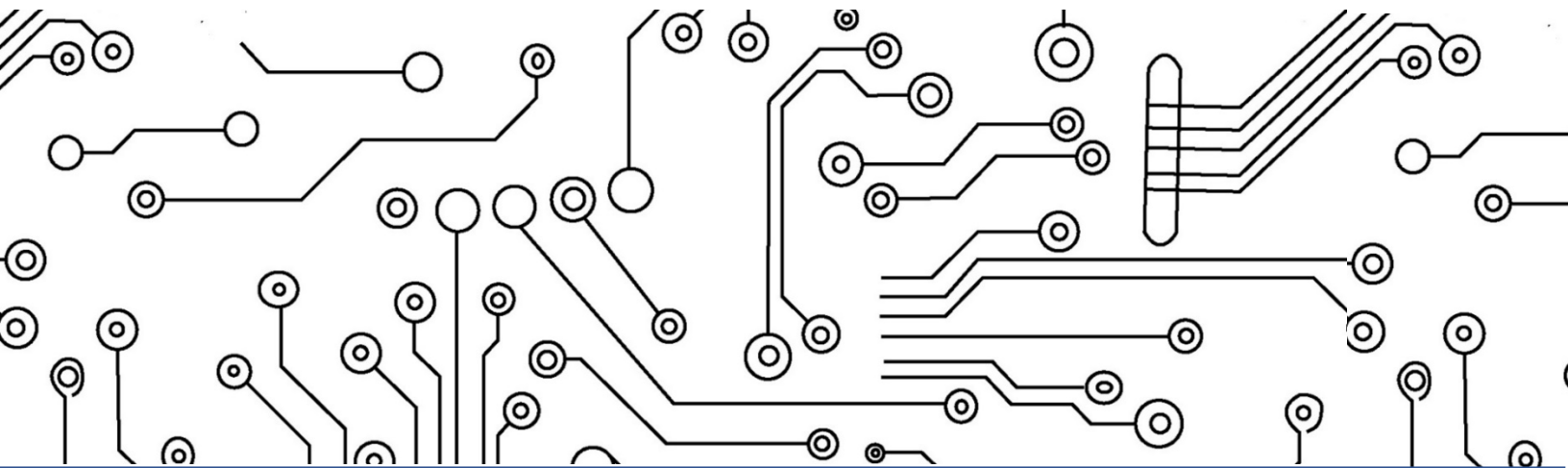# Talent Supply and Demand Gap Analysis

Minnesota's Semiconductor Industry
2023

Developed for the GreaterMSP Partnership
By RealTime Talent, March 2023

Introduction

About This Report

This report was developed by RealTime Talent (www.realtimetalent.org) to support the development of a CHIPS for America Act submission by the GreaterMSP Partnership. Here, we highlight the importance of the Semiconductor Industry to Minnesota's economy and its most critical related career pathways statewide. This study focuses on the occupations most central to the Semiconductor Industry, and does not elevate the related construction, education, childcare, or other workforce needs outside of the immediate industry that would be necessary to support the expansion of Minnesota's local Semiconductor Industry. This report also does not unpack the workforce policy or worker visa considerations that could increase access to global talent to support the Semiconductor Industry. As such, this report focuses on the unique strengths and gaps in Minnesota's local Semiconductor Industry workforce.

RealTime Talent utilized baseline forecasts and the current mix of industry occupational needs to model the talent needs for the current demand in the Semiconductor Industry to be met over the next three to five years, as well as an input-output model to determine the total number of additional workers needed to double Minnesota's share of semiconductor production output. To understand what types of occupations would experience the greatest demand, this study compares the projected baseline need to the projected baseline supply of new workers into those occupations, and then layers on the modeled additional direct talent needs for further talent pipeline growth. The new annual supply of talent into Core Semiconductor Occupations is based on volumes of graduates from related programs and workers who return to this part of the labor force over the next three to five years. Workers who change jobs over the next three to five years are not included in the supply calculations, as it is assumed that talent will continue changing jobs at the same rate unless a focused effort is made to influence that rate. By comparing demand with the new supply, we can calculate baseline occupation gaps (talent shortages) and broader talent shortfalls in a Semiconductor Industry expansion scenario. As many of the Gateway and Target Occupations require postsecondary education or industry credentials, an analysis of the most prominent award gaps—the programs in which Minnesota postsecondary institutions are underproducing graduates in comparison to national benchmarks—are used to hone in on priority strategies across the education landscape.

This report uses an Origin-to-Gateway-to-Target Occupation model, a concept currently used by the Rework America Alliance and modified in this report by RealTime Talent. The model illustrates promising likely and aligned pathways into the core career pathways in the Semiconductor Industry locally. The model is shown on the following page, along with the definitions of each grouping of occupations. You can read more about this approach in the *Talent Demand Detail* section of this report.

Origin-to-Gateway-to-Target (OGT) Model

Target Occupations
High wage (above statewide average)
*High-skill (*require some credential)
High-demand (2/4 indicators: under 3% unempl, higher than average 5-year growth, total 5-year demand >50% of current empl, high job posting volume)
    *Often also high occupation gap and award gap

Gateway Occupations
Mid-wage ($42,500 – $63,700 statewide average)
Low-middle skills (typically HS diploma, some OJT)
Sufficient demand (typically 3-5% unemployment and/or high volumes of current opportunities)

Origin Occupations
Low wage (<$42,500/year)
Low skill (no credential required)
Low demand (historically over 5% unemployment, low growth, low replacement demand, and/or low job postings)

The following NAICS codes have been used to identify talent needs and postsecondary pathways:

| NAICS	Industry
334413	Semiconductor and Related Device Manufacturing
334412	Bare Printed Circuit Board Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
334419	Other Electronic Component Manufacturing
334417	Electronic Connector Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
333242	Semiconductor Machinery Manufacturing
10334	Semiconductor Production

Industry Overview

The Semiconductor Industry produced about $1.3 billion in GDP for Minnesota in 2021, representing a 0.3% industry share of total GDP—an increase of 3.2% over the past ten years.[1] An early estimate of 2022 GDP contributions of the industry show about $1.58 billion produced by the Semiconductor Industry.[2] Minnesota ranks 12th out of 50 states in the total contribution of the Semiconductor Industry to the state's total GDP; the Minneapolis-Saint Paul 15-County Metro (MSP Metro) ranks 14th out of all 927 Metropolitan Statistical Areas (MSAs) in the United States for the industry's contribution to regional GRP; Winona ranks 59th, Mankato ranks 101st, and the Rochester MSA ranks 103rd. Talent employed in the Semiconductor Industry in Minnesota produced about $291 thousand dollars in output per worker, at about 137 to 143 estimated establishments found within the state's borders.

