satisfy hiring needs from job seekers already living in the region, especially when hiring skilled workers.* Many employers report little difficulty filling positions when successfully recruiting from outside the local region. These workers either commute daily into, or relocate to, NE Ohio.

The goal of regional workforce (talent) development, therefore, is to quicken the pace of efforts to attack skill gaps by increasing and improving the supply of local workers. Can higher education and vocational and technical training institutions in NE Ohio play a greater role to increase the numbers of qualified job applicants? Can they be of more strategic and tactical help to equip emerging and incumbent workers with

the skills and credentials employers now want? Can completers be connected with jobs in real time?

The public investment into our postsecondary education resources is too great to ignore when addressing skills gaps. It is vital to determine just how to position these public resources in ways that enable them to succeed in creating better alignment.

A major part of what is needed is an ability to quantify the skills gap for jobs most critical to the manufacturing sector in NE Ohio.



Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

This investigation aims to identify the occupations/ jobs in demand where manufacturing employers find it difficult to fulfill hiring quotas for engineering and skilled workers already living in the region. The purpose of this investigation is to pinpoint opportunities to create greater alignment of NE Ohio's postsecondary education and training programs with the skills and jobs manufacturing employers demand. This means restructuring learning outcomes of Engineering and Manufacturing programs with a laser-focus on the knowledge and skills need workers need as manufacturers embrace technological change. Just as important is the need for more responsive delivery models like boot camps that quicken the pace of new workers in the labor market. Both approaches are vital and warrant major investment of time and resources.

The primary focus of this investigation is on NE Ohio's manufacturing sector and jobs directly or indirectly supporting production. This includes occupational families of **Engineering; Installation, Maintenance, & Repair; and Production**.

III. Top Findings & Conclusions

This investigation is the first to comprehensively investigate the role of manufacturing in supporting the NE Ohio economy, past and future. It provides wide-ranging, yet in-depth, insights based on an equally deep-dive into supply and demand of IT talent in the 10-County NE Ohio labor market. It also documents the region's skills gap for new hires by manufacturing for engineers and manufacturing technology workers, including insight into the need for the upskilling of industries current, experienced workers.

Manufacturers with job openings for **Engineering and Skilled Manufacturing** workers face a skills gap in NE Ohio's labor market. This study provides hard data to drive discussions on where gaps exist; which jobs employers seek job experience more than education and training as evidence of skills; and which postsecondary career and technical education programs best prepare students with the skills employers seek.

Full Report

Skills Gap for Engineering and Skilled Manufacturing Workers in NE Ohio

I. Introduction

II. Role of Research and Methodology

This investigation quantifies the skills gap for these workers by occupation, level of education, and prior work experience. Hard data are produced for skills and expertise by occupation. Combined, these insights can sharpen efforts to respond to the talent needs of manufacturers that are growing jobs. NE Ohio is the combined MSAs of Cleveland, Akron and Canton plus Wayne County which form a 10-county region of overlapping local labor markets where most workers live and work.

Postsecondary education and training providers include public and private colleges and universities; adult career centers; and new, fast track technical IT training programs. Together, these institutions create the major capacity to prepare workers for career employment in advanced manufacturing technology.

THE OBJECTIVES

The investigation addresses these issues head-on with the following objectives:

- Brief review of the continued importance of the manufacturing sector to the regional economy of the Cleveland, Akron and Canton metro areas, along with an assessment of potential job growth and occupational needs of manufacturers when filling open positions.
- Provides an understanding of the demand and supply conditions operating in the NE Ohio labor market for new hires and assesses the capacity of postsecondary education and training programs in the region on how well they produce potential completers that meet employer skill shortages.
- Quantifies the gap between demand and supply of manufacturing workers in NE Ohio and implications.
- Pinpoints the top occupations where manufacturing demand exceeds supply.
- Provides an assessment of the nature and level of education embodied in the different engineering and manufacturing technology programs that result in poor alignment with employer demand.
- Brief review of the future of manufacturing technologies and impacts on jobs and skills in demand.

The challenge to providing actionable strategic information to quantify the skills gap has always been two-fold:

- The need for a deeper understanding of skills in short supply for occupations in great demand

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

- A clear way to quantify sources of job seekers to fill open positions by occupations.

Up to now, less attention has been devoted to quantifying supply than demand. Even less attention has been given to acknowledging that skill gaps vary across occupations in manufacturing. Many variants in education and training programs suggest that not all programs are equally effective in preparing students for jobs employers cannot easily fill. The 'Gap' has been assumed synonymous with large demand and anecdotal information from employers expressing difficulty in finding enough qualified applicants.

This report takes these challenges head-on.

The investigation is presented in three parts:

1. Part One: A deep understanding of the importance of manufacturing in the NE Ohio economy, its growth potential, and demand and supply conditions operating in the labor market for Engineers and Skilled Maintenance and Production workers.
2. Part Two: A detailed quantification of the gap between demand and supply of IT workers in Central Ohio and implications. Also included is detailed analysis of and the capacity of postsecondary education and training programs in the region to produce potential completers that meet skill shortages.
3. Part Three: An overview of the future of manufacturing technology and workforce needs as firms response the opportunities and challenges of disruptive technologies: Industry 4.0.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Part One

I. Profile of NEO's Manufacturing Sector and Occupational Needs

The number of jobs in the region's Manufacturing sector remain mostly concentrated in Cuyahoga (69,539), Summit (29,573) and Stark Counties (26,268). Close behind, however, are Lake (21,198), and Lorain (16,838). This pattern of decentralization of manufacturing jobs makes daily commutes to manufacturing workplaces feasible for residents within the ten-county region.

HOW IMPORTANT IS MANUFACTURING TO THE NE OHIO ECONOMY?

Despite the great loss of manufacturing jobs in NE Ohio, total jobs in the sector remain 54% greater than is the case nationally. Based on jobs in manufacturing as a share of all jobs, NE Ohio still has a greater share of its job base in manufacturing. It also remains a larger than average share of the region's job base when compared with metro economies of similar size.

NE Ohio: State of Manufacturing 2016 to 2022					
County Name	2016 Jobs	2022 Jobs	2016 - 2022 Change	Current Total Earnings	2022 Location Quotient
Cuyahoga County	69,531	66,203	(3,328)	\$77,962	1.09
Summit County	29,573	28,640	(933)	\$69,581	1.26
Stark County	26,268	26,064	(204)	\$66,426	1.91
Lake County	21,198	22,095	897	\$77,788	2.71
Lorain County	16,838	16,551	(287)	\$75,639	1.92
Wayne County	14,424	16,177	1,753	\$67,333	3.79
Portage County	10,607	10,992	385	\$65,781	2.08
Medina County	9,099	9,321	222	\$65,531	1.75
Geauga County	7,450	7,325	(125)	\$62,375	2.27
Carroll County	1,494	1,704	210	\$52,952	2.57
NEO	206,480	205,073	(1,407)	\$72,427	
EMSI Analyst					

The continued prominence of manufacturing as a source of jobs in NEO in no way can mask the huge loss of jobs long-term, and particularly since the last recession. At the same time, the drastic decline in the numbers of jobs in no way infers a collapse of manufacturing prowess in the region. Using volume of output, many market segments of manufacturing are doing well, and some are growing jobs in NEO. Manufacturing jobs are expected to remain level from now through 2022.

NE Ohio: Manufacturing Jobs Compared with Nation		
Jobs (2016)	% Change (2016-2022)	Avg. Earnings Per Job (2016)
206,480	(0.7%)	\$72,427
54% above National average	Nation: 3.2%	Nation: \$79,200
EMSI Analyst		

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Some industry and detailed market segments are doing so well that significant positive gains in jobs are expected by 2022. Half of all manufacturing jobs in 2016 were in manufacturing operations with growing workforces.

NE Ohio: Manufacturing Industries w/ Expected Job Growth 2016 to 2022		
Jobs (2016)	% Change (2016-2022)	Avg. Earnings Per Job (2016)
107,714	3.1%	\$73,913
41% above National average	Nation: 2.9%	Nation: \$82,833
EMSI Analyst		

Overall, these specific manufacturing industries and product markets, in many cases are not the traditional backbone of the NEO economy; and are expected to add jobs in NEO (3.1% by 2022) at slightly greater than what will occur in the nation for the same industries.

SIGNIFICANT JOB GROWTH IN NICHE MANUFACTURING INDUSTRIES FOR NEO

What distinguishes the industries listed in the top portion of the table below is rates of positive expected job growth between 2016 and 2022. This is largely due to NEO's companies out-performing companies nationally in their respective industries. What also is impressive is that these industries generally are not among those

NE Ohio: Manufacturing Industries Job Performance in Near Future								
NAICS	Description	2016 Jobs	2022 Jobs	2016 - 2022 Change	2016 - 2022 % Change	2022 Location Quotient	Competitive Effect	Current Total Earnings
334	Computer and Electronic Product Manufacturing	8,335	9,337	1,002	12%	0.88	1,188	\$84,984
311	Food Manufacturing	16,079	17,682	1,603	10%	1.04	502	\$59,604
324	Petroleum and Coal Products Manufacturing	1,432	1,818	386	27%	1.56	347	\$138,483
315	Apparel Manufacturing	906	1,043	137	15%	0.83	284	\$33,968
312	Beverage and Tobacco Product Manufacturing	1,573	2,033	460	29%	0.73	240	\$56,305
321	Wood Product Manufacturing	2,838	3,173	335	12%	0.73	197	\$47,196
316	Leather and Allied Product Manufacturing	337	435	98	29%	1.42	99	\$33,024
313	Textile Mills	449	462	13	3%	0.41	39	\$65,762
327	Nonmetallic Mineral Product Manufacturing	4,503	4,609	106	2%	1.06	(39)	\$62,503
322	Paper Manufacturing	5,724	5,554	(170)	(3%)	1.50	(47)	\$82,498
314	Textile Product Mills	860	733	(127)	(15%)	0.62	(79)	\$40,206
323	Printing and Related Support Activities	7,133	6,058	(1,075)	(15%)	1.41	(301)	\$52,287
333	Machinery Manufacturing	23,943	24,742	799	3%	2.10	(301)	\$74,658
325	Chemical Manufacturing	15,530	15,765	235	2%	1.80	(508)	\$96,597
335	Electrical Equipment, Appliance, and Component Manufc	7,826	7,712	(114)	(1%)	1.86	(524)	\$96,489
331	Primary Metal Manufacturing	12,964	12,482	(482)	(4%)	3.13	(677)	\$79,548
337	Furniture and Related Product Manufacturing	3,688	3,020	(668)	(18%)	0.72	(696)	\$51,701
339	Miscellaneous Manufacturing	9,743	9,253	(490)	(5%)	1.39	(724)	\$63,529
336	Transportation Equipment Manufacturing	21,669	21,842	173	1%	1.22	(1,460)	\$81,785
326	Plastics and Rubber Products Manufacturing	16,743	15,746	(997)	(6%)	2.14	(1,518)	\$58,339
332	Fabricated Metal Product Manufacturing	44,204	41,576	(2,628)	(6%)	2.66	(4,852)	\$67,912
	All Manufacturing	206,480	205,073	(1,407)	(1%)		(8,829)	\$72,427
	EMSI Analyst							

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

that historically have favored NEO as locations. Only *Petroleum and Coal* and *Leather* products have location quotients greater than 1.25.

Beyond these new to NEO job growth manufacturing industries, several traditionally strong driver industry groups are expected to experience positive job growth through 2022:

- Primary Metals
- Machinery Manufacturing
- Chemical Manufacturing
- Transportation Manufacturing
- Fabricated Metals Manufacturing

PRODUCT MARKETS PRODUCING JOB GROWTH IN NEO

Only market segments with at least 200 jobs in 2016 are included. With the single exception of Paints and Coatings all have double-digit percent increases in total jobs by 2022. Most are from the industry groups identified in the table.

There is an impressive number of market segments with positive economic outlooks for NEO. Much of the job growth in each market segment is due to local firms out-performing their market peers nationally. (This is quantified by the Competitive Effect column.)