Semiconductor Industry's Contribution to Minnesota's GDP, Annually

GDP: Indexed 2011 = 100

Minnesota GDP   U.S. GDP

0.3 %
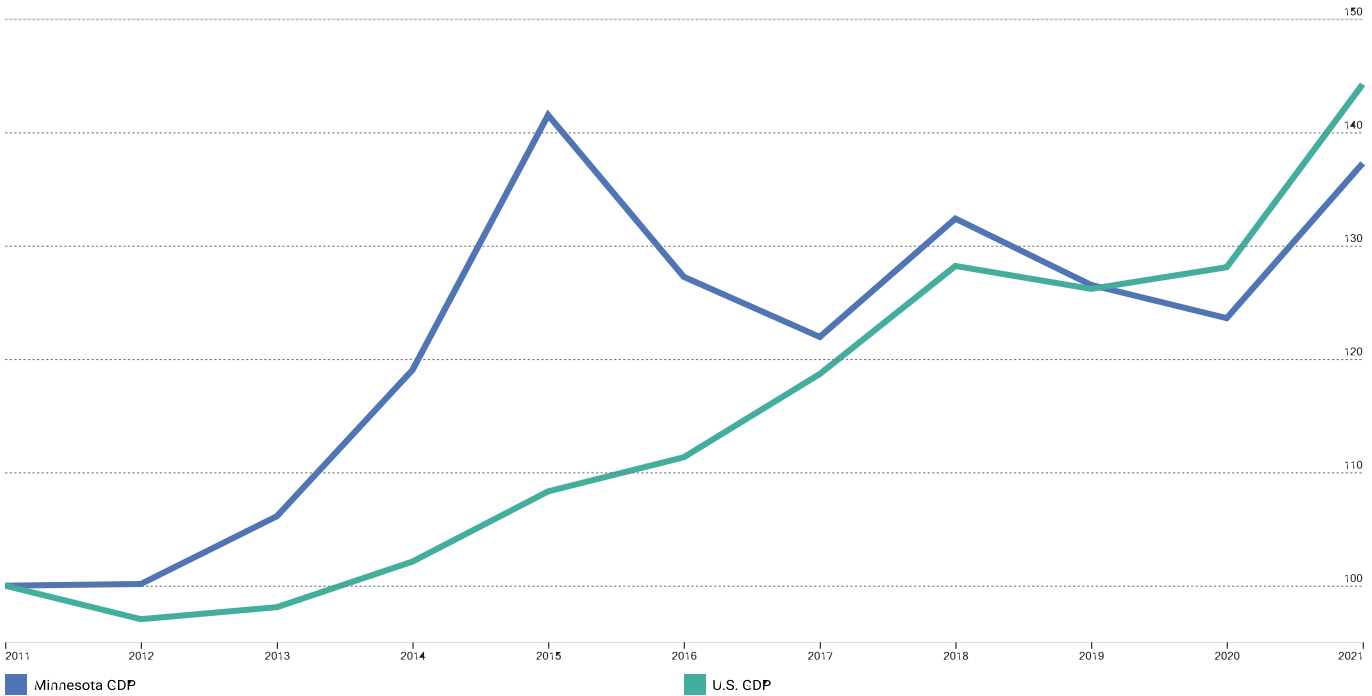
Industry Share of Total GDP /
0.5 % in the nation

Region
Nation

3.2 % ↑

Avg Ann % Change Last 10 Yrs /
3.7 % in the nation

Region
Nation
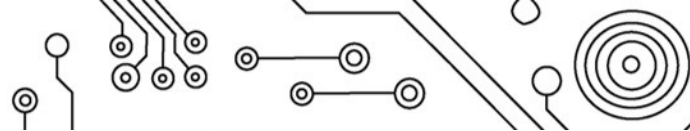
$291k

Output per Worker /
$415k in the nation

Region
Nation

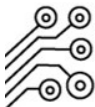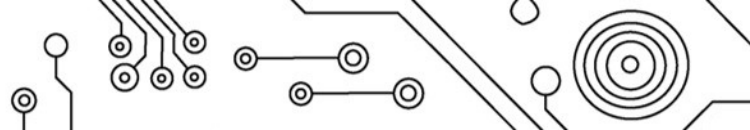**2022 GDP Estimates, Demand, and Competitive Effect Ranked by State, in order of Estimated 2022 GRP Contribution of the Semiconductor Industry[3]**

GDP Rank	State	GDP (2022, billions)	Jobs (2022)	Jobs LQ (2022)	Competitive Effect	Estimated Payrolled Business Locations	Wages, Salaries, & Proprietor Earnings (2022)	% Demand met in-region	Demand met in-region	% Demand met by imports
1	California	$43.5	98,566	2.00	(78)	1,706	$228,566	95.0%	$13,269,904,676.90	5.0%
2	Texas	$13.0	45,491	1.26	873	543	$151,613	68.3%	$5,721,803,181.83	31.7%
3	Oregon	$11.3	36,180	6.81	1,389	178	$156,656	73.8%	$905,769,820.08	26.2%
4	Arizona	$7.6	25,750	3.09	57	214	$150,097	77.2%	$1,332,472,531.52	22.8%
5	Massachusetts	$4.8	17,806	1.82	480	224	$136,699	69.8%	$1,908,870,718.31	30.2%
6	New York	$4.3	17,860	0.72	(161)	274	$103,306	32.8%	$1,850,951,519.64	67.2%
7	Florida	$3.8	18,273	0.72	(731)	401	$108,764	41.5%	$2,050,875,930.91	58.5%
8	Idaho	$2.3	8,110	3.54	(860)	73	$145,534	45.9%	$188,097,985.89	54.1%
9	Michigan	$1.9	10,577	0.92	327	188	$73,136	17.3%	$783,264,623.75	82.7%
10	North Carolina	$1.8	7,624	0.59	335	109	$120,147	29.2%	$825,326,755.22	70.8%
11	Pennsylvania	$1.7	9,830	0.62	(13)	188	$79,835	19.8%	$685,792,872.43	80.2%
12	Minnesota	$1.6	9,338	1.22	(394)	143	$85,754	43.4%	$754,943,384.76	56.6%
13	Illinois	$1.5	10,558	0.67	(354)	358	$68,625	18.7%	$732,354,394.88	81.3%
14	Washington	$1.4	6,667	0.69	(167)	113	$103,572	24.0%	$751,811,197.00	76.0%
15	New Jersey	$1.3	7,028	0.64	142	208	$93,259	21.1%	$559,978,164.62	78.9%