- The diversification of market segments adds some economic stability for the manufacturing sector.
- In total, nearly 40,000 jobs in 2016 (about one in five of all jobs in manufacturing) are from these growing markets of manufactured goods and services.
- While the percentage of job growth is minor, expected gains number in the hundreds in each case. The dominance of products in advanced manufacturing is clear; these market segments are highlighted in light blue.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Manufacturing Product Segments with Expected Job Growth 2016 to 2022 (Minimum of 200 Jobs in 2016)								
NAICS	Description	2016 Jobs	2022 Jobs	2016 - 2022 Change	2016 - 2022 % Change	2022 Location Quotient	Competitive Effect	Current Total Earnings
Food Manufacturing								
311612	Meat Processed from Carcasses	1,908	2,319	411	22%	1.67	184	\$53,275
311919	Other Snack Food Manufacturing	1,904	2,319	415	22%	5.25	238	\$47,127
311911	Roasted Nuts and Peanut Butter Manufacturing	830	1,071	241	29%	6.19	129	\$48,631
311352	Confectionery Manufacturing from Purchased Chocolate	751	875	124	17%	2.70	120	\$33,191
311942	Spice and Extract Manufacturing	550	673	123	22%	2.52	43	\$80,099
311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing	259	360	101	39%	2.02	64	\$50,310
311611	Animal (except Poultry) Slaughtering	225	336	111	49%	0.24	106	\$33,707
		6,428	7,953	1,526				
Chemical Manufacturing								
325510	Paint and Coating Manufacturing	3,595	3,788	193	5%	9.04	102	\$86,760
325199	All Other Basic Organic Chemical Manufacturing	1,682	1,846	164	10%	4.36	5	\$139,565
325620	Toilet Preparation Manufacturing	1,040	1,144	104	10%	2.01	66	\$65,229
325180	Other Basic Inorganic Chemical Manufacturing	581	639	58	10%	1.57	44	\$95,470
325120	Industrial Gas Manufacturing	464	519	55	12%	2.62	32	\$98,318
		7,363	7,936	574				
Machinery Manufacturing								
333120	Construction Machinery Manufacturing	2,164	2,488	324	29%	2.33	337	\$66,128
333314	Optical Instrument and Lens Manufacturing	1,798	2,350	552	57%	2.98	217	\$57,319
333995	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing	1,047	1,130	83	19%	0.77	15	\$60,054
333993	Air and Gas Compressor Manufacturing	875	1,161	286	23%	4.33	122	\$76,962
333993	Packaging Machinery Manufacturing	807	995	188	23%	6.08	122	\$77,627
333921	Elevator and Moving Stairway Manufacturing	658	704	46	31%	2.14	30	\$72,239
		7,350	8,828	1,479				
Transportation Equipment								
336412	Aircraft Engine and Engine Parts Manufacturing	1,440	1,984	544	15%	3.11	347	\$91,070
336212	Truck Trailer Manufacturing	1,305	1,681	376	31%	5.18	266	\$50,499
336214	Travel Trailer and Camper Manufacturing	939	1,069	130	22%	2.65	84	\$65,244
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	745	937	192	20%	2.69	176	\$70,260
336360	Motor Vehicle Seating and Interior Trim Manufacturing	609	700	91	33%	1.34	128	\$59,609
		5,039	6,371	1,333				
Fabricated Metal Product Manufacturing								
332919	Other Metal Valve and Pipe Fitting Manufacturing	2,369	2,628	259	14%	6.31	86	\$60,826
332420	Metal Tank (Heavy Gauge) Manufacturing	451	576	125	29%	2.16	90	\$90,431
332117	Powder Metallurgy Part Manufacturing	395	449	54	31%	0.71	13	\$67,063
		3,215	3,654	438				
Computer and Electronic Product Manufacturing								
334614	Software and Other prerecorded Compact Disc, Tape, and Record Reproducing	1,170	1,441	271	22%	3.01	112	\$92,169
334517	Irradiation Apparatus Manufacturing	719	924	205	36%	3.05	89	\$98,571
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance	516	613	97	30%	2.33	92	\$51,854
334419	Other Electronic Component Manufacturing	363	569	206	26%	1.43	195	\$60,456
334210	Telephone Apparatus Manufacturing	325	443	118	49%	1.25	88	\$116,326
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	268	289	21	12%	1.75	27	\$53,480
		3,361	4,279	918				
Electrical Equipment, Appliance and Component Manufacturing								
335932	Noncurrent-Carrying Wiring Device Manufacturing	939	1,027	88	23%	3.75	67	\$70,409
335121	Residential Electric Lighting Fixture Manufacturing	625	692	67	45%	2.02	56	\$60,192
335929	Other Communication and Energy Wire Manufacturing	353	458	105	28%	4.02	90	\$61,965
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	325	390	65	10%	2.11	1	\$73,237
		2,243	2,566	325				
Primary Metals								
331523	Nonferrous Metal Die-Casting Foundries	998	1,218	220	9%	3.77	68	\$56,286
331420	Copper Rolling, Drawing, Extruding, and Alloying	688	750	62	9%	2.57	69	\$77,263
331222	Steel Wire Drawing	502	651	149	30%	4.72	46	\$51,353
331513	Steel Investment Foundries	226	276	50	11%	6.89	99	\$58,194
331318	Other Aluminum Rolling, Drawing, and Extruding	212	310	98	46%	1.05	88	\$50,981
		2,626	3,205	579				
Non-metallic Mineral Products								
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	921	1,083	162	18%	7.49	27	\$68,887
327991	Cut Stone and Stone Product Manufacturing	516	595	79	15%	1.64	8	\$43,783
327215	Glass Product Manufacturing Made of Purchased Glass	303	363	60	20%	0.75	57	\$51,252
		1,740	2,041	301				
Paper Manufacturing								
322219	Other Paperboard Container Manufacturing	886	969	83	9%	3.62	43	\$55,960
322212	Folding Paperboard Box Manufacturing	515	633	118	23%	2.00	82	\$69,120
322299	All Other Converted Paper Product Manufacturing	296	356	60	20%	1.89	25	\$73,011
		1,698	1,959	261				
EMSI Analyst		387	430	43				

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Major Market Segments in NE Ohio Manufacturing that are Producing Job Growth Require Advanced Technologies

“Advanced Manufacturing is a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies.”¹

Advanced Manufacturing NAICS Codes

332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance, and Component Manufacturing
336	Transportation Equipment Manufacturing
339	Miscellaneous Manufacturing

WHAT ARE THE JOBS IN THE GROWTH INDUSTRIES?

Not surprising, 52% of all jobs in 2016 were for *Production* workers. These workers are directly involved in the production of goods and manufacturing services. It represents a wide range of specific jobs ranging from Production Manager to Helpers, with some occupations specific to the product being produced, or the production process itself. *The overall average of \$16 per hour provides full time workers with a living wage, depending on family size.*

NE Ohio: Occupations Employed in Manufacturing Industries Expected to Grow Jobs 2016 to 2022							
SOC	Description	Employed in Industry Group (2016)	Employed in Industry Group (2022)	Change (2016 - 2022)	% Change (2016 - 2022)	% of Total Jobs in Industry Group (2016)	Median Hourly Earnings
EMSI Analyst							
51-0000	Production Occupations	56,436	57,264	828	1%	52.4%	\$16.42
43-0000	Office and Administrative Support Occupations	9,819	9,972	153	2%	9.1%	\$16.26
53-0000	Transportation and Material Moving Occupations	8,473	8,950	477	6%	7.9%	\$15.33
11-0000	Management Occupations	6,351	6,647	296	5%	5.9%	\$41.02
17-0000	Architecture and Engineering Occupations	6,171	6,500	329	5%	5.7%	\$34.31
49-0000	Installation, Maintenance, and Repair Occupations	5,885	6,346	461	8%	5.5%	\$20.36
41-0000	Sales and Related Occupations	3,815	4,034	219	6%	3.5%	\$16.06
13-0000	Business and Financial Operations Occupations	3,737	3,922	185	5%	3.5%	\$29.30
15-0000	Computer and Mathematical Occupations	1,941	2,037	96	5%	1.8%	\$34.11
19-0000	Life, Physical, and Social Science Occupations	1,827	1,864	37	2%	1.7%	\$31.87
47-0000	Construction and Extraction Occupations	1,088	1,133	45	4%	1.0%	\$21.32

¹ Presidents' Council of Advisors on Science and Technology

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

No other occupational group accounts for more than 9% of all jobs in these growing industries and market segments of manufacturing. The other occupational groups directly or indirectly involved with product and process innovations and on-going production are Installation, Maintenance, and Repair and Engineering professional, technologists, and technicians.

Each contributed 6% of all jobs as of 2016. *Engineers* and *Engineering Technologists/ Technicians* are critical in design and development of new and improved products and more efficient production and distribution systems. *Installation, Maintenance and Repair* workers are critical to implementing and sustaining production systems and equipment.

These three occupational groups play vital roles in NEO's growing segments of manufacturing and are the focus of the remainder of this investigation.

Engineering

Industrial, Mechanical, Electrical and Chemical Engineers, in that order, had the most jobs located in NEO's growth manufacturing markets. Only modest expansion of engineers is expected by 2022—only an increase of 56 for Industrial Engineers in the next seven years, for example. Only an increase of 233 for all engineers is expected.

The picture for Engineering Technologists/Technicians is more anemic. Only a total of 65 are projected to be added by 2022, less than 10 each year. Overall, these middle-level occupations have not been highly evident in the manufacturing sector.

Production

Metal and Plastic and *Assemblers and Fabricators Workers* have been the largest source of employment for Production workers overall. Respectively, each is expected to add 431 and 361 workers by 2022.

- Occupations with the largest percentage gains are *Welders* at 10% and *Electrical and Electronic Equipment Assemblers* at 11%.
- *Metal and Plastic Workers* pay on average living wages to full time workers; *Assemblers and Fabricators* often do not.
- *Machinists* are the largest source of jobs in Metal Working and is expected to add 155 positions by 2022.
- *CNC Programmers* pay the best on average although the number of new jobs by 2022 is only 20.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Engineering; and Factory Floor Occupations Employed in Manufacturing Industries Expected to Grow Jobs 2016 to 2022							
SOC	Description	Employed in Industry Group (2016)	Employed in Industry Group (2022)	Change (2016 - 2022)	% Change (2016 - 2022)	% of Total Jobs in Industry Group (2016)	Median Hourly Earnings
Engineering							
Engineers							
17-2112	Industrial Engineers	1,375	1,431	56	4%	1.3%	\$36.22
17-2141	Mechanical Engineers	1,280	1,335	55	4%	1.2%	\$35.05
17-2199	Engineers, All Other	445	460	15	3%	0.4%	\$42.11
17-2071	Electrical Engineers	380	418	38	10%	0.4%	\$36.55
17-2041	Chemical Engineers	288	305	17	6%	0.3%	\$42.43
17-2131	Materials Engineers	218	222	4	2%	0.2%	\$41.47
17-2072	Electronics Engineers, Except Computer	168	191	23	14%	0.2%	\$41.13
17-2011	Aerospace Engineers	146	159	13	9%	0.1%	\$50.59
17-2061	Computer Hardware Engineers	106	118	12	11%	0.1%	\$41.79
		4,406	4,639	233			
Engineering Technologists/ Technicians							
17-3026	Industrial Engineering Technicians	481	496	15	3%	0.4%	\$21.91
17-3029	Engineering Technicians, Except Drafters, All Other	257	262	5	2%	0.2%	\$27.27
17-3013	Mechanical Drafters	248	246	(2)	(1%)	0.2%	\$24.54
17-3027	Mechanical Engineering Technicians	205	213	8	4%	0.2%	\$24.16
17-3023	Electrical and Electronics Engineering Technicians	179	212	33	18%	0.2%	\$27.48
17-3024	Electro-Mechanical Technicians	104	110	6	6%	0.1%	\$25.28
		1,474	1,539	65			
Installation, Maintenance, and Repair							
Supervisors of Installation, Maintenance, and Repair Workers							
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	540	561	21	4%	0.5%	\$29.04
Electrical and Electronic Equipment Mechanics, Installers, and Repairers							
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	205	214	9	4%	0.2%	\$26.74
Other Installation, Maintenance, and Repair Occupations							
49-9041	Industrial Machinery Mechanics	2,252	2,539	287	13%	2.1%	\$21.40
49-9071	Maintenance and Repair Workers, General	1,886	1,952	66	3%	1.8%	\$18.21
49-9043	Maintenance Workers, Machinery	336	375	39	12%	0.3%	\$20.95
49-9044	Millwrights	191	205	14	7%	0.2%	\$29.63
		4,665	5,072	406			
Production							
Supervisors of Production Workers							
51-1011	First-Line Supervisors of Production and Operating Workers	3,724	3,852	128	3%	3.5%	\$26.52
Metal Workers and Plastic Workers							
51-4041	Machinists	2,965	3,120	155	5%	2.8%	\$18.41
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	1,703	1,867	164	10%	1.6%	\$17.65
51-4121	Welders, Cutters, Solderers, and Brazers	1,081	1,162	81	7%	1.0%	\$17.45
51-4051	Metal-Refining Furnace Operators and Tenders	518	529	11	2%	0.5%	\$18.55
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	213	233	20	9%	0.2%	\$22.46
		6,480	6,910	431			
Assemblers and Fabricators							
51-2092	Team Assemblers	4,072	4,265	193	5%	3.8%	\$14.09
51-2022	Electrical and Electronic Equipment Assemblers	990	1,103	113	11%	0.9%	\$13.51
51-2099	Assemblers and Fabricators, All Other	930	961	31	3%	0.9%	\$13.03
51-2023	Electromechanical Equipment Assemblers	254	278	24	9%	0.2%	\$15.38
		6,247	6,608	361			
Food Processing Workers							
51-3092	Food Batchmakers	1,120	1,235	115	10%	1.0%	\$13.21
51-3011	Bakers	770	785	15	2%	0.7%	\$11.23
51-3023	Slaughterers and Meat Packers	522	628	106	20%	0.5%	\$10.95
51-3099	Food Processing Workers, All Other	350	381	31	9%	0.3%	\$11.03
51-3022	Meat, Poultry, and Fish Cutters and Trimmers	328	436	108	33%	0.3%	\$12.32
51-3093	Food Cooking Machine Operators and Tenders	288	324	36	13%	0.3%	\$11.96
51-3091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders	245	265	20	8%	0.2%	\$13.41
		3,622	4,054	431			
Plant and System Operators							
51-8091	Chemical Plant and System Operators	452	480	28	6%	0.4%	\$22.38
		452	480	28			
Other Production Occupations							
51-9111	Packaging and Filling Machine Operators and Tenders	3,597	3,795	198	6%	3.3%	\$13.55
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	3,229	3,282	53	2%	3.0%	\$17.34
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	2,150	2,210	60	3%	2.0%	\$16.72
51-9011	Chemical Equipment Operators and Tenders	1,775	1,822	47	3%	1.6%	\$19.96
51-9198	Helpers--Production Workers	1,574	1,610	36	2%	1.5%	\$11.98
51-9199	Production Workers, All Other	1,480	1,518	38	3%	1.4%	\$11.65
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	577	593	16	3%	0.5%	\$15.81
		14,382	14,831	448			
Total		48,320	51,145	2,824			

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Installation, Maintenance, and Repair

Industrial Machinery Mechanics and *Maintenance and Repair* workers, by far, provided the most jobs in this occupational grouping. Due to projected industry growth, the need for Mechanics should grow 13% by 2022.

CONCLUSION

To summarize, we now know the relative importance of the wide range of occupations and jobs in the three occupational groups most critical to supporting the growth of the region's manufacturing sector, and in what industries and specific markets job growth will most likely occur in the next seven years.

What we do not know is how these scenarios of manufacturing growth are dependent on industry adaptation and utilization of 'disruptive technologies': how these efforts will impact the emerging demand for workers in terms of job assignments and skills.

- *How different will the occupational profile of NEO's manufacturing appear in the next few years?*
- *How different will the skill sets appear for traditional jobs in manufacturing?*

Which Occupations Are Most in Demand in the Labor Market?

All data used so far provides no information about employer demand now, or in the recent past, for any of these occupations. The best analytics available on real-time labor market activity based on online job postings is provided by Burning Glass Technologies, a big data firm specializing in labor market dynamics by parsing online ads posted by employers to gain insights helpful to workforce development planning. Historically, long-term trends reveal that *Production* jobs are a smaller and smaller share of all jobs in manufacturing—mainly the result of increased productivity. More so than off-shoring of production, this is a result of increased automation of routine tasks and responsibilities previously performed by them. Past trends in adding workers by occupation are not a good indication of what employers choose to hire now and going forward. Detailed analysis of job postings is an excellent source of insights that reflect today's realities.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

DEMAND FROM MANUFACTURERS FOR WORKERS IN ENGINEERING; MANUFACTURING & PRODUCTION; AND INSTALLATION, MAINTENANCE, & REPAIR

NEO: Manufacturing Jobs with Most Postings during 2016--Engineering; Manufacturing/ Production; and Installation/Maintenance & Repair				
BGTOCC Code	BGTOCC	Job Postings		
	Management			
11305101	Quality Control Systems Managers	243		
11904100	Engineering Manager	230		
	Subtotal		473	6.3%
	Engineer Professionals			
17214100	Mechanical Engineer	645		
17219904	Manufacturing Engineer	431		
17211200	Industrial Engineer	266		
17207100	Electrical Engineer	262		
17204100	Chemical / Process Engineer	182		
17219902	Validation Engineer	116		
17205100	Civil Engineer	100		
17213100	Materials Engineer	91		
	Subtotal		2,093	28.0%
	Engineering Technologist/ Technicians			
17302909	Manufacturing / Production Technician	95		
17302300	General / Electrical Engineering Technician	87		
17301300	Mechanical / Electrical Drafter	83		
27102191	Product Development Engineer	50		
17301900	CAD Designer / Drafter	44		
17302700	Industrial / Mechanical Engineering Technician	37		
	Subtotal		396	5.3%
	Scientific			
19409901	Quality Control Analyst	138		
	Subtotal		138	1.8%
	Installation, Maintenance and Repair			
49907191	Maintenance Technician	557		
49101100	Maintenance / Service Supervisor	207		
49907192	Field Service Technician	107		
49909900	Repair / Service Technician	103		
49904100	Industrial Mechanic	76		
49902100	HVAC Mechanic / Installer	54		
	Subtotal		1,104	14.8%
	Production			
51919900	Production Worker	665		
51901292	Manufacturing Machine Operator	636		
51101191	Production Supervisor	485		
51404100	Machinist	334		
51906100	Quality Inspector / Technician	300		
51101192	Production Plant Manager	194		
51404191	CNC Operator	174		
51403100	Press / Press Brake Operator	111		
51407291	Molding / Casting Worker	96		
51202200	Electronic / Electrical Assembler	94		
51411100	Tool and Die Maker	93		
51401200	CNC Programmer	80		
	Subtotal		3,262	43.7%
	Total	7,466		
	Source: Labor Insight Jobs (Burning Glass Technologies)			

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Based on online ads active at some point in 2016, Production occupations had the most posts placed by manufacturing. In NEO, the online posting of jobs by manufacturers is for Production Workers (44%).

The largest number of postings for individual occupations by manufacturers are:

- *Production Workers* (a title that combines a range of specific O*Net titles such as Assemblers; Pattern Makers; Glass Blowers; etc. see Attachment)
- *Maintenance Technician; Manufacturing Machine Operator* (a title that combines a large number of very specific O*Net titles such as Setters, Operators, and Tenders of specific types of machines to manufacturer a range of product types. See Attachment)
- *Production Supervisor*
- *Machinists*

To better understand why some occupations were identified by employers as in demand, the responses for each occupation were linked with the type of manufacturing. Machine Operator, for example, was identified as in demand by precision processes, process manufacturing in general, metal fabrication and plastics fabrication.

- CNC Operator/ Machinists is only in demand by precision manufacturing processes.
- Engineers and Technicians is only in demand by Original Equipment manufacturers and Electronic Components producers.
- Welder is not in demand within any type of manufacturing, according to the respondents.

MORE ON PRODUCTION WORKER AND MANUFACTURING MACHINE OPERATOR

Production Worker and *Manufacturing Machine Operator* were the most often posted jobs throughout 2016. Typically, these are not skilled jobs, and often do not meet the criteria set for middle-skill jobs.

- Computer or IT skills are almost totally missing from ads for these two 'factory' jobs. There is little evidence that the posted jobs require measuring or use of math. The implication is that these workers will not be working with digitized information, systems or controls.
- These job ads stipulate a mean salary of \$32,600 which falls short of a living wage; require no prior experience; and only a high school credential is required.

The remainder of *Production Occupations* is more likely where employers face a shortage of skilled job seekers, based on education and training or prior job experience. These posts account for just over 2,000 ads placed by manufacturers and suggest where a skills gap might exist in NEO.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Skills in Demand Listed in Ads for Production Workers and Manufacturing Machine Operators during 2016					
36% of Job Notices Do Not List a Single Skill					
Specialized Skills	Job Postings	Baseline (Employability) Skills		Computer/ IT Skills	
Inspection	32.53%	Physical Demand	29.05%	Microsoft Office	3.36%
Machine Operation	32.53%	Mathematics	22.21%	SAP	3.24%
Hand Tools	24.73%	Troubleshooting	19.45%	Microsoft Excel	2.76%
Packaging	16.69%	Computer Skills	17.17%	Computer Aided Drafting/Design (CAD)	1.32%
Labeling	15.49%	Detail-Oriented	17.05%	Microsoft Outlook	0.96%
Micrometers	14.65%	Communication Skills	12.85%	AutoCAD	0.84%
Repair	14.41%	Work Area Maintenance	12.24%	Enterprise Resource Planning (ERP)	0.72%
Machinery	14.29%	English	9.60%	Microsoft Powerpoint	0.60%
Calipers	11.28%	Preventive Maintenance	9.00%	Microsoft Word	0.48%
Forklift Operation	11.28%	Problem Solving	8.40%	Pro*C	0.48%
Source: Labor Insight Jobs (Burning Glass Technologies)					

MOST DEMAND FOR ENGINEERING WORKERS IS FROM MANUFACTURING

Six of ten job postings for engineers and engineering technologists are from manufacturers.

Second largest source of postings is from *Professional, Scientific, and Technical Services* industries which includes the Engineering Services industry.

No other industry provides more than 3% of all postings.

MANUFACTURING DEMAND FOR ENGINEERING WORKERS IS MOSTLY FOR A FEW TYPES OF ENGINEERING EXPERTISE

NE Ohio: Industries with Most Ads for Engineering Workers during 2016		
	Posting with Unknown Industry	0.28%
NAICS Code	Industry	Job Postings
31-33	Manufacturing	60.02%
54	Professional, Scientific, and Technical Services	13.48%
23	Construction	3.12%
56	Administrative and Support and Waste Management and Remediation Services	2.85%
92	Public Administration	2.72%
48-49	Transportation and Warehousing	2.68%
62	Health Care and Social Assistance	2.48%
52	Finance and Insurance	2.31%
	Industries with 90% of all Ads	89.66%
Source: Labor Insight Jobs (Burning Glass Technologies)		

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Not all ads provide information that identifies the industry of the job posted. Of those that do, 44% are from Manufacturing. The breakdown of postings by industry sources is limited to other 56% where industry is known or can be inferred.

Five occupations have 55% or more from Manufacturing.

- *Manufacturing Engineers* top the list with 90% from the Manufacturing sector.
- *Industrial, Chemical/Process, and Validation Engineers* also appear more often from Manufacturing firms.
- All Technologist/ Technician jobs posted typically are from other industry sectors. Only *Manufacturing/ Production Technician* has half of all ads from the manufacturing sector.

NE Ohio: Engineering Jobs Total and In Manufacturing during 2016				
BGTOCC Code	BGTOCC	All Ads	Mfging Ads	% in Mfging
		Job Postings		
11904100	Engineering Manager	624	230	36.9%
17214100	Mechanical Engineer	1,185	645	54.4%
17207100	Electrical Engineer	811	262	32.3%
17205100	Civil Engineer	526	100	19.0%
17219904	Manufacturing Engineer	481	431	89.6%
17211200	Industrial Engineer	464	266	57.3%
17204100	Chemical / Process Engineer	324	182	56.2%
17302300	General / Electrical Engineering Technician	290	87	30.0%
17301300	Mechanical / Electrical Drafter	215	83	38.6%
17219902	Validation Engineer	204	116	56.9%
17302909	Manufacturing / Production Technician	189	95	50.3%
17213100	Materials Engineer	166	91	54.8%
17301900	CAD Designer / Drafter	162	44	27.2%
17302700	Industrial / Mechanical Engineering Technician	126	37	29.4%
17211100	Health and Safety Engineer	124	48	38.7%
17301102	Civil / Architectural Designer / Drafter	80	10	12.5%
17201100	Aerospace Engineer	75	20	26.7%
17302200	Civil Engineering Technician	67	17	25.4%
17208100	Environmental Engineer	60	7	11.7%
17206100	Hardware Engineer	57	15	26.3%
17207291	Electronics Engineer	56	10	17.9%
17301200	Electrical / Electronic Designer	43	14	32.6%
17208101	Water / Wastewater Engineer	37	4	10.8%
17302400	Test Technician	35	5	14.3%
17302991	Non-Destructive Testing Specialist	32	19	59.4%
27102191	Product Development Engineer	89		
	Total Posts	5,898	2,608	44.2%

Researching a possible skills gap for engineering workers will be based on jobs posted regardless of industry of employment.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

ANOTHER SET OF POTENTIALLY MIDDLE-SKILL WORKERS CRITICAL TO MANUFACTURING ARE THOSE IN INSTALLATION, MAINTENANCE AND REPAIR, AND MOST IMPORTANTLY WITHIN THE PRODUCTION SYSTEMS.

Maintenance Technician accounts for exactly half of all these jobs posted. Almost all captured by adding *Maintenance/Service Supervisor* and *Field Service Technician*.

Hiring new workers for any of these occupations might be difficult for manufacturers, depending on specific skills training and prior work experience preferred by employers and the availability of appropriate postsecondary skills training within NEO.

Currently most of these jobs existing in the region are outside manufacturing. This is true for recent job postings as well.

A large number of specific jobs are rarely needed in manufacturing; many are needed in service and repair industries.

NEO: Maintenance, Repair and Installation Job Ads from Manufacturing during 2016				
BGTOCC Code	BGTOCC	All Ads	MFG	% in MFG
		Job Postings		
49907191	Maintenance Technician	2,504	557	22.2%
49101100	Maintenance / Service Supervisor	825	207	25.1%
49907192	Field Service Technician	417	107	25.7%
49904100	Industrial Mechanic	187	76	40.6%
49209400	Electrical Tester / Technician	97	32	33.0%
49904400	Millwright	32	29	90.6%
49906200	Biomedical Equipment Technician	68	12	17.6%
49209100	Avionics Technician	13	4	30.8%
49209500	Electrical Substation / Relay Repairer	13	4	30.8%
49909900	Repair / Service Technician	713	103	14.4%
49905200	Cable Technician / Installer	71	10	14.1%
49209700	Television / Satellite Television Installer	38	5	13.2%
49902100	HVAC Mechanic / Installer	417	54	12.9%
49202200	Satellite / Broadband Technician	222	22	9.9%
49302100	Auto Body Technician	117	10	8.5%
49909800	Maintenance Helper / Assistant	140	10	7.1%
49209800	Alarm / Security System Technician	100	7	7.0%
49304200	Heavy Equipment Mechanic	112	7	6.3%
49309300	Tire Changer / Technician	50	3	6.0%
49301100	Aircraft / A & P Mechanic	103	4	3.9%
49302300	Automotive Service Technician / Mecha	1,659	45	2.7%
49303100	Diesel Mechanic	467	12	2.6%
49309100	Bike Technician	61	1	1.6%
		8,426	1,321	15.7%

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Top Skills Appearing in Ads for Machinists, Last 365 Days								
Specialized Skills			Baseline Skills			Computer/IT Skills		
281	#	%	281	#	%	281	#	%
Machining	226	95.4%	Mathematics	99	41.8%	ISO 9000	4	1.7%
Computer Numerical Control (CNC)	196	82.7%	Editing	66	27.8%	SAP	4	1.7%
Lathes	118	49.8%	Troubleshooting	65	27.4%	Computer Aided Drafting/Design (CAD)	3	1.3%
Inspection	115	48.5%	English	35	14.8%	.NET Programming	2	0.8%
Grinders	77	32.5%	Problem Solving	34	14.3%	CAD/CAM	2	0.8%
Calipers	53	22.4%	Writing	28	11.8%	Microsoft Operating Systems	2	0.8%
Micrometers	50	21.1%	Work Area Maintenance	25	10.5%	Surfcam	2	0.8%
Repair	46	19.4%	Physical Demand	24	10.1%	Computer Aided Manufacturing (CAM)	1	0.4%
Computerized Numerical Control Lathes	43	18.1%	Communication Skills	21	8.9%	Hypertext Preprocessor (PHP)	1	0.4%
Hand Tools	38	16.0%	Organizational Skills	18	7.6%	JavaScript	1	0.4%
Calculation	31	13.1%	Detail-Oriented	17	7.2%	Microsoft Excel	1	0.4%
Technical Drawings	29	12.2%	Team Work/ Collaboration	15	6.3%	Microsoft Word	1	0.4%
Power Tools	28	11.8%	Computer Skills	13	5.5%			
Machine Tools	26	11.0%	Preventive Maintenance	13	5.5%			
Routers	26	11.0%	Energetic	10	4.2%			
Source: Burning Glass Labor/Insight								

NE Ohio: Manufacturing and Production Job Ads from Manufacturing during 2016				
		MFG	All Ads	% in MFG
BGTOCC Code	Occupation Title	Job Postings		
51101191	Production Supervisor	485	892	54.4%
51404100	Machinist	334	595	56.1%
51404191	CNC Operator	174	297	58.6%
51407291	Molding / Casting Worker	96	186	51.6%
51401200	CNC Programmer	80	153	52.3%
51912100	Coating / Industrial Painter	49	88	55.7%
51901100	Chemical Operator	25	42	59.5%
51901292	Manufacturing Machine Operator	636	1,351	47.1%
51101192	Production Plant Manager	194	420	46.2%
51411100	Tool and Die Maker	93	194	47.9%
51403300	Grinder / Sharpener	46	94	48.9%
51919900	Production Worker	665	1,717	38.7%
51906100	Quality Inspector / Technician	300	814	36.9%
11305101	Quality Control Systems Managers	242	549	44.1%
19409901	Quality Control Analyst	138	384	35.9%
51403100	Press / Press Brake Operator	111	254	43.7%
51202200	Electronic / Electrical Assembler	94	264	35.6%
	Total	3,762	8,294	45.4%
Source: Labor Insight Jobs (Burning Glass Technologies)				

Part Two

I. Jobs In-Demand Outnumber Qualified Jobseekers = Skills Gap

As noted, there were thousands of job postings from manufacturers for engineering linked to production and production systems in NE Ohio's labor market in 2016. Where do applicants come from? Skills in demand by employers are fluid, constantly changing and vary widely across occupations in demand. As a result, the occupations experiencing a talent or skills gap changes over time and region-to-region.

WHERE DO APPLICANTS COME FROM?

Skills in demand by employers are fluid, constantly changing and vary widely across occupations in demand. As a result, the occupations experiencing a talent or skills gap change over time and region-to-region.