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[3] All estimates provided in this table are for the 2022 calendar year, modeled using the Lightcast 2023Q1 Dataset. Numbers will vary moderately from other values for total employment, wages, and GDP found in this report that rely on 202Q3 published data pertaining solely to Minnesota and the MSP Metro area. Regional Demand, Sales, and GRP in this table are calculated using Lightcast's complete class of worker dataset (including QCEW employees, non-QCEW employees, self-employed, and extended proprietors).

2022 GDP Estimates, Demand, Competitive Effect, Industry Mix Effect, Earnings, Taxes, and Subsidies Ranked by MSA, in order of Estimated 2022 GRP Contribution of the Semiconductor Industry

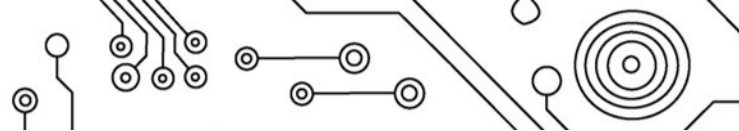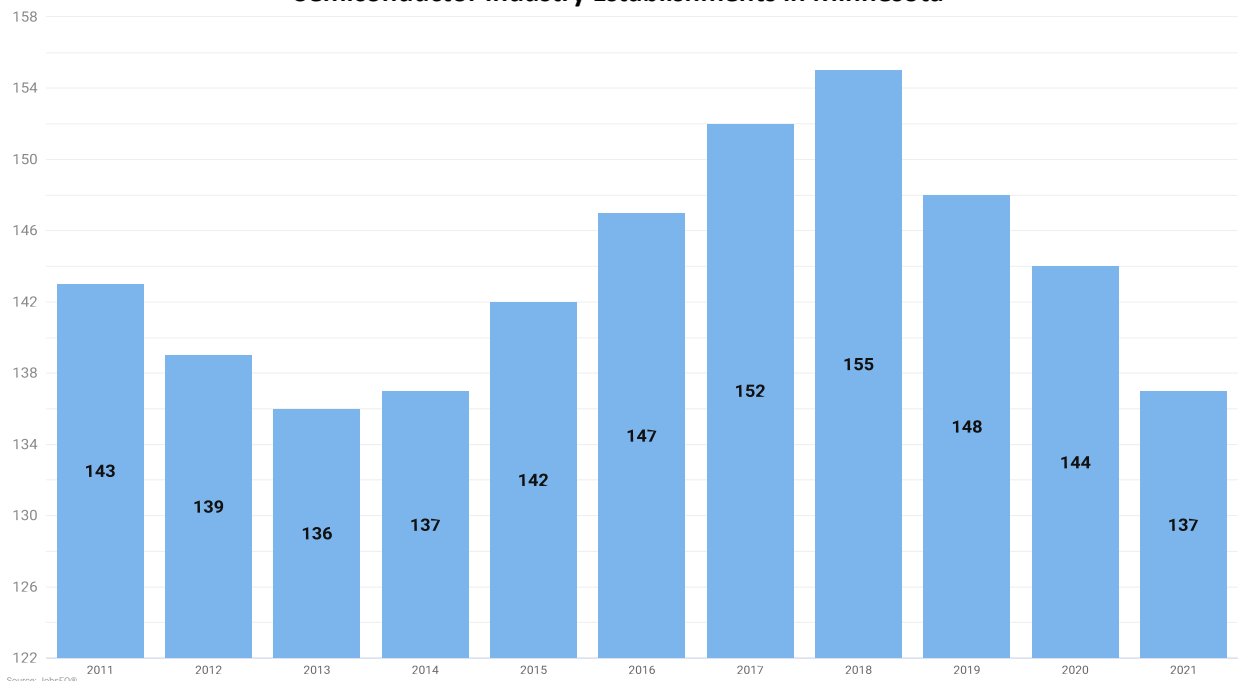| GRP Rank	MSA Name	GRP (2022)	Jobs (2022)	2019 - 2022 % Change	Jobs LQ (2022)	Top 200 MSAs LQ Rank	Competitive Effect	Ind. Mix Effect	2022 Payrolled Business Locations	Avg. Earnings Per Job	COL Index	COL Adjusted Total Current Earnings	2022 Taxes	2022 Subsidies
1	San Jose-Sunnyvale-Santa Clara, CA	$29,402,577,118	47,654	(0%)	16.12	2	(985)	877	507	$361,518	145.8	$247,954	$889,108,872	($27,285,329)
2	Portland-Vancouver-Hillsboro, OR-WA	$11,252,374,320	36,691	8%	10.90	6	2,259	621	150	$181,969	121.3	$150,016	$237,673,415	($8,682,660)
3	Phoenix-Mesa-Chandler, AZ	$7,295,201,255	24,476	10%	3.98	28	1,936	406	166	$178,350	107.9	$165,292	$181,549,441	($6,355,801)
4	Dallas-Fort Worth-Arlington, TX	$6,365,691,123	23,031	2%	2.22	54	182	412	207	$169,900	99.2	$171,270	$170,554,928	($7,559,711)
5	Los Angeles-Long Beach-Anaheim, CA	$5,704,726,236	22,279	(3%)	1.21	99	(1,078)	421	492	$150,114	158.1	$94,949	$249,543,821	($8,708,096)
6	Austin-Round Rock-Georgetown, TX	$5,397,698,457	16,047	7%	5.10	20	796	275	121	$202,410	97.0	$208,670	$135,634,565	($5,437,795)
7	San Francisco-Oakland-Berkeley, CA	$4,353,179,583	13,425	24%	2.12	57	2,387	199	219	$184,337	165.1	$111,652	$155,262,549	($11,445,672)
8	Boston-Cambridge-Newton, MA-NH	$4,279,835,105	14,575	1%	1.98	63	(40)	264	202	$177,561	135.4	$131,138	$126,742,817	($9,202,148)
9	Boise City, ID	$2,177,796,536	7,565	(7%)	7.16	14	(696)	149	37	$172,878	97.9	$176,587	$48,931,986	($1,045,184)
10	Palm Bay-Melbourne-Titusville, FL	$2,111,260,295	9,094	7%	15.23	4	487	155	35	$136,071	101.8	$133,665	$61,964,963	($1,901,069)
11	New York-Newark-Jersey City, NY-NJ-PA	$2,025,116,524	9,668	(1%)	0.39	159	(261)	179	249	$124,696	137.5	$90,688	$129,861,060	($6,153,114)
12	San Diego-Chula Vista-Carlsbad, CA	$1,769,938,061	6,005	5%	1.40	93	203	105	141	$177,000	142.5	$124,210	$68,654,299	($3,839,234)
13	Chicago-Naperville-Elgin, IL-IN-WI	$1,174,703,421	8,171	(10%)	0.68	134	(1,038)	166	229	$85,659	103.2	$83,003	$85,376,749	($5,585,612)
14	Minneapolis-St. Paul-Bloomington, MN-WI	$1,164,456,721	6,473	(3%)	1.25	98	(328)	123	100	$112,989	104.8	$107,814	$55,824,748	($3,493,444)
15	Grand Rapids-Kentwood, MI	$1,118,308,964	6,167	(3%)	4.10	25	(299)	117	15	$77,183	92.1	$83,804	$70,288,000	($2,307,882)
59	Winona, MN	$172,232,745	1,328	(17%)	21.04	1	(299)	29	2	$78,795	101.7	$77,477	$11,757,452	($886,597)
101	Mankato, MN	$66,423,124	460	(17%)	3.26	35	(103)	10	4	$71,293	101.3	$70,378	$4,508,811	($161,142)
103	Rochester, MN	$65,410,837	278	(32%)	0.91	119	(138)	8	5	$130,726	103.6	$126,183	$2,452,243	($64,850)
129	Fargo, ND-MN	$43,328,187	209	Insf.	0.53	144	207	0	2	$109,502	101.5	$107,883	$907,674	($61,240)
163	Austin, MN	$25,963,360	124	Insf.	2.96	38	115	0	1	$84,664	102.1	$82,923	$1,766,656	($55,711)
	Total		399,240	1%			(728)	7,217	5,765	$167,291		$138,985		