If NE Ohio postsecondary career education and training providers are to *align technical programs with employer demand, it is important to have hard data on which occupations have a skills gap, what level of education and prior work experience employers seek, and what specific programs best prepare students to perform well on the job.*

Prior years of work experience is more important than level of education when determining where to look for qualified supply of job seekers.

Even for the same occupation, job ads might be seeking senior-level, experienced mid-level, or less experienced entry-level applicants. This depends on the nature and level of responsibility of positions in which they consider hiring.

Caveats when using job postings as an indicator of employer hiring activity

Not all job postings result in new hires, and those that do occur over a variable time frame.

- A portion of hires occur without a posting.
- Some postings are easy for employers to fill and some are extremely difficult. It all depends on job requirements set by employers and the ready supply of qualified applicants.
- Online ads for IT professionals have the most skills listed in ads of all occupations—typically over 20 per ad.

While employers intend to hire new workers for jobs they post, not all posted positions result in hires:

- Uncertainty in the market place results in applicants not being hired.
- How many of these are filled depends on several things: Finding the right applicants; budget needed to hire; need to fill positions remains firm; and more.
- Some employers use online postings simply to test the waters and get a read on the talent seeking new jobs.

Also, it is difficult to determine how many new workers they wish to hire based on a single posting. The number of job postings is NOT an absolute indicator of the number of new hires that employers wish to make. Even if hires do occur they take place over different lengths of time. The harder it is to find the individuals employers want to hire, the longer it will take to fill a posted position.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Hard data on hires **by occupation** is not centrally collected. We can assume that employers have an intent, or likelihood, of hiring when going to the expense of posting jobs. But, circumstances change and timelines slip.

ALIGNING DEMAND WITH POTENTIAL SOURCES OF TALENT SUPPLY

Quantifying shortages of supply to fill open positions is best understood, not by occupation title alone, but by segmenting job openings by entry-level and mid-level demand. This is more important than the job alone. Experience of applicants is more important than education in the search to enumerate supply. This starts with understanding more about demand measured by real-time online job postings.

BREAKING DOWN MANUFACTURING JOB ADS

In terms of education, they express preferences for majors and level of education credentials in job ads.

Education Credentials Advertised in Job Postings

Not surprisingly, the skilled manufacturing job ads often are silent about educational requirements. Forty-two percent of all ads for Production jobs have no information about educational requirements; even more (49%) of all ads for Maintenance, Installation and Repair ads include no education requirements. In contrast, seventy-nine percent of engineers and engineering technology/ technician jobs stipulate education expectations of employers.

The data capture what employers say is the minimum and/or preferred level of education they want for each group of job postings: Engineering; Production; and Maintenance, Installation, and Repair.

- **High school or vocational training for Skilled Jobs:** In most cases, technical training is preferred in addition to a high school credential. This would only be relaxed for job seekers with evident job experience where skills were developed.
- **Associate degree for Skilled Jobs:** These percentages reflect the reality that employers prefer applicants that have completed the degree over vocation training certificates. This is more prevalent for the positions posted in Maintenance, Installation and Repair. This is likely due to Maintenance Technician and Maintenance Service Supervisor accounting for most of the job postings.
- **Bachelor's degree for Production Jobs:** Employers prefer a Bachelors for 27% of Production jobs posted. This likely is the result of the

NE Ohio: Education Levels Required or Preferred Appearing in Ads during 2016			
	Engineering	Production	Maintenance
Education	Job Postings		
High school or vocational training	4.50%	70.10%	73.86%
Associate's degree	6.56%	8.75%	23.20%
Bachelor's degree	89.51%	27.31%	14.39%
Master's degree	16.35%	5.41%	2.20%
Doctoral degree	1.36%	0.48%	-
Percent of Ads with no Educational Info	21.0%	42.0%	49.0%
This report provides information on both the preferred and minimum/required education levels listed in job postings. For this reason, a job posting may be counted in more than one of the educational categories.			
Source: Labor Insight Jobs (Burning Glass Technologies)			

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

larger number of postings for supervisor or manager and others jobs requiring greater levels of technical skills.

Prior Work Experience Advertised in Job Postings

Prior work experience is importance in that it reflects how employers differentiate between newly-trained job seekers with no prior work experience performing the duties of the occupation and the applicant with several years of job experience regardless of their training.

Clearly, these three types of occupations have every different view about the importance of little to no prior work experience (providing they have the education employers want).

- **Production Jobs:** 42% of ads stipulate little to no prior work experience necessary (0 to 2 years of prior work experience).
- **Maintenance, Installation, & Repair Jobs:** 60% of all ads want 3 to 5 years of work experience. This may be that it is harder to find applicants that meet their education preferences. As a result, greater emphasis is placed on work experience. Or, employers may have a history of success when hiring experienced workers regardless of recent training.
- **Engineers and Technologists/ Technicians:** the majority of ads want experienced workers regardless of strict requirements on education levels in appropriate majors.

NE Ohio: Prior Work Experience Appearing in Ads during 2016			
	Engineering	Production	Maintenance
Experience Level	Job Postings		
9+ years	7.11%	4.09%	4.94%
6 to 8 years	10.28%	4.59%	5.21%
3 to 5 years	62.28%	48.89%	59.95%
0 to 2 years	20.33%	42.42%	29.90%
Percent of Ads with No Info	38.1%	54.0%	45.0%
Source: Labor Insight Jobs (Burning Glass Technologies)			

Important to Quantify the Skills Gap for Entry and Mid-Level Ads for Workers

To quantify the skills gap for *Engineering and Skilled Manufacturing* talent, we must create a research design that dissects demand for each occupation by level of education credential and prior years of work experience.

“Individuals emerging from IT education and training programs” is the best way to define a pool of potential job seekers with skills acquired through formal education rather than from work experience.

Supply of IT workers for entry-level jobs

Entry-level jobs are the best prospects for recent college grads, most of whom will not come with significant prior work experience.

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According to Will Markow at Burning Glass:

“Most employers specify three to five years because they do not want an entry-level worker. They are less likely to hire recent college grads with no prior work experience in which they

honed these skills on the job. But, demanding new hires with related job experience constrains their traditional sourcing options to either churn in the local existing workforce, which from a regional perspective is a zero-sum solution, or hiring workers from outside the region.”

Guide to Identifying Labor Market Supply		
Prior Work Experience	Minimum Level of Education Credential	
	Bachelors and Above	Less than a Bachelors
	Source of Supply	
0 to 2 Years	Recent Completers of Education & Training	
3 to 5 Years	Experience Workforce	

“Some of the more forward-thinking employers will source workers from related, yet distinct, occupations or backgrounds and provide them with training. However, I think that is still the exception to the rule.”

Most young people and transitioning adults who enter college programs intent to start or shift career paths. They lack significant, if any, prior work experience performing duties needed today by employers seeking to fill jobs. Upon completion of IT programs, these students, at best, meet employer demand for entry-level positions.

Churn is considered healthy for the economy—workers pursue career change or advancement by changing employers and firms can implement changes in job assignments and replace less-productive workers to improve firm competitiveness. Because of workers vacating previous jobs: “The clear majority of hiring in the U.S. is driven by the need to replace workers who leave one job for another...this job to job movement is known as labor market churn.”²

METHODOLOGY: AN INNOVATIVE APPROACH USING BIG DATA ANALYTICS

Three major sources of data are used to measure demand and supply: Burning Glass’ Labor/ Insights³ for labor analytics on demand; IPEDS⁴ for the most comprehensive source of data on recent completers of post-

² Careerbuilder and EMSI, *The Pulse of U.S. Hiring Activity: Labor Market Churn by Occupation & Metro*, <http://www.economicmodeling.com/2014/12/02/the-slowdown-in-job-churn-explained-and-visualized/>

³ A direct investigation of jobs employers post online provides a more complete picture of jobs in demand as they emerge and change. Burning Glass identifies employers with high demand for workers and occupations with the most openings and reveals details about employers’ demand for skills and credentials. Burning Glass has compiled a database of over 150 million job listings, updated daily from roughly 40,000 websites nation-wide. The database includes listings from major job boards, newspapers, government agencies, and a broad array of small, medium, and large employers—so long as they are placed online. The sites captured include a strong representation of the small businesses driving economic recovery; 51 percent of sites mined produce 20 or fewer jobs. Most sites are employer sites. Also, Burning Glass leverages patented text mining to code 70-plus data elements to render detailed skills-level intelligence on who is hiring and where, what jobs are in demand, and what skills and credentials employers now require for those jobs.

⁴ Integrated Postsecondary Education Data System is the primary source for information on U.S. colleges, universities, and technical and vocational institutions. The completion of all IPEDS surveys, in a timely and accurate manner, is mandatory for all institutions that participate in or are applicants for participation in any Federal financial assistance program authorized by Title IV of the Higher Education Act (HEA) of 1965. IPEDS responds to certain of the requirements pursuant to Section 421(a)(1) of

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secondary and vocational education and training; and proprietary data purchased from Burning Glass on postsecondary programs designed to prepare students for career employment in IT matched with detailed data on IT demand by occupation and data-based estimates of the numeric gap between annual job postings and annual completers from college and vocational programs.

This calculation is done for each occupation: An AI model is used to compare the learning outcomes of each IT program against several sources of data on skills and knowledge required to perform the occupation well. If there is a strong degree of overlap between student learning outcomes and the occupations skill set, then the program is identified as one that generally prepares students well to do IT jobs assigned to the occupational title. Each of nearly 40 programs are assessed for each of nearly 40 IT occupations. The result is a much more cross-matching of programs to occupations, and vice versa. Further, this analysis is performed for the two levels of educational attainment—Bachelor's or more and Associate's or shorter postsecondary program.

Using data purchased from Burning Glass provided a definitive matching of Engineering and Skilled Maintenance and Production workers with career and technical education programs by Classification of Instructional Program (CIP) where students learn the core skills now required by employers when hiring for each individual occupation. This level of nuance has not been available before in discussions about poor alignment of supply with what employers need. The result: *skills that a Machinist needs are not the same as for a Production Supervisor, for example.*

Also, purchased from Burning Glass are the estimates of demand versus supply of workers for each occupation for the year 2015. This is based on the number of job openings posted and the supply of recent completers from programs. Combined, these two data analytics document the numeric gaps for NE Ohio. These findings and implications form a single source of hard data that provides a wellspring of information that employers, educators, workforce boards, and regional intermediaries can explore together and create actions to improve the alignment of demand and supply in the next three to five years.

I. Empirical definition of Skills Gap for entry-level jobs

So, the question is this: is the full spectrum of providers of NE Ohio postsecondary education and training producing enough badges, certificate and degree completers each year to meet the entry-level demand for IT professionals?

- The NE Ohio IT Skills Gap between demand and supply focuses on demand for entry-level hires. To determine supply, we analyze the annual supply of grads from programs that imbue completers with skills employers now demand. The best single source of comprehensive data on completers by program is known as IPEDs. This requires submission of such data from all institutions and organizations, public or private, that have received designation as Title IV provider which permits them to access federal financial aid for qualifying students.
- As a result, the gap can be one of quantity (grads) or quality (specific learning outcomes), or both.

the Carl D. Perkins Vocational Education Act. *The data related to vocational programs and program completions are collected from postsecondary institutions known to provide occupationally specific vocational education.*

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Analysis of supply will be understated to the extent that large numbers of current and future workers obtain enroll and complete the new, alternative delivery systems for their technical training; programs that do not need to report their data for inclusion in IPEDs.

Even for the same occupation, job ads placed by employers might be seeking senior-level, experienced mid-level, or less experienced entry-level applicants given the nature of positions in which they consider hiring. A single indicator of level for an occupation is more the prior years of work experience, than level of education desired, when posting jobs.

- The majority of job ads are seeking to hire experienced workers with at least 3 to 5 years of relevant job experience.
- Ads for senior personnel typically want 6 or more years of experience.
- This leaves 23% of all Engineering; 28% of all Maintenance, Repair & Installation; and 48% of all Production job ads stipulating little job experience needed to apply.
- ***Entry-level jobs include only those ads asking for no more than two years of prior work experience.***

SKILLS GAP FOR EXPERIENCED, MID-LEVEL, WORKERS

New postsecondary completers are not the likely source of applicants for mid- and senior-level applicants.

- The supply of experienced workers with the appropriate educational credentials and evidence of needed skill sets is largely met by those already employed.
- The supply is augmented by the ability of employers to search for workers outside of NEO.
- Experienced workers are less likely to be recent graduates from NEO institutions.

THE QUESTION IS: ARE THERE ENOUGH GRADUATES FROM NE OHIO YEAR TO MEET THE DEMAND FOR ENTRY-LEVEL DEMAND FOR MANUFACTURING TECHNOLOGY AND ENGINEERING WORKERS? IF NOT, WHICH SPECIFIC OCCUPATIONS HAD THE LARGEST NUMERIC GAP?

- The NE Ohio Skills Gap between demand and supply analysis focused ***only*** on demand for ***entry-level*** new hires.
- Supply is the annual supply of grads from programs that imbue completers with skills employers now demand. NEO postsecondary education and training organizations are the source of grads.
- The gap can be one of quantity (grads) or quality (specific major), or both.

The region's capacity for improving an existing and emergent workforce comes from the entities that make up our education and workforce systems: postsecondary education (especially colleges and universities); vocational and technical training centers; the public workforce system (funded by federal and state resources); economic development organizations; and other major efforts to support talent development.

Greater alignment and partnership among these regional workforce development partners is vital to hastening the pace that improves workforce quality for the employer.

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Entry-level vs Mid-level Demand to Hire for Production Jobs

As expected, these jobs when broken down by occupation, reveal that many are predominately entry-level; meaning no extensive prior work experience is required.

However, there are exceptions as is evident from the data. Clearly this has much to do with skills employers are demanding; skills which often are learned in prior work experiences, more so than in formal education or training programs.

Entry-level Job Postings for Maintenance, Repair & Installation Workers

In contrast to Production jobs, greater shares of postings are for entry-level workers.

Technical training specific to many of these specific types of job assignments is well known and may be more important to employers when deciding who to hire.

The exceptions to this might be Maintenance Technician and Maintenance/ Service Supervisor given the strong preference of employers to hire experienced workers.

NE Ohio: Entry-level Job Postings for Production Workers from Manufacturers				
	Entry-level = 0 to 2 Years of Prior Work Experience	Work Experience		
BGTOCC Code	BGTOCC	3 years +	0 to 2 years	% Entry-Level
		Job Postings		
51101191	Production Supervisor	292	80	27.4%
51901292	Manufacturing Machine Operator	228	177	77.6%
51919900	Production Worker	194	140	72.2%
51404100	Machinist	180	58	32.2%
11305101	Quality Control Systems Managers	170	21	12.4%
51906100	Quality Inspector / Technician	152	51	33.6%
51101192	Production Plant Manager	132	12	9.1%
51404191	CNC Operator	80	39	48.8%
19409901	Quality Control Analyst	73	43	58.9%
51411100	Tool and Die Maker	61	13	21.3%
51202200	Electronic / Electrical Assembler	48	29	60.4%
51403100	Press / Press Brake Operator	38	30	78.9%
51407291	Molding / Casting Worker	34	19	55.9%
51401200	CNC Programmer	29	6	20.7%
51403300	Grinder / Sharpener	19	9	47.4%
51511200	Printing Press Operator	15	11	73.3%
51901100	Chemical Operator	8	4	50.0%
Source: Labor Insight Jobs (Burning Glass Technologies)				

NE Ohio: Entry-level Job Postings for Maintenance, Repair, & Installation Workers from Manufacturers				
	Entry-level = 0 to 2 Years of Prior Work Experience	Work Experience		
BGTOCC Code	BGTOCC	3 years +	0 to 2 years	% Entry-Level
		Job Postings		
BGTOCC Code	BGTOCC	Job Postings		
49907191	Maintenance Technician	312	78	25.0%
49101100	Maintenance / Service Supervisor	142	16	11.3%
49907192	<i>Field Service Technician</i>	57	27	47.4%
49909900	<i>Repair / Service Technician</i>	55	25	45.5%
49904100	<i>Industrial Mechanic</i>	40	18	45.0%
49302300	<i>Automotive Service Technician / Mechanic</i>	25	14	56.0%
49904400	Millwright	20	4	20.0%
49209400	<i>Electrical Tester / Technician</i>	18	7	38.9%
49902100	HVAC Mechanic / Installer	14	2	14.3%
	Total	683	191	28.0%
Source: Labor Insight Jobs (Burning Glass Technologies)				

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

The importance of these findings is that very different strategies are needed by educators if they are to help with providing experienced workers with the additional education needed to prepare them for these jobs in NE Ohio manufacturing.

Entry-level Job Postings for Engineering Occupations

In addition to education, prior work experience generally is more important for engineer jobs than for engineering technologists or technicians.

Still, there are hundreds of entry-level jobs posted during 2016 in both categories of engineering expertise from manufacturers.

NE Ohio: Entry-Level Jobs Across All Engineering Occupations Most In-Demand, 2016					
	Entry Level=0 to 2 Years of Prior Work Experience	Years of Experience			
	Total Jobs Posted=6268	0 to 2		All Ads Listing Work Experience	
BGTOCC Code	BGTOCC	Job Postings		#	Entry-Level as % Of All
		#	%		
17214100	Mechanical Engineer	282	19.6%	1,349	20.9%
17207100	Electrical Engineer	185	12.9%	835	22.2%
17219904	Manufacturing Engineer	160	11.1%	885	18.1%
17211200	Industrial Engineer	141	9.8%	663	21.3%
17204100	Chemical / Process Engineer	113	7.9%	436	25.9%
17302300	General / Electrical Engineering Technician	82	5.7%	184	44.6%
17219902	Validation Engineer	70	4.9%	290	24.1%
17302909	Manufacturing / Production Technician	60	4.2%	125	48.0%
11904100	Engineering Manager	60	4.2%	522	11.5%
17302700	Industrial / Mechanical Engineering Technician	41	2.8%	93	44.1%
17211100	Health and Safety Engineer	35	2.4%	147	23.8%
17205100	Civil Engineer	34	2.4%	101	33.7%
17301900	CAD Designer / Drafter	31	2.2%	65	47.7%
17301300	Mechanical / Electrical Drafter	30	2.1%	86	34.9%
17213100	Materials Engineer	29	2.0%	136	21.3%
27102191	Product Development Engineer	17	1.2%	91	18.7%
17301200	Electrical / Electronic Designer	10	0.7%	29	34.5%
17206100	Hardware Engineer	9	0.6%	17	52.9%
17301102	Civil / Architectural Designer / Drafter	7	0.5%	14	50.0%
17208100	Environmental Engineer	7	0.5%	31	22.6%
17302902	Engineering Technologist	7	0.5%	43	16.3%
17302400	Test Technician	4	0.3%	13	30.8%
17207291	Electronics Engineer	4	0.3%	30	13.3%
Source: Labor Insight Jobs (Burning Glass Technologies)					

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

What could be accomplished if the postsecondary education and training systems in NE Ohio were producing completers and grads in the *programs that best prepare them for skills in demand*? Enrollment, retention and completion numbers for programs that produce too few or too many completers that align with required skills for these jobs only worsen the situation. Do existing regional manufacturing and engineering programs adequately cover critical new skills employers want?

Until now, NE Ohio has had no hard data capable of assessing the nature and degree of poor alignment of existing programs and the gap that worsens due to learning outcomes that fail to keep pace with skill requirements.

Gaps are assumed on the basis of large numbers of jobs in demand, and anecdotal evidence from employers of their difficulty in hiring from within the region, and maybe from elsewhere.

NE Ohio: Entry-level Job Postings for Production Workers from Manufacturers				
	Entry-level = 0 to 2 Years of Prior Work Experience	Work Experience		
BGTOCC Code	BGTOCC	3 years +	0 to 2 years	% Entry-Level
		Job Postings		
51101191	Production Supervisor	292	80	27.4%
51901292	Manufacturing Machine Operator	228	177	77.6%
51919900	Production Worker	194	140	72.2%
51404100	Machinist	180	58	32.2%
11305101	Quality Control Systems Managers	170	21	12.4%
51906100	Quality Inspector / Technician	152	51	33.6%
51101192	Production Plant Manager	132	12	9.1%
51404191	CNC Operator	80	39	48.8%
19409901	Quality Control Analyst	73	43	58.9%
51411100	Tool and Die Maker	61	13	21.3%
51202200	Electronic / Electrical Assembler	48	29	60.4%
51403100	Press / Press Brake Operator	38	30	78.9%
51407291	Molding / Casting Worker	34	19	55.9%
51401200	CNC Programmer	29	6	20.7%
51403300	Grinder / Sharpener	19	9	47.4%
51511200	Printing Press Operator	15	11	73.3%
51901100	Chemical Operator	8	4	50.0%
Source: Labor Insight Jobs (Burning Glass Technologies)				

NE Ohio: Entry-level Job Postings for Maintenance, Repair, & Installation Workers from Manufacturers				
	Entry-level = 0 to 2 Years of Prior Work Experience	Work Experience		
BGTOCC Code	BGTOCC	3 years +	0 to 2 years	% Entry-Level
		Job Postings		
BGTOCC Code	BGTOCC	Job Postings		
49907191	Maintenance Technician	312	78	25.0%
49101100	Maintenance / Service Supervisor	142	16	11.3%
49907192	<i>Field Service Technician</i>	57	27	47.4%
49909900	<i>Repair / Service Technician</i>	55	25	45.5%
49904100	<i>Industrial Mechanic</i>	40	18	45.0%
49302300	<i>Automotive Service Technician / Mechanic</i>	25	14	56.0%
49904400	Millwright	20	4	20.0%
49209400	<i>Electrical Tester / Technician</i>	18	7	38.9%
49902100	HVAC Mechanic / Installer	14	2	14.3%
	Total	683	191	28.0%
Source: Labor Insight Jobs (Burning Glass Technologies)				

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

SKILLS GAP AT BACHELORS LEVEL

Typically, Bachelor degrees are required or preferred by employers for Engineer jobs.

The findings are clear: some but not all Engineer occupations have greater job openings for entry-level workers than NEO are graduating annually from engineering programs.

Top of the list in terms of the number of entry-level postings is *Mechanical Engineer*; it is followed by *Electrical, Civil, and Industrial Engineers*. Last on the list is *Manufacturing Engineer*.

The remaining engineer occupations in the table are experiencing much smaller numerical gaps between demand and supply.

In all, the demand for entry-level engineers in 2015 was 1029 while the graduates during the same year from NEO engineering programs that prepare students generally for these specific professions totaled only 290.

NE Ohio Manufacturing & Engineering Occupations: Entry-level Ads Are More Than Twice the Number of Grads with Bachelors, Year 2015			
Entry-level = 0 to 2 Years of Work Experience			
Grads from Bachelors Programs in Ratio to Openings Preferring a Bachelors			
BGTOcc		Numbers Gap	
		Jobs Postings	Annual Grads
Under Supply of Graduates from Bachelors Programs			
	Engineering		
17-2141.00	Mechanical Engineer	244	50
17-2071.00	Electrical Engineer	185	17
17-2051.00	Civil Engineer	153	49
17-2112.00	Industrial Engineer	103	71
17-2199.04	Manufacturing Engineer	96	53
17-3013.00	Mechanical / Electrical Drafter	62	0
17-2131.00	Materials Engineer	51	30
17-2111.00	Health and Safety Engineer	39	3
17-3019.00	CAD Designer / Drafter	34	0
17-3023.00	General / Electrical Engineering Technician	31	11
17-2061.00	Hardware Engineer	30	6
	Total	1029	290
	Production		
51-9061.00	Quality Inspector / Technician	137	0
51-1011.91	Production Supervisor	92	9
51-9012.92	Manufacturing Machine Operator	32	0
51-4041.91	CNC Operator	6	1
51-4012.00	CNC Programmer	4	2
51-4111.00	Tool and Die Maker	2	0
51-9011.00	Chemical Operator	1	0
	Total	274	12
	installation/Maintenance and Repair		
49-9062.00	Biomedical Equipment Technician	3	0
49-2094.00	Electrical Tester / Technician	9	7
49-2091.00	Avionics Technician	2	0
49-2022.00	Satellite / Broadband Technician	3	0
49-1011.00	Maintenance / Service Supervisor	55	9
	Total	72	16

Clearly a substantial under supply of graduates in engineering are emerging from higher education. This would be the case even if all grads were employed in NE Ohio.

Aside from engineer professionals, there is some demand for entry-level engineering technologists or technicians with a Bachelors degree. *Mechanical / Electrical Drafter* and *CAD Designer/ Drafter* stand out. Virtually no program in NEO is producing grads from programs that prepare students for these jobs now.

Why so many ads for engineering occupations?

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Official projections for engineering jobs by manufacturers were quite anemic comparatively as reported earlier. Notices of potential intent to hire new workers, however, capture much more than the need for employers to add new positions. These ads include the need to replace workers who have retired, left the company altogether, or who have taken a different job within the company. The numbers reported also include industry needs beyond manufacturing which only accounted for 60% of all such jobs in 2016.

From the perspective of employers and the higher education system, these data are the best indication available of the likely number of hires that occur.

A BACHELOR DEGREE FOR FACTORY FLOOR WORKERS?

A shortage of Bachelors awarded in programs that prepare them for a few jobs in *Production or Maintenance, Repair, & Installation* occupations appears to exist. *Quality Inspector/ Technician* has the largest numerical gap. *Production Supervisor* is second. Both jobs have more postings wanting a Bachelors rather than a Certificate or Associate degree.

Only discussion with employers can provide further insight into what level of education versus skills training applies and why, what specific skills and knowledge is developed during completion of either an Associate or Bachelors program, and what specific program of study can best prepare students. No programs are being offered at the Bachelors level with these jobs in mind.

With demand so small, this discussion may be an anomaly.

Skills Gap at Certificate/ Associate Level

Only jobs for Engineering Technologists/ Technicians; Production; and Maintenance, Repair & Installation are experiencing shortages in supply of completers from certificate or Associate degree programs designed to prepare students for these jobs.

Interpreting the results of matching supply of completers with jobs in demand that are entry-level (which is most) is more complicated due to employers that stipulate that a high school credential is minimally acceptable to apply.

As discussed earlier, though, the more skilled these jobs are, the more technical education and training is needed by applicants. This can be completed during or after high school; even completed at adult career centers as non-credit credentials.

This is more as issue for jobs in *Maintenance, Repair and Installation* where job ads are predominantly seeking applicants with no more than high school credentials.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Prior work experience of three or more years is stipulated in job ads almost half the time, however, for these occupations. This may be how employers are ensuring that skilled workers apply, rather than by formal

NE Ohio: Manufacturing Occupations: Entry-level Ads Are More Than Twice the Number of Grads with High School, Certificate or Associate Dereee, 2015				
Entry-level = 0 to 2 Years of Work Experience				
	Certificate/ Associate Programs Grads in Ratio to Postings for Less than Bachelor's			
BGTOcc	BG Occupation Title	Numbers Gap		
		Demand		Supply
		High School	Certificates/ Associate's	Total Certificates and Associates
Under supply of Certificate or Associate Degrees				
	Engineering			
17-3029.09	Manufacturing / Production Technician	95	36	24
17-3023.00	General / Electrical Engineering Technician	68	77	39
17-3013.00	Mechanical / Electrical Drafter	33	59	27
17-3027.00	Industrial / Mechanical Engineering Technician	29	9	24
17-3019.00	CAD Designer / Drafter	16	47	27
		240	229	141
19-4099.01	Quality Control Analyst	59	23	47
47-2073.00	Operating Engineer / Heavy Equipment Operator	33	0	0
	Installation, Maintenance and Repair			
49-9071.91	Maintenance Technician	980	89	34
49-3031.00	Diesel Mechanic	375	3	101
49-9071.92	Field Service Technician	124	98	59
49-2022.00	Satellite / Broadband Technician	116	24	0
49-9041.00	Industrial Mechanic	80	3	3
49-3011.00	Aircraft / A & P Mechanic	69	0	0
49-2098.00	Alarm / Security System Technician	27	7	0
49-9062.00	Biomedical Equipment Technician	20	18	2
49-2097.00	Television / Satellite Television Installer	15	7	0
49-9012.00	Controls / Valve Technician	10	6	3
49-2091.00	Avionics Technician	8	0	0
49-9044.00	Millwright	5	0	3
49-9081.00	Wind Turbine Technician	4	2	3
		1833	257	208
	Production			
51-9012.92	Manufacturing Machine Operator	1015	26	0
51-9061.00	Quality Inspector / Technician	301	36	1
51-2022.00	Electronic / Electrical Assembler	170	0	38
51-4041.00	Machinist	160	8	18
51-4041.91	CNC Operator	151	7	24
51-1011.91	Production Supervisor	112	17	7
51-4033.00	Grinder / Sharpener	55	0	0
51-4111.00	Tool and Die Maker	39	6	17
51-4012.00	CNC Programmer	28	2	12
51-9011.00	Chemical Operator	27	0	2
51-1011.92	Production Plant Manager	6	2	5
		2064	104	Sh

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

training per se. Whatever the case, the skills gap analysis demonstrates greater demand for postsecondary education and training completers on an annual basis than are currently being produced within NEO.