Semiconductor Industry Establishments in Minnesota[4]

Chart showing semiconductor industry establishments in Minnesota by year:

Year	Establishments
2011	143
2012	139
2013	136
2014	137
2015	142
2016	147
2017	152
2018	155
2019	148
2020	144
2021	137

Source: JobsEQ®
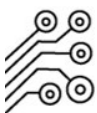
Minnesota saw moderate declines in total Semiconductor Industry firms in Minnesota, and total employment in the industry over the past five years. Competitive effect indicates how much of the recent job change within Minnesota's Semiconductor Industry is the result of some unique competitive advantage of the state. By definition, competitive effect measures the job change that occurs within a regional industry that cannot be explained by broader trends (such as the National Growth Effect and the Industrial Mix Effect). Minnesota's competitive effect of -394 was calculated by subtracting the Expected Change from the actual regional job change in the Semiconductor Industry, indicating that Minnesota's job trajectory in the industry is declining at a more rapid rate in comparison to observations nationally.

As of the third quarter of 2022, the Semiconductor Industry in Minnesota is estimated to make $324.4 million in annual purchases from suppliers in the United States with about 57% or $185.5 million of these purchases being made from businesses located in Minnesota. According to data from The Bureau of Economic Analysis (BEA), 43.4% of Minnesota's Semiconductor Industry's demand is satisfied within the state, ranking 8th out of 50 states for demand met in-state. This amounts to $754.94 million dollars spent by industries and consumers on essential goods in Minnesota's Semiconductor Industry.

Semiconductor Industry Purchases by Supplier Industry, 2022Q3

6-digit Supplier Industries	Purchases from In-Region ($M)	Purchases from Out-of-Region ($M)
Corporate, Subsidiary, and Regional Managing Offices	$26.0	<$0.1
Semiconductor and Related Device Manufacturing	$7.6	$13.0
Other Electronic Component Manufacturing	$14.3	$1.0
Offices of Lawyers	$7.2	$5.7
Residential Property Managers	$4.9	$4.4
Remaining Supplier Industries	$125.6	$114.8
Total	**$185.5**	**$138.9**

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[4] Chmura Economics 2022Q3 Dataset.

In all, about 9,487 people work in the Semiconductor Industry in Minnesota as of the third quarter of 2022—a 4.3% increase from a year prior. Total employment in this industry accounts for about 0.3% of Minnesota's total workforce.

Overall employment in Minnesota has grown by nearly 118,000 workers (4.0%) between the second quarter of 2021 and the third quarter of 2022, and the five-year forecast recovered with a 45,970 expansion of employment over five years as of the most current baseline forecasts, or about 0.3% average annual growth. During this time frame, Semiconductor Industry employment is anticipated to remain flat or contract slightly (-0.1%) due to a tight talent pool. Total baseline demand for Semiconductor Industry talent is anticipated to be around 4,566 professionals needed to fill positions due to job exits and transfers, such as retirements and job changes out of the industry.