Engineering Technologists/ Technicians

- Manufacturing/ Production Technician
- General/ Electrical Engineering Technician
- Mechanical/ Electrical Drafter

Maintenance, Repair and Installation Workers

- Maintenance Technician
- Field Service Technician

Production Workers

- Quality Inspector/ Technician
- Electronic/ Electrical Assembler
- Machinist

Supply of Recent Grads to Meet Demand for Manufacturing and Engineering Workers

This list of education and training providers produced completions in one or more program of study designed to prepare students to pursue careers in Manufacturing or Engineering.

NE Ohio: Grads from Manufacturing and Engineering Programs in 2015 by Institution	
Institution	
Auburn Career Center	Lorain County Community College
Baldwin Wallace University	Lorain County Joint Vocational School District
Canton City Schools Adult Career and Technical Education	Medina County Career Center
Case Western Reserve University	Notre Dame College
Cleveland State University	Oberlin College
Community Services Division-Alliance City	Ohio State University Agricultural Technical Institute
Cuyahoga Community College District	Ohio Technical College
Fortis College-Cuyahoga Falls	Ohio Technical College-PowerSport Institute
Fortis College-Cuyahoga Falls	Polaris Career Center
Fortis College-Ravenna	Portage Lakes Career Center
Hiram College	Remington College-Cleveland Campus
ITT Technical Institute-Akron	Stark State College
ITT Technical Institute-Strongsville	The College of Wooster
ITT Technical Institute-Warrensville Heights	University of Akron Main Campus
John Carroll University	University of Mount Union
Kent State University at Kent	Ursuline College
Lakeland Community College	Vatterott College-Cleveland
	Walsh University

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NEO SUPPLY OF RECENT GRADS FROM MAJORS MATCHED TO MANUFACTURING WORKERS AND ENGINEERING PROFESSIONALS AND TECHNOLOGISTS/ TECHNICIANS

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential								
CIP Code	CipTitle	DegreeLevel						Total % of All
		Cert.		Assoc	Bach.	Mas.	Phd	
		< 2 yrs.	2 yrs +					
	Engineering							
14.01	General Engineering							
14.0101	Engineering, General.	6		4	5	8	9	2.3%
14.0102	Pre-Engineering.							
14.02	Aerospace, Aeronautical and Astronautical Engineering.							
14.0201	Aerospace, Aeronautical and Astronautical/Space Engineering.			0	26	4		2.1%
14.05	Biomedical/Medical Engineering.							
14.0501	Bioengineering and Biomedical Engineering				129			9.1%
14.07	Chemical Engineering							
14.0701	Chemical Engineering.	33			112	21	21	13.2%
14.0702	Chemical and Biomolecular Engineering.							
14.0799	Chemical Engineering, Other.							
14.08	Civil Engineering							
14.0801	Civil Engineering, General.				91	47	16	10.9%
14.0803	Structural Engineering.							
14.0899	Civil Engineering, Other.							
14.09	Computer Engineering							
14.0901	Computer Engineering, General.				56	2	4	4.4%
14.0902	Computer Hardware Engineering.							
14.0903	Computer Software Engineering.					16	4	1.4%
14.0999	Computer Engineering, Other.							
14.10	Electrical, Electronics and Communications Engineering.							
14.1001	Electrical and Electronics Engineering	6			102	147	13	18.9%
14.1004	Telecommunications Engineering.							
14.1004	Telecommunications Engineering.							
14.18	Materials Engineering.				7	11	2	1.4%
14.19	Mechanical Engineering			17	268	48	13	24.5%
14.20	Metallurgical Engineering.							
14.27	Systems Engineering.				4	1	3	0.6%
14.32	Polymer/Plastics Engineering				16	33	21	4.9%
14.33	Construction Engineering.			5				0.4%
14.35	Industrial Engineering.				18	13		2.2%
14.36	Manufacturing Engineering.							
14.37	Operations Research					47		3.3%
14.42	Mechatronics, Robotics, and Automation Engineering			2				0.1%
14.43	Biochemical Engineering.							
14.44	Engineering Chemistry.							
14.45	Biological/Biosystems Engineering.							
14.99	Engineering, Other.			4				0.3%
	Total All Engineering Completions (1415)	45		32	834	398	106	1415

In this section, what is known about the supply from the region's postsecondary education and training sources are documented for the most recent year for which data is available, 2015, by nature of program or major and level of completion.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Several sources of data analysis are included:

- Cross-walk that matches postsecondary majors to Occupations in which completers are qualified to apply, based on proprietary source from Burning Glass Technologies
- Completers from postsecondary institutions located in the NE Ohio region, by level of completion for 2015, the most recent year for data, based on data from IPEDs which includes names of institutions and detailed completion data for all majors (CIPS).
- All data are targeted on occupations noted above.

Across all levels of completion, *Mechanical, Electrical and Electronic, Chemical, and Civil engineering* programs produced the largest numbers in 2015.

Engineering Technologies/ Technicians Programs

The large number of Associate degree grads from Automotive Engineering Technology/ Technician *Electrical, Electronic, and Communications Technology/ Technician* programs account for 25% and 13%, respectively, of all awards in 2015 from *Engineering Technologies/ Technicians* programs across all levels of completions and specializations.

HVAC is the only other program with as much as 9% of all grads. Significance by absence of performance (given occupations with shortages of supply) are:

- Quality Control and Safety Technologies/ Technicians
- Drafting/ Design Engineering Technologies/ Technicians
- Electromechanical Instrumentation and Maintenance Technologies/ Technicians
- Industrial Production Technologies/ Technicians

Mechanic and Repair Technologies/ Technicians

Much of the supply of new talent in this sector is motor vehicle related, having nothing to do with jobs from manufacturers. Only Electrical/ Electronic Maintenance and Repair Technology has many certificate completers (159). This is not of much help to manufacturers seeking Maintenance Technicians or Field Service Technicians.

In general, it appears that there is little alignment between the skills training that manufacturers need and what currently is being offered in NEO.

Precision Production

While the numbers of short term completers of Welding are high, little education and training is being provided despite significant demand for certain production workers as discussed.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential								
CIP Code	CipTitle	DegreeLevel						Total % of All
		Cert.		Assoc	Bach.	Mas.	Phd	
		< 2 yrs.	2 yrs +					
	Engineering Technologies/ Technician							
15	Engineering Technology, General				57			4.8%
15.02	Civil Engineering Technology/Technician							
15.0201	Civil Engineering Technology/Technician			14				1.2%
15.03	Electrical, Electronic and Communications Engineering Technology/Technician.							
15.0303	Electrical, Electronic and Communications Engineering Technology/Technician.	5		115	33			12.9%
15.0305	Telecommunications Technology/Technician							
15.0306	Integrated Circuit Design.							
15.0399	Electrical and Electronic Engineering Technologies/Technicians			11	8			1.6%
15.04	Electromechanical Instrumentation and Maintenance Technologies/Technicians.							
15.0401	Biomedical Technology/Technician.			2				0.2%
15.0403	Electromechanical Technology/Electromechanical Engineering Technology.							
15.0404	Instrumentation Technology/Technician.			2				0.2%
15.0405	Robotics Technology/Technician	2						0.2%
15.0499	Electromechanical and Instrumentation and Maintenance Technologies/Technicians, Other.							
15.05	Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology/Technician.							
15.0501	Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology/Technician.	90		19				9.2%
15.0503	Energy Management and Systems Technology/Technician	12		15				2.3%
15.0507	Environmental Engineering Technology/Environmental Technology.			7				0.6%
15.06	Industrial Production Technologies/Technicians.							
15.0611	Metallurgical Technology/Technician.							
15.0612	Industrial Technology/Technician.	35		6				3.4%
15.0613	Manufacturing Engineering Technology/Technician.	3		28	9			3.4%
15.0615	Chemical Engineering Technology/Technician.	2						0.2%
15.0699	Industrial Production Technologies/Technicians, Other.	3						0.3%
15.07	Quality Control and Safety Technologies/Technicians.							
15.0702	Quality Control Technology/Technician.	1						0.1%
15.0703	Industrial Safety Technology/Technician.							
15.0799	Quality Control and Safety Technologies/Technicians, Other.	1						0.1%

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential					
CIP Code	CipTitle	DegreeLevel		Assoc	% of All
		Cert.			
		< 2 yrs.	2 yrs +		
	MECHANIC AND REPAIR TECHNOLOGIES/ TECHNICIANS				
47.01	<i>Electrical/Electronics Maintenance and Repair Technology</i>				
47.0103	Electrical/Electronics Maintenance and Repair Technology	13			1.0%%
47.0105	Communications Systems Installation and Repair Technology.				
47.011	Industrial Electronics Technology/Technician.				
47.0199	Security System Installation, Repair, and Inspection Technology/Technician.	50			3.9%
47.02	<i>Electrical/Electronics Maintenance and Repair Technology</i>				
47.0201	Electrical/Electronics Maintenance and Repair Technology, Other.	159		3	12.6%
47.03	<i>Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician.</i>				
47.0303	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician.	1		7	0.6%
47.06	<i>Industrial Mechanics and Maintenance Technology.</i>		33	39	5.6%
47.0603	Vehicle Maintenance and Repair Technologies, General.	10	66		5.9%
47.0604	Autobody/Collision and Repair Technology Technician	173	67	32	21.2%
47.0605	Automobile/Automotive Mechanics Technology/Technician.				
47.0607	Diesel Mechanics Technology/Technician.				
47.0608	Airframe Mechanics and Aircraft Maintenance Technology/Technician.				
47.0609	Aircraft Powerplant Technology/Technician.				
47.0611	Avionics Maintenance Technology/Technician.	21	38	30	6.9%
47.0612	Motorcycle Maintenance and Repair Technology/Technician.				
47.0613	Vehicle Emissions Inspection and Maintenance Technology/Technician.		62	39	7.9%
47.0614	Medium/Heavy Vehicle and Truck Technology/Technician.				
47.0616	Alternative Fuel Vehicle Technology/Technician.				
47.0617	Marine Maintenance/Fitter and Ship Repair Technology/Technician.	3	3	12	1.4%
47.0618	High Performance and Custom Engine Technician/Mechanic				
47.0699	Recreation Vehicle (RV) Service Technician.				
47.99	<i>Vehicle Maintenance and Repair Technologies, Other.</i>				
47.9999	Vehicle Maintenance and Repair Technologies, Other.				
	Mechanic and Repair Technologies/Technicians, Other.				
	Precision Production				
48.05	<i>Precision Metal Working</i>				
48.0501	Machine Tool Technology/Machinist.	35		1	2.8%
48.0503	Machine Shop Technology/Assistant.	27			2.1%
48.0506	Sheet Metal Technology/Sheetworking.				
48.0507	Tool and Die Technology/Technician.				
48.0508	Welding Technology/Welder	358		2	28.0%
	Total	850	269	165	1,284

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential								
CIP Code	CipTitle	DegreeLevel						Total % of All
		Cert.		Assoc	Bach.	Mas.	Phd	
		< 2 yrs.	2 yrs +					
	Engineering Technologies/ Technician							
15.08	Mechanical Engineering Related Technologies/Technicians.							
15.0801	Aeronautical/Aerospace Engineering Technology/Technician.							
15.0803	Automotive Engineering Technology/Technician.	246		55				25.3%
15.0805	Mechanical Engineering/Mechanical Technology/Technician.	13		56	50			10.0%
15.0899	Mechanical Engineering Related Technologies/Technicians, Other.				13			1.1%
15.0899	Mechanical Engineering Related Technologies/Technicians, Other.							
15.09	Mining and Petroleum Technologies/Technicians.							
15.0903	Petroleum Technology/Technician	27		13				3.4%
15.10	Construction Engineering Technologies.							
15.1001	Construction Engineering Technology/Technician	20		33	27			6.7%
15.11	Engineering Related Technologies							
15.1102	Surveying Technology/Surveying	10		6	10			2.2%
15.1103	Hydraulics and Fluid Power Technology/Technician	2		1				0.3%
15.12	Computer Engineering Technologies/Technicians.							
15.1201	Computer Engineering Technology/Technician.							
15.1203	Computer Hardware Technology/Technician.							
15.1204	Computer Software Technology/Technician.							
15.1299	Computer Engineering Technologies/Technicians, Other.			7				0.6%
15.13	Drafting/Design Engineering Technologies/Technicians.							
15.1301	Drafting and Design Technology/Technician, General.	6		37				3.6%
15.1302	CAD/CADD Drafting and/or Design Technology/Technician.	19						1.6%
15.1303	Architectural Drafting and Architectural CAD/CADD.			4				0.3%
15.1304	Civil Drafting and Civil Engineering CAD/CADD.	2						0.2%
15.1305	Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD.							
15.1306	Mechanical Drafting and Mechanical Drafting CAD/CADD.	13						1.1%
15.1399	Drafting/Design Engineering Technologies/Technicians, Other.							
15.15	Engineering Related Fields							
15.1501	Engineering/Industrial Management.							
15.1503	Packaging Science.							
15.99	All other							
15.9999	Engineering Technologies and Engineering-Related Fields, Other.	26		14				3.4%
	Total Engineering Technologies (1190)	538		445	207			100.0%

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Do Some Majors Better Prepare Students for Specific Occupations?

In this section, all programs of study that generally prepare students to perform duties of select occupations with skill gaps are presented.

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential							
CIP Code	CIP Title						BGTOcc
		DegreeLevel					
		Cert.	Assoc	Bach.	Mas.	Phd	
ENGINEERING PROFESSIONALS							
<i>Mechanical Engineer</i>							17-2141.00
14.0101	Engineering, General.			X			
14.0102	Pre-Engineering.			X			
14.1901	Mechanical Engineering.			X	X		
14.9999	Engineering, Other.			X			
15.9999	Engineering Technologies and Engineering-Related Fields, Other.			X			
Engineering Technologist/ Technician							
<i>Industrial / Mechanical Engineering Technician</i>							17-3027.00
15.0403	Electromechanical Technology/Electromechanical Engineering Technology.	X	X	X			
15.0404	Instrumentation Technology/Technician.	X	X	X			
15.0611	Metallurgical Technology/Technician.	X	X	X			
15.0612	Industrial Technology/Technician.	X	X	X			
15.0613	Manufacturing Engineering Technology/Technician.	X	X	X			
15.0615	Chemical Engineering Technology/Technician.	X	X	X			
15.0699	Industrial Production Technologies/Technicians, Other.	X	X	X			
15.0801	Aeronautical/Aerospace Engineering Technology/Technician.	X	X	X			
15.0805	Mechanical Engineering/Mechanical Technology/Technician.	X	X	X			
15.0899	Mechanical Engineering Related Technologies/Technicians, Other.	X	X	X			
47.0105	Industrial Electronics Technology/Technician.	X	X	X			

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Manufacturing Engineer

NE Ohio: Program Majors with Strong Match with Selected Occupations by Level of Credential							
CIP6Code	CipTitle						BGTOcc
		DegreeLevel					
		Cert.	Assoc	Bach.	Mas.	Phd	
ENGINEERING PROFESSIONALS							
Manufacturing Engineer							17-2199.04
14.0101	Engineering, General.			X			
14.0102	Pre-Engineering.			X			
14.1901	Mechanical Engineering.			X	X		
14.2701	Systems Engineering.			X	X		
14.3501	Industrial Engineering.			X	X		
14.3601	Manufacturing Engineering.			X	X		
14.9999	Engineering, Other.			X			
15.9999	Engineering Technologies and Engineering-Related Fields, Other.			X			
Engineering Technologist/ Technician							
Manufacturing / Production Technician							17-3029.09
15.0403	Electromechanical Technology/Electromechanical Engineering Technology.	X	X				
15.0404	Instrumentation Technology/Technician.	X	X				
15.0611	Metallurgical Technology/Technician.	X	X				
15.0612	Industrial Technology/Technician.	X	X				
15.0613	Manufacturing Engineering Technology/Technician.	X	X				
15.0615	Chemical Engineering Technology/Technician.	X	X				
15.0699	Industrial Production Technologies/Technicians, Other.	X	X				
15.0801	Aeronautical/Aerospace Engineering Technology/Technician.	X	X				
15.0805	Mechanical Engineering/Mechanical Technology/Technician.	X	X				
15.0899	Mechanical Engineering Related Technologies/Technicians, Other.	X	X				
47.0105	Industrial Electronics Technology/Technician.	X	X				

This is one of the engineer jobs with a numeric skills gap—too few grads from any of the engineering majors at the Bachelor's level. Do employers prefer hiring entry-level grads with a major in manufacturing engineering? If so, the problem is more than numeric; it is also qualitative. No one graduated with this major in NEO during 2015.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential							
CIP Code	CIP Title						BGTOcc
		DegreeLevel					
		Cert.	Assoc	Bach.	Mas.	Phd	
ENGINEERING PROFESSIONALS							
Industrial Engineer							17-2112.00
14.1901	Mechanical Engineering.			X			
14.3501	Industrial Engineering.			X	X		
14.3601	Manufacturing Engineering.			X	X		
15.0703	Industrial Safety Technology/Technician.			X			
15.1503	Packaging Science.			X	X		
50.0404	Industrial and Product Design.			X	X		
50.0404	Industrial and Product Design.						
Engineering Technologist/ Technician							
Industrial / Mechanical Engineering Technician							17-3027.00
15.0403	Electromechanical Technology/Electromechanical Engineering Technology.	X	X	X			
15.0404	Instrumentation Technology/Technician.	X	X	X			
15.0611	Metallurgical Technology/Technician.	X	X	X			
15.0612	Industrial Technology/Technician.	X	X	X			
15.0613	Manufacturing Engineering Technology/Technician.	X	X	X			
15.0615	Chemical Engineering Technology/Technician.	X	X	X			
15.0699	Industrial Production Technologies/Technicians, Other.	X	X	X			
15.0801	Aeronautical/Aerospace Engineering Technology/Technician.	X	X	X			
15.0805	Mechanical Engineering/Mechanical Technology/Technician.	X	X	X			
15.0899	Mechanical Engineering Related Technologies/Technicians, Other.	X	X	X			
47.0105	Industrial Electronics Technology/Technician.	X	X	X			

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

NE Ohio: Program Majors with Strong Match with Occupations in Manufacturing and Engineering by Level of Credential							
CIP6Code	CipTitle						BGTOcc
		DegreeLevel					
		Cert.	Assoc	Bach.	Mas.	Phd	
ENGINEERING PROFESSIONALS							
Electrical Engineer							17-2071.00
14.0101	Engineering, General.			X			
14.0102	Pre-Engineering.			X			
14.1001	Electrical and Electronics Engineering			X	X		
14.1004	Telecommunications Engineering.			X	X		
14.1099	Electrical, Electronics and Communications Engineering, Other.			X	X		
14.9999	Engineering, Other.			X			
15.9999	Engineering Technologies and Engineering-Related Fields, Other.			X			
Engineering Technologist/ Technician							
Electrical / Electronic Designer; Test Technician; and Mechanical / Electrical Drafter							17-3012.00
14.1001	Electrical and Electronics Engineering			X			
14.1004	Telecommunications Engineering.			X			
14.1099	Electrical, Electronics and Communications Engineering, Other.			X			
15.0303	Electrical, Electronic and Communications Engineering Technology/Technician.		X				
15.0305	Telecommunications Technology/Technician.		X				
15.0306	Integrated Circuit Design.		X				
15.0399	Electrical and Electronic Engineering Technologies/Technicians, Other.		X				
15.0611	Metallurgical Technology/Technician.	X	X				
15.0612	Industrial Technology/Technician.	X	X				
15.0613	Manufacturing Engineering Technology/Technician.	X	X				
15.0615	Chemical Engineering Technology/Technician.	X	X				
15.0699	Industrial Production Technologies/Technicians, Other.	X	X				
15.1201	Computer Engineering Technology/Technician.		X				
15.1203	Computer Hardware Technology/Technician.		X				
15.1204	Computer Software Technology/Technician.		X				
15.1299	Computer Engineering Technologies/Technicians, Other.		X				
15.1301	Drafting and Design Technology/Technician, General.		X				
15.1302	CAD/CADD Drafting and/or Design Technology/Technician.		X				
15.1303	Architectural Drafting and Architectural CAD/CADD.		X				
15.1304	Civil Drafting and Civil Engineering CAD/CADD.		X				
15.1305	Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD.		X				
15.1306	Mechanical Drafting and Mechanical Drafting CAD/CADD.		X				
15.1399	Drafting/Design Engineering Technologies/Technicians, Other.		X				
47.0105	Industrial Electronics Technology/Technician.	X	X				

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

SKILLS GAP FOR EXPERIENCED, MID-LEVEL, WORKERS

New postsecondary completers are not the likely source of applicants for mid- and senior-level applicants.

- The supply of experienced workers with the appropriate educational credentials and evidence of needed skill sets is largely met by those already employed—employers primarily seek to hire from a pool of workers already employed, although for someone else, or promote from within.
- The supply is augmented by the ability of employers to search for workers outside of NEO.
- Experienced workers are less likely to be recent graduates from NEO institutions.

Those numbers bear out a broader trend bedeviling manufacturing: the demand is for skilled workers, not traditional assembly line workers, and those skilled workers are in shorter supply. Based on analysis of data from both the Bureau of Labor Statistics and Burning Glass, there are 16 general production workers for each vacancy, but the ratio for skilled production workers is only 7-to-1. In certain specialties, such as avionics technicians and CNC programmers, the ratio drops to 5-to-1. Those are not skills that can be picked up overnight, so employers will likely need to consider how they develop talent and partner with training institutions to come up with a long-term fix.

Concentration of Production Postings			
	Low	Medium	High
Concentration of Software Postings	High	District of Columbia Virginia Maryland	Delaware Colorado Massachusetts Washington California New Jersey
	Medium	New York	Arizona Georgia Illinois North Carolina
	Low	Texas Hawaii Florida Missouri Louisiana Mississippi New Mexico Nevada West Virginia Oklahoma Wyoming Alaska	Ohio Alabama Rhode Island Kansas Pennsylvania Idaho Maine South Carolina Kentucky Vermont North Dakota Montana Tennessee
			Connecticut Oregon Minnesota Michigan Utah South Dakota Iowa New Hampshire Indiana Nebraska Arkansas Wisconsin

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Advances in Technology and the Impacts on Manufacturing

The digital revolution and Industrial 4.0⁵ presents both opportunities and challenges to manufacturing globally. It is important to know how the NE Ohio manufacturing sector is responding and to track evidence of how these global forces are impacting the future of work in NE Ohio.

According to McKinsey & Company, which has been tracking these trends for several years,

“The explosion in data and new computing capabilities—along with advances in other areas such as artificial intelligence, automation and robotics, additive technology, and human-machine interaction—are unleashing innovations that will change the nature of manufacturing itself.”⁶

Digital manufacturing centers around a computer system. It requires quantity and quality computer systems in manufacturing plants. It has the same goals as computer-integrated manufacturing (CIM), flexible or lean manufacturing, and design for manufacturing (DFM). The main difference is that digital manufacturing was evolved for use in the computerized world.⁷

“A basket of digitally-enabled technologies that include 3-D printing, robotics, and adaptive CNC mills, smart finished products such as connected cars using the Internet of Things, and data analytics, are changing how things are designed, made, and serviced.”⁸

Industry 4.0 is driven by four disruptions

- Volume of Digitized Data Presents Opportunities to Use Data to drive improvements.
- Emergence of Business Intelligence/ Advanced Analytics Capabilities.
- New forms of human-machine interaction.
- New ability to use digital instructions to produce products (such as robotics and 3-D printing). Seven Forces that Impact Advanced Manufacturing; Finance & Insurance; Healthcare; and Professional Services; and Healthcare.

⁵ This is the fourth major wave of major changes in manufacturing: Lean manufacturing in the 70's; outsourcing during the 90's; and automation since 2000.

⁶ McKinsey & Company, *Digital Manufacturing: The revolution will be virtualized*, August 2015

⁷ https://en.wikipedia.org/wiki/Digital_manufacturing

⁸ McKinsey & Company, *Digitizing the Value Chain*, March 2016

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

“AUTOMATION WILL NOT HAPPEN OVERNIGHT, AND FIVE KEY FACTORS WILL INFLUENCE THE PACE AND EXTENT OF ITS ADOPTION”⁹:

DISRUPTIVE TECHNOLOGIES DEFINE THE ADVANCED INDUSTRIES SECTOR

Numerous breakthrough technologies are not only transforming the advanced industries sector but in many respects redefining it. The cross-cutting nature of many of these disruptive technologies reinforces the ongoing convergence of production and innovation, manufacturing and services, and material and digital. Among the most defining technology trends are:

- **Additive manufacturing / 3-D printing:** 3-D printing is the additive process of building objects through layering. Additive manufacturing has the potential to substantially reduce the cost and time of prototyping in production industries and could also enable the mass customization of products.
- **Advanced materials:** Advanced materials are developed from compounds at a molecular level through applied physics, materials science, and chemistry. Advanced materials hold the prospect of reducing the weight of vehicles without losing strength, creating efficient clean energy, and more durable machinery.
- **Advanced robotics:** Automation and advanced robotics allow for greater speed, consistency, and complexity in the production process. Although robotics are not new, only recently has artificial intelligence become sophisticated enough to automate nonroutine tasks such as assembly line quality control monitoring.
- **Big data/ advanced analytics:** Big data refers to data sets that are too large for traditional computing tools and require unique software and skilled technicians to store, manage, and analyze. Big data are important for not only managing complex global supply chains or customer relationships, but also learning and innovation in the production process.
- **Cloud computing:** Cloud technology allows nearly all computing applications to be delivered through networks or over the Internet. By radically reducing operating costs, cloud computing can potentially revolutionize business models in every industry from retail to software development.
- **Internet of Things:** Advanced software, robotics, cheap sensors, and network connectivity are combining to allow objects to interact digitally. As technologies improve, networked smart devices can bring new dynamism to old tasks and systems.
- **Next-generation genomics:** Genomics is the study of DNA to unlock new organic knowledge. Low-cost gene-sequencing machines hold promise for revolutionary drug treatments, new biofuels, and drought- and pest-resistant crops. Coming technologies will likely even yield radical innovations in gene manipulation.

Sources: McKinsey Global Institute, “Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy” (2013); President’s Council of Advisors on Science and Technology, “Capturing Domestic Competitive Advantage in Advanced Manufacturing” (2012).

There are five factors influencing the pace of adoption.

Third is labor market dynamics, including the supply, demand, and costs of human labor as an alternative to automation.

“...we estimate it will take decades for automation’s effect on current work activities to play out fully. While the effects of automation might be slow at a macro level within entire sectors or economies, they could be quite fast at a micro level, for an individual worker whose activities are automated, or a company whose industry is disrupted by competitors using automation.”¹⁰

⁹ *Automation and Future of Work*; released by McKinsey Global Institute
January 2017

¹⁰ Ibid, p.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Top occupations in demand for Disruptive Technologies: Northeast Ohio

Common and Unique Skills and Occupations for Six Disruptive Technologies

The first table includes the Top Five Specialized Skills listed the most among postings seeking persons with specific proficiency with each of the disruptive technologies, one at a time. In the table, the five skills listed first

Specialized Skills Among the Top Five for Job Postings for the Disruptive Technologies						
	Internet of Things	Cyber-security	Cloud Computing	Data Analytics	Additive Manufacturing	Advanced Robotics
3D Modeling/ Design					X	
Mechanical Engineering					X	
Computer Aided Drafting/Design (CAD)					X	
Product Development					X	
Mechanical Design					X	
JAVA	X					
Apache Hadoop	X					
Big Data	X		X			
SQL	X		X	X		
Oracle	X		X	X		
Platform as a Service (PaaS)			X			
Software as a Service (SaaS)			X			
Project Management		X	X	X		
Information Security		X				
Network Security		X				
Technical Support		X				
Information Systems		X				
LINUX		X				
Cryptography		X				
SAS				X		
Data Analysis				X		
Robotics						X
Inspection						X
Programmable Logic Controller (PLC) Programming						X
Systems Integration						X
Burning Glass, Labor/ Insight						

were most in demand for jobs to work in an Additive Manufacturing environment, e.g. Only Project Management, as a skill, appears in more than disruptive technology. Truly, distinct skills are tops given specific job responsibilities for workers, depending on the technical area.