The MSP Metro ranks 24th nationwide out of the top 200 largest metro areas for its local supply of talent employed in the principal sub-industry of Semiconductor and Related Device Manufacturing (NAICS 334413), and Minnesota ranks 17th in local concentration of this detailed industry (LQ 0.60) out of 50 states.[5] Comparing Minnesota's total employment in the seven detailed sub-industries listed below that are tied to the Semiconductor Industry to the rest of the nation, Minnesota ranks 10th out of 50 states for concentration of local employment in the broad Semiconductor Industry and 11th for total volume of industry employment; the MSP Metro ranks 13th in total volume of Semiconductor Industry employment.

Local Semiconductor Industry Competitive Advantage

Minnesota: 10th in LQ, 11th in employment volume

MSP Metro: 98th in LQ, 13th in employment volume

Winona MSA: 1st in LQ, 48th in employment volume

As a region, Winona MSA ranks first nationally in location quotient (LQ 21.04) while the MSP Metro ranks 98th in Semiconductor Industry local concentration (LQ 1.25); the region ranks 19th out of all 385 major metropolitan areas nationwide for its industry diversity, which gives the MSP Metro and Southeast Minnesota a competitive local advantage for economic growth and Semiconductor Industry expansion potential.[6]

Minnesota has a uniquely concentrated volume of Bare Printed Circuit Board Manufacturing (LQ 4.50) and Printed Circuit Assembly Manufacturing (LQ 2.04), as well as Electronic Connector Manufacturing (LQ 1.63) and Other Electronic Component Manufacturing (LQ 1.34). The fabrication of the elements required for the building of semiconductors is an important part of the industry mix in Minnesota. As a whole, jobs in the Semiconductor Industry are found in Minnesota about 22% more than a typical U.S. community (LQ 1.22) and pay average wages ($84,770) well above the overall wage statewide ($67,747).

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[5] Lightcast. Rebuilding our Semiconductor Workforce. February 2023.
[6] Lightcast. Industry Diversity Map. 2023Q1 Dataset.

Semiconductor Industry in Minnesota, 2022Q3

NAICS	Industry	Current			5-Year History		5-Year Forecast				
		Empl	Avg Ann Wages	LQ	Empl Change	Ann %	Total Demand	Exits	Transfers	Empl Change	Ann % Change
334413	Semiconductor and Related Device Manufacturing	2,256	$124,824	0.61	125	1.1%	1,102	404	691	7	0.1%
334412	Bare Printed Circuit Board Manufacturing	2,247	$85,829	4.50	-73	-0.6%	1,049	399	682	-32	-0.3%
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	2,239	$58,416	2.04	-92	-0.8%	1,075	400	683	-8	-0.1%
334419	Other Electronic Component Manufacturing	1,577	$72,302	1.34	-179	-2.1%	788	283	485	20	0.2%
334417	Electronic Connector Manufacturing	694	$69,738	1.63	127	4.1%	335	124	212	-1	0.0%
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing	278	$53,007	0.88	26	2.0%	128	49	84	-5	-0.4%
333242	Semiconductor Machinery Manufacturing	195	$112,032	0.37	43	5.1%	87	35	63	-11	-1.1%
	Semiconductor Industry	**9,487**	**$84,770**	**1.22**	**-23**	**0.0%**	**4,566**	**1,694**	**2,901**	**-28**	**-0.1%**
	Total - All Industries	**3,038,766**	**$67,747**	**1.00**	**-11,615**	**-0.1%**	**1,808,345**	**736,369**	**1,025,950**	**46,026**	**0.3%**

Source: JobsEQ®
Data as of 2023Q3 unless noted otherwise
Note: Figures may not sum due to rounding.
1. Data based on a four-quarter moving average unless noted otherwise.
2. Wage data represent the average for all Covered Employment
3. Data represent found online ads active within the last thirty days in the selected region; data represents a sampling rather than the complete universe of postings. Ads lacking zip code information but designating a place (city, town, etc.) may be assigned to the zip code with greatest employment in that place for queries in this analytic. Due to alternative county-assignment algorithms, ad counts in this analytic may not match that shown in RTI (nor in the popup window ad list).
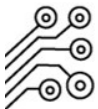
Geographic Distribution

There is a statewide need for Semiconductor Industry talent, though a moderately higher concentration of firms hiring talent are located in the 15-county MSP Metro and the Southeast-South Central portions of the state. Hennepin County and Winona County have the highest volumes of employment in the Semiconductor Industry, collectively representing 50% of all Industry employment. One in three Minnesota Semiconductor Industry workers are employed in Hennepin County, and about two in 15 are employed in Winona County.

It is worth noting that when we look at the local concentration of talent employed in the Semiconductor Industry, or the Location Quotient, it is not the MSP Metro that has the highest unique concentration of talent. Instead, it is the Southeast, South Central, and Central Minnesota counties that rank highest in their hyper-concentration of talent.

Specifically, there are more than 19 times the

We have statewide need for talent, but a few communities are hubs for the Semiconductor Industry.

Top counties by **employment** include:
> Hennepin County (36%, 49 establishments)
> Winona County (14%, 2 establishments)
> Carver County (7.5%, 7 establishments)
> Ramsey County (6.5%, 10 establishments)
> Anoka County (6%, 10 establishments)

Counties with uniquely **high concentrations** of Semiconductor Industry talent are not MSP Metro counties where we see the highest employment or establishment volumes. These counties are:
> Winona County (LQ 20.23)
> Waseca County (LQ 12.12)
> Meeker County (LQ 7.41)
> Carver County (LQ 6.36)
> Faribault County (LQ 5.58)

concentration of Semiconductor Industry workers in Winona County than a typical US community. Waseca County, Meeker County, Carver County, and Faribault County all have extremely high location quotients for this talent as well.

Semiconductor Industry Employment in Minnesota by County, 2022Q3
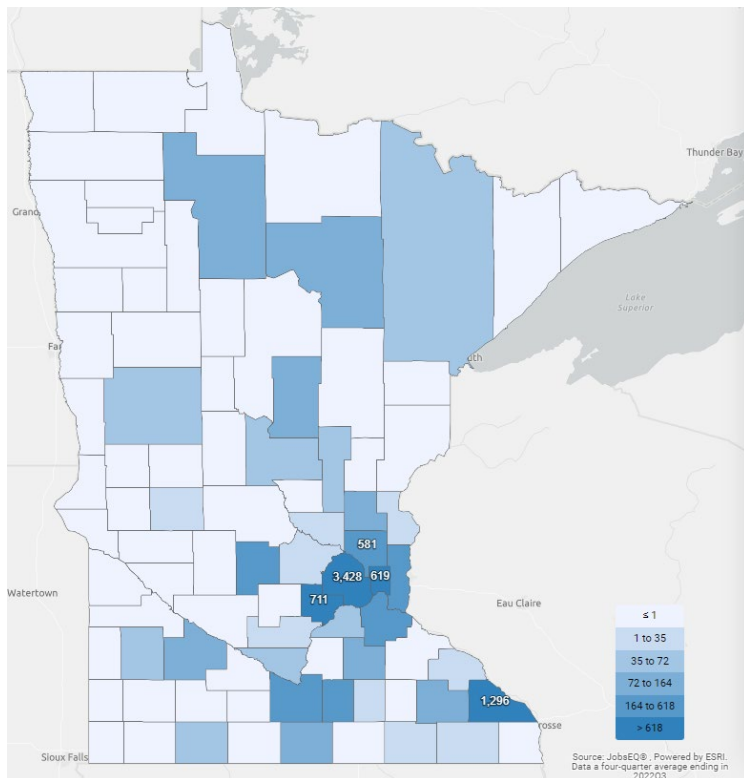
County	Empl
Hennepin County, Minnesota	3,428
Winona County, Minnesota	1,296
Carver County, Minnesota	711
Ramsey County, Minnesota	619
Anoka County, Minnesota	581
Dakota County, Minnesota	491
Blue Earth County, Minnesota	405
Washington County, Minnesota	285
Waseca County, Minnesota	201
Meeker County, Minnesota	164
All Others	1,285

Industry Employment Forecast

Minnesota saw a strong job market throughout 2022 and elevated recruitment among employers across most sectors. As the available talent pool was exhausted, unemployment rates dropped dramatically across critical roles and in many scenarios demand far outpaced talent supply. Forecasting future needs under current conditions with an eye to anticipated talent pipelines into the Semiconductor Industry suggests that there may be long-term shortages of talent in several critical occupations in this industry unless more talent is recruited from related industries. With a volatile employment trend over the past ten years, the Semiconductor Industry is currently forecast to remain relatively flat over the next five years unless new talent pipelines and investment into the industry are brought to the state.

Semiconductor Industry Employment Forecast Under Baseline Scenario, Minnesota
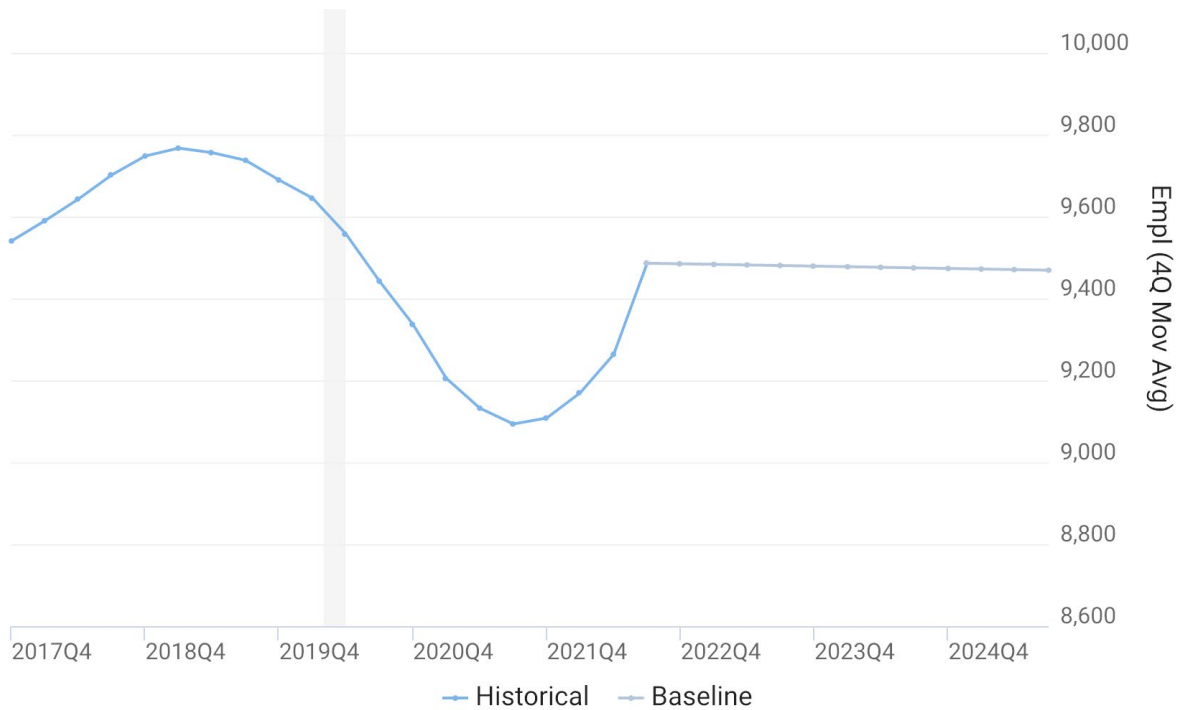
Source: JobsEQ®,Data as of 2022Q3

Talent Demand Detail

In short, Minnesota needs about 10,713 more workers in the Semiconductor Industry alone by 2027 to double our output, not including the many indirect and induced workforce needs.

However, we only anticipate having access to 4,338 workers statewide based on existing talent pipelines, unemployed talent with related skillsets—if we experienced a perfectly-aligned workforce scenario.

A conservative estimate of the overall gap Minnesota will have if we aim to double our Semiconductor Industry output is an additional 6,375 Semiconductor Industry professionals.

Overview of Talent Demand

According to Lightcast's *Rebuilding Our Semiconductor Workforce* report, an additional 236,878 additional workers will be needed in the detailed Semiconductor Industry (NAICS 334413) nationwide to double the US share of global semiconductor manufacturing, accounting for both direct-and indirect job needs. Approximately 29% of these new workers would be in Production Occupations, 18% in Architecture and Engineering, and the remainder in other fields such as Management, Business, Financial, Information Technology, and Administrative Support areas. In Minnesota, a greater share of new workers will be in Production (40.5%) and Architecture and Engineering Occupations (21.0%).