The second table identifies the Top Five Occupations linked to each distinct disruptive technology and the challenges employers face that require the specific skills from the first table. In this case, the diversity of assignments that Software Developer/Engineers are asked to address is evident in that this occupation is in the top five for each of IT-based technical area of expertise. Also, this is the case for *Network Engineer/ Architect* and *Cyber/ Information Security Engineer/ Analyst*.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Common and Unique Skills and Occupations for Six Disruptive Technologies

Occupations Among the Top Five for Job Postings for the Disruptive Technologies						
	Internet of Things	Cyber-security	Cloud Computing	Data Analytics	Additive Manufacturing	Advanced Robotics
Software Developer/Engineer	X	X	X	X		
Network Engineer/ Architect	X	X	X			
Database Architects	X					
Data Scientist	X					
Database Administrator	X			X		
Cyber/ Information Security Engineer/ Analyst		X	X			
Auditor		X				
Systems Analyst				X		
Web Developer			X	X		
Business/ Management Analyst				X		
Computer Programmer				X		X
General/ Electrical Engineering Technician						X
Mechanical/ Electrical Drafter					X	
Manufacturing Engineer					X	
Electrical Engineer						X
Business Development/ Sales Manager			X			X
Sales Representative			X			
Computer Systems Engineer Architect			X			
Marketing Manager			X			
Burning Glass, Labor/ Insight						

Addressing the challenges to industries of Big Data & Analytics; placing data on Clouds, and the emergence of Internet of Things has created the rapid growth of information and network security. Employers need workers that can hone their expertise in one or more of these areas.

It appears that employers are concerned with what skills are needed (many new tools emerge out of need) and then determine which occupations are best suited to address the need. While a single new occupation at the mid-level now exists for cyber-security, basic skills and knowledge is the job of other positions as well—even an Auditor.

Manufacturing Occupations at Risk of Automation

“According to our analysis, fewer than 5 percent of occupations can be entirely automated using current technology. However, about 60 percent of occupations could have 30 percent or more of their constituent activities automated. In other words, automation is likely to change the vast majority of occupations—at least to some degree—which will necessitate significant job redefinition and a transformation of business processes. As roles and processes get redefined, the economic benefits of automation will extend far beyond labor savings. Particularly in the highest-paid occupations, machines can augment human capabilities to a high degree, and amplify the value of expertise by increasing an individual’s work capacity and freeing the employee to focus on work of higher value.”¹¹

How are these new technologies impacting workforce demand in northeast Ohio’s economy?

¹¹ McKinsey and Company, *Four Fundamentals of Workplace Automation*, 2015.

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

IN TERMS OF WHAT PROFESSIONAL AND TECHNICAL MANUFACTURING WORKERS NEED TO KNOW AND DEVELOP SKILLS TO WORK WITH IN TODAY'S ADVANCED MANUFACTURING ENVIRONMENT, OCCUPATIONS ARE BLURRING.

SPECIFIC SKILLS DIFFER BETWEEN ENGINEERING AND IT JOBS BUT WORKERS NEED TO SOME OF BOTH AREAS OF EXPERTISE

- As expected, Engineering Skills are more often listed for Engineers, and IT skills for IT workers.
- But, still all are working on same projects, these ads seek specific skills typically learned in the other discipline.

Nation: Clustering of Skills in Job Ads Asking for Mechatronics, Robotics, & Automation Major During 2016; Engineering and IT Occupations Compared			
Engineering Occupations		IT Occupations	
Skill Clusters	Job Postings	Skill Clusters	Job Posting
Most Requested Skill Clusters			
Engineering: Mechanical Engineering	62.81%	Information Technology: Software Development	59.81%
Engineering: Robotics	49.15%	Engineering: Mechanical Engineering	57.09%
Manufacturing and Production: Computer-Aided	38.79%	Engineering: Robotics	53.59%
Engineering: Electrical and Computer Engineering	38.61%	Information Technology: System Design and	46.21%
Information Technology: Microsoft Office and	25.52%	Engineering: Electrical and Computer	44.66%
Engineering: Drafting and Engineering Design	25.33%	Information Technology: C and C++	43.11%
Engineering: Engineering Software	23.63%	Manufacturing and Production: Computer-Aided Manufacturing	26.41%
Information Technology: System Design and	21.75%	Engineering: Engineering Software	21.55%
Maintenance, Repair, and Installation: Basic Electrical	20.43%	Business: Project Management	20.97%
		Information Technology: Operating Systems	20.78%
		Analysis: Mathematical Software	19.81%
		Information Technology: Microsoft Development	19.81%
		Information Technology: Scripting Languages	19.61%
Selectively Requested Skill Clusters			
Architecture and Construction: Electrical Construction	17.61%	Information Technology: Java	19.22%
Business: Project Management	17.51%	Information Technology: Technical Support	19.22%
Manufacturing and Production: Manufacturing Processes	17.33%	Information Technology: Microsoft Office and Productivity Tools	18.06%
Engineering: Engineering Activities	15.82%	Information Technology: SQL	17.67%
Information Technology: Technical Support	15.82%	Engineering: Drafting and Engineering Design	15.53%
Information Technology: IT Hardware	14.97%	Engineering: Simulation	14.95%
Manufacturing and Production: Welding	14.12%	Engineering: Engineering Activities	14.37%
Information Technology: C and C++	12.81%	Architecture and Construction: Electrical	14.17%
Engineering: Process Engineering	12.43%	Business: Optimization	14.17%
Maintenance, Repair, and Installation: Schematic	12.43%	Manufacturing and Production: Product	13.98%
Information Technology: Software Development	12.24%	Analysis: Machine Learning	13.59%
Manufacturing and Production: Machinery	12.15%	Information Technology: Networking Hardware	12.82%
Source: Labor Insight Jobs (Burning Glass Technologies)			

Today's engineers need to be part Systems Analyst; IT professionals need to know a lot about Automation, Mechatronics and Artificial Intelligence. Project Management is important to both professions.

All this simply demonstrates how complicated it is for educators to use traditional disciplines to prepare workers for these positions. Institutions are turning to more inter-disciplinary approaches to postsecondary programs.

ATTACHMENT

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Conversion of O*Net Occupation Titles to Burning Glass Titles Engineering			
ONET	ONET Title	BGTOCC	BGTOCC Title
17-2011.00	Aerospace Engineers	17-2011.00	Aerospace Engineer
17-2199.10	Wind Energy Engineers	11-9199.93	Alternative Energy Manager
17-3021.00	Aerospace Engineering and Operations Technicians	49-2091.00	Avionics Technician
17-2031.00	Biomedical Engineers	17-2031.00	Biomedical Engineer
17-3019.00	Drafters, All Other	17-3019.00	CAD Designer / Drafter
17-2041.00	Chemical Engineers	17-2041.00	Chemical / Process Engineer
17-2199.01	Biochemical Engineers	17-2041.00	Chemical / Process Engineer
17-2051.00	Civil Engineers	17-2051.00	Civil Engineer
17-3022.00	Civil Engineering Technicians	17-3022.00	Civil Engineering Technician
17-3012.02	Electrical Drafters	17-3012.00	Electrical / Electronic Designer
17-2071.00	Electrical Engineers	17-2071.00	Electrical Engineer
17-2072.00	Electronics Engineers, Except Computer	17-2072.91	Electronics Engineer
17-2199.03	Energy Engineers	17-2199.03	Energy Engineer
17-3029.00	Engineering Technicians, Except Drafters, All Other	17-3029.02	Engineering Technologist
17-3029.02	Electrical Engineering Technologists	17-3029.02	
17-3029.03	Electromechanical Engineering Technologists	17-3029.02	
17-3029.04	Electronics Engineering Technologists	17-3029.02	
17-3029.05	Industrial Engineering Technologists	17-3029.02	
17-3029.06	Manufacturing Engineering Technologists	17-3029.02	
17-2081.00	Environmental Engineers	17-2081.00	Environmental Engineer
17-3025.00	Environmental Engineering Technicians	17-3025.00	Environmental Engineering Technician
17-3023.01	Electronics Engineering Technicians	17-3023.00	General / Electrical Engineering Technician
17-3023.03	Electrical Engineering Technicians	17-3023.00	
17-3029.08	Photonics Technicians	17-3023.00	
17-3029.11	Nanotechnology Engineering Technologists	17-3023.00	
17-3029.12	Nanotechnology Engineering Technicians	17-3023.00	Health and Safety Engineer
17-2111.01	Industrial Safety and Health Engineers	17-2111.00	
17-2111.02	Fire-Prevention and Protection Engineers	17-2111.00	
17-2111.03	Product Safety Engineers	17-2111.00	Industrial / Mechanical Engineering Technician
17-3024.00	Electro-Mechanical Technicians	17-3027.00	
17-3024.01	Robotics Technicians	17-3027.00	
17-3026.00	Industrial Engineering Technicians	17-3027.00	
17-3027.00	Mechanical Engineering Technicians	17-3027.00	
17-3027.01	Automotive Engineering Technicians	17-3027.00	
17-3029.07	Mechanical Engineering Technologists	17-3027.00	
17-3029.10	Fuel Cell Technicians	17-3027.00	Industrial Engineer
17-2112.00	Industrial Engineers	17-2112.00	
17-3029.09	Manufacturing Production Technicians	17-3029.09	Manufacturing / Production Technician
17-2199.04	Manufacturing Engineers	17-2199.04	Manufacturing Engineer
17-2199.05	Mechatronics Engineers	17-2199.04	
17-2199.06	Microsystems Engineers	17-2199.04	
17-2199.09	Nanosystems Engineers	17-2199.04	
17-2121.01	Marine Engineers	17-2121.00	Marine Engineer / Architect
17-2121.02	Marine Architects	17-2121.00	
17-2131.00	Materials Engineers	17-2131.00	Materials Engineer
17-3012.01	Electronic Drafters	17-3013.00	Mechanical / Electrical Drafter
17-3012.02	Electrical Drafters	17-3013.00	
17-3013.00	Mechanical Drafters	17-3013.00	
17-2141.00	Mechanical Engineers	17-2141.00	Mechanical Engineer
17-2141.01	Fuel Cell Engineers	17-2141.00	
17-2141.02	Automotive Engineers	17-2141.00	
17-2199.08	Robotics Engineers	17-2141.00	
17-3029.01	Non-Destructive Testing Specialists	17-3029.91	Non-Destructive Testing Specialist
17-2199.07	Photonics Engineers	17-2199.07	Optical / Laser Engineer
17-3029.00	Engineering Technicians, Except Drafters, All Other	17-3024.00	Test Technician
17-2051.01	Transportation Engineers	17-2051.01	Transportation Engineer
17-2199.02	Validation Engineers	17-2199.02	Validation Engineer

Skills Gap for Engineering and Skilled Workers in NE Ohio Manufacturing

Conversion of O*Net Occupation Titles to Burning Glass Titles PRODUCTION			
	ONET Title	BGT OCC	BGT OCC Title
51-2011.00	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	49-2091.00	Avionics Technician
51-1011.00	First-Line Supervisors of Production and Operating Workers	51-1011.91	Production Supervisor
51-1011.00	First-Line Supervisors of Production and Operating Workers	51-1011.92	Production Plant Manager
51-2022.00	Electrical and Electronic Equipment Assemblers	51-2022.00	Electronic / Electrical Assembler
51-2023.00	Electromechanical Equipment Assemblers	51-2022.00	
51-4012.00	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	51-4012.00	CNC Programmer
51-4031.00	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	51-4031.00	Press / Press Brake Operator
51-4033.00	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	51-4033.00	Grinder / Sharpener
51-4194.00	Tool Grinders, Filers, and Sharpeners	51-4033.00	
51-4041.00	Machinists	51-4041.00	Machinist
51-4034.00	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	51-4041.00	
51-4011.00	Computer-Controlled Machine Tool Operators, Metal and Plastic	51-4041.91	CNC Operator
51-7042.00	Woodworking Machine Setters, Operators, and Tenders, Except Sawing	51-4041.91	
51-4072.00	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	51-4072.91	Molding / Casting Worker
51-9195.07	Molding and Casting Workers	51-4072.91	
51-9197.00	Tire Builders	51-4072.91	Tool and Die Maker
51-4111.00	Tool and Die Makers	51-4111.00	
51-4121.06	Welders, Cutters, and Welder Fitters	51-4121.00	Welder / Solderer
51-4121.07	Solderers and Brazers	51-4121.00	
51-4122.00	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	51-4121.00	Heat Treating Technician
51-4191.00	Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic	51-4191.91	
51-9051.00	Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders	51-8021.00	Plant Operator
51-8099.00	Plant and System Operators, All Other	51-8099.00	
51-8099.01	Biofuels Processing Technicians	51-8099.00	
51-8099.03	Biomass Plant Technicians	51-8099.00	
51-6091.00	Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers	51-9012.92	Manufacturing Machine Operator
51-4021.00	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	51-9012.92	
51-4022.00	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	51-9012.92	
51-4023.00	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	51-9012.92	
51-4032.00	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	51-9012.92	
51-4035.00	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	51-9012.92	
51-4051.00	Metal-Refining Furnace Operators and Tenders	51-9012.92	
51-4199.00	Metal Workers and Plastic Workers, All Other	51-9012.92	
51-9021.00	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	51-9012.92	
51-9023.00	Mixing and Blending Machine Setters, Operators, and Tenders	51-9012.92	
51-9032.00	Cutting and Slicing Machine Setters, Operators, and Tenders	51-9012.92	
51-9041.00	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	51-9012.92	
51-9111.00	Packaging and Filling Machine Operators and Tenders	51-9012.92	
51-9191.00	Adhesive Bonding Machine Operators and Tenders	51-9012.92	
51-9192.00	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	51-9012.92	
51-9193.00	Cooling and Freezing Equipment Operators and Tenders	51-9012.92	
51-9196.00	Paper Goods Machine Setters, Operators, and Tenders	51-9012.92	
51-9199.00	Production Workers, All Other	51-9012.92	
51-9061.00	Inspectors, Testers, Sorters, Samplers, and Weighers	51-9061.00	Quality Inspector / Technician
51-4193.00	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	51-9121.00	Coating / Industrial Painter
51-9121.00	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	51-9121.00	
51-9199.00	Production Workers, All Other	51-9199.00	Production Worker
51-2021.00	Coil Winders, Tapers, and Finishers	51-9199.00	
51-2092.00	Team Assemblers	51-9199.00	
51-4052.00	Pourers and Casters, Metal	51-9199.00	
51-4061.00	Model Makers, Metal and Plastic	51-9199.00	
51-4062.00	Patternmakers, Metal and Plastic	51-9199.00	
51-4071.00	Foundry Mold and Coremakers	51-9199.00	
51-4192.00	Layout Workers, Metal and Plastic	51-9199.00	
51-9141.00	Semiconductor Processors	51-9199.00	
51-9195.03	Stone Cutters and Carvers, Manufacturing	51-9199.00	
51-9195.04	Glass Blowers, Molders, Benders, and Finishers	51-9199.00	
51-9195.05	Potters, Manufacturing	51-9199.00	
51-9198.00	Helpers--Production Workers	51-9199.00	