In the event of Minnesota's Semiconductor Industry doubling its sales and output, increasing output by about $1.58 billion dollars, just over 6,000 additional direct employment opportunities would be created in the industry, as well as an additional 850 indirect employment in suppliers of the industry, and nearly 3,000 induced employment opportunities in industries more removed (service industries, food, education, hospitals, and others to support the growing workforce and economy). In all, about 7,004 additional jobs would need to be boosted in Minnesota's Semiconductor Industry and most closely-related supplier industries to support growth, and the economy could be expected to see another 2,990 jobs added—totaling an estimated 9,993 of direct, indirect, and induced employment needed to sustain a doubling of Minnesota's Semiconductor Industry output.

How many workers will be needed in Minnesota's Semiconductor Industry under a conservative baseline forecast scenario by the end of 2027?

~4,566

new professionals statewide

How many core pathway workers are we likely to fall short with Minnesota's current talent pipelines in place?

~228 talent shortage

How many more workers would the Semiconductor Industry and closely related supplier industries need to double the industry's output?

~7,004 additional workers

Focusing in solely on the direct employment needs of the industry and factoring in existing talent pipelines (4,566 new professionals needed statewide), our currently unemployed labor force in core occupations of need within the industry (4,636 unemployed professionals across the top 36 occupations specialized in the Semiconductor Industry), and assuming that future workers will continue entering and exiting the industry and occupations at a similar rate as observed historically, graduate pipeline trends will remain consistent with what has been observed locally over the past five years, talent age demographics being modeled into occupation forecasts, and assuming near perfect alignment of potentially available talent pools to where roles are needed, we model an estimated baseline talent shortage of 228 industry professionals in the sector under a baseline employment demand forecast. In the case of doubling Minnesota's Semiconductor Industry output (an additional 6,147 workers in the industry alone), the talent

shortage is estimated closer to 6,375 workers needed that existing local postsecondary programs and talent pipelines have not provided.[7]

Growth of $1.58 Billion in Sales/Output of Minnesota's Semiconductor Industry, 2022Q3

	Direct	Indirect	Induced	Total
Employment	6,147	857	2,990	9,993
Sales/Output	$1,580,000,000	$201,656,250	$714,905,541	$2,496,561,790
Compensation	$564,191,504	$86,830,227	$226,742,772	$877,764,504

Multipliers for the Semiconductor Industry, 2022Q3

	Direct	Indirect	Induced	Total
Employment	1.00	0.14	0.49	1.63
Sales/Output	1.00	0.13	0.45	1.58
Compensation	1.00	0.15	0.40	1.56

Industry/Occupation Mix

As of the third quarter of 2022, about one in three people employed in the Semiconductor Industry hold Production occupations (36.4%), while about one in four hold Engineering roles (24.2%). These two fields of employment are the areas of greatest workforce need and largest likely talent shortages in the industry.[8] There is a wide range of employer types and firm sizes in this industry, with differences in the mix of occupations in demand accordingly. Further insights into the unique occupation mix by employer is detailed in the *Job Postings* section of this report and further explored in the business engagement efforts of this work.
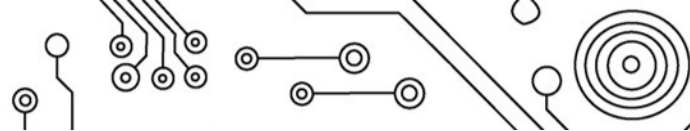
Semiconductor Industry Staffing Pattern, 2022Q3

Production 36.4% | Architecture and Engineering 24.2% | Management 9.5% | Computer and Mathematical 7.8% | Business and Financial Operations 7.5% | All Others 14.5%

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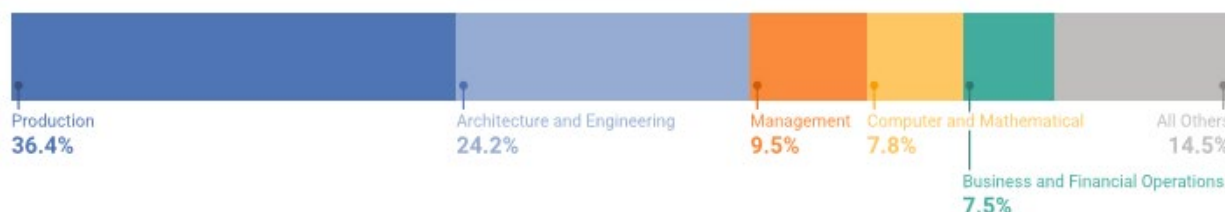
[7] Chmura Economics, 2022Q3 Dataset.

[8] Chmura Economics, 2022Q3 Dataset.
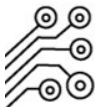
Top Occupations Employed in the Semiconductor Industry in Minnesota

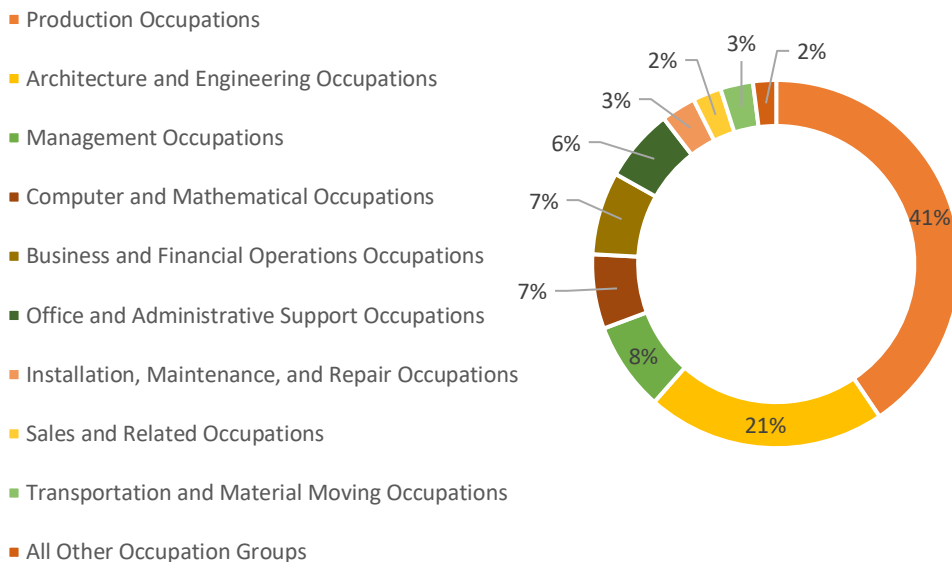| SOC	Detailed Occupation (6-Digit)	Current				5-Year Demand			
		Empl	Share Industry Empl	Share Occ Empl in Semi	Avg Ann Wages	Exits	Transf	Empl Growth	Total Demand
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	1,274	13.4%	16.2%	$36,200	305	419	-2	723
17-2112	Industrial Engineers	689	7.3%	5.6%	$102,000	85	140	51	275
15-1252	Software Developers	430	4.5%	1.0%	$122,500	41	110	31	182
17-3026	Industrial Engineering Technologists and Technicians	411	4.3%	13.2%	$66,400	72	127	-1	198
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	394	4.2%	3.5%	$43,900	77	143	-40	180
51-9141	Semiconductor Processing Technicians	331	3.5%	88.1%	$38,900	68	122	-1	189
51-2092	Team Assemblers	327	3.5%	1.3%	$37,100	61	113	-34	140
17-3023	Electrical and Electronic Engineering Technicians	276	2.9%	13.4%	$64,800	66	75	-14	127
51-1011	First-Line Supervisors of Production and Operating Workers	238	2.5%	1.7%	$68,600	43	79	-1	122
17-2072	Electronics Engineers, Except Computer	235	2.5%	14.3%	$108,400	31	46	17	95
11-9041	Architectural and Engineering Managers	208	2.2%	5.0%	$167,800	21	52	0	72
17-2071	Electrical Engineers	194	2.0%	4.6%	$109,500	26	38	11	75
11-1021	General and Operations Managers	183	1.9%	0.3%	$152,700	21	58	0	79
17-2141	Mechanical Engineers	149	1.6%	2.4%	$97,900	15	29	0	44
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	140	1.5%	2.1%	$76,600	21	49	-7	63
43-5071	Shipping, Receiving, and Inventory Clerks	124	1.3%	0.8%	$42,200	24	41	-7	59
17-2061	Computer Hardware Engineers	123	1.3%	15.9%	$108,500	13	26	0	38
51-4041	Machinists	122	1.3%	1.1%	$53,400	23	41	-1	64
11-3051	Industrial Production Managers	118	1.2%	2.3%	$127,600	13	29	0	41
13-2011	Accountants and Auditors	117	1.2%	0.4%	$94,400	17	33	0	50
49-9071	Maintenance and Repair Workers, General	110	1.2%	0.4%	$65,000	22	31	0	53
43-5061	Production, Planning, and Expediting Clerks	101	1.1%	1.6%	$56,800	20	36	0	55
49-9041	Industrial Machinery Mechanics	97	1.0%	1.2%	$68,800	19	28	10	56
51-4121	Welders, Cutters, Solderers, and Brazers	87	0.9%	0.8%	$40,900	13	33	-1	46
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	86	0.9%	0.3%	$92,800	15	28	0	42
	All Other Component Occupations	**2,907**	**30.7%**	**0.1%**		**511**	**909**	**-40**	**1,380**
	Total	**9,470**	**100%**	**100%**	**n/a**	**1,642**	**2,834**	**-30**	**4,444**
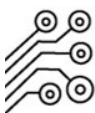
Over the next five years, the Semiconductor Industry will need to add 1,804 additional Production workers to the workforce under a baseline forecast scenario, representing about 40.5% of all future employment demand for the industry.[9]

Total Employment Demand by Broad Occupation Group, 5-year 2027 Forecast

- Production Occupations
- Architecture and Engineering Occupations
- Management Occupations
- Computer and Mathematical Occupations
- Business and Financial Operations Occupations
- Office and Administrative Support Occupations
- Installation, Maintenance, and Repair Occupations
- Sales and Related Occupations
- Transportation and Material Moving Occupations
- All Other Occupation Groups

Total Employment Demand by Broad Occupation Group, 5-year 2027 Forecast

		Current		5-Year Demand				
SOC	Occupation	Empl	Avg Ann Wages	Exits	Transfers	Empl Growth	Total Demand	% Total 5-Year Demand
51-0000	Production Occupations	3,455	$42,300	722	1,188	-105	1,804	40.5%
17-0000	Architecture and Engineering Occupations	2,292	$91,800	338	535	62	935	21.0%
11-0000	Management Occupations	898	$157,000	103	244	0	347	7.8%
15-0000	Computer and Mathematical Occupations	742	$116,800	78	183	31	291	6.5%
13-0000	Business and Financial Operations Occupations	715	$93,300	104	221	-1	324	7.3%
43-0000	Office and Administrative Support Occupations	557	$52,300	133	180	-28	285	6.4%
49-0000	Installation, Maintenance, and Repair Occupations	263	$67,900	52	75	10	136	3.1%
41-0000	Sales and Related Occupations	223	$105,000	37	76	-1	112	2.5%
53-0000	Transportation and Material Moving Occupations	175	$42,900	46	82	-1	128	2.9%
37-0000	Building and Grounds Cleaning and Maintenance Occupations	54	$41,900	18	19	0	37	0.8%
19-0000	Life, Physical, and Social Science Occupations	49	$87,700	5	20	0	25	0.6%
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	33	$89,500	5	10	0	15	0.3%
23-0000	Legal Occupations	19	$159,700	3	3	1	7	0.2%
47-0000	Construction and Extraction Occupations	7	$76,100	1	2	0	4	0.1%
33-0000	Protective Service Occupations	4	$51,900	1	2	0	3	0.1%
29-0000	Healthcare Practitioners and Technical Occupations	1	$94,600	0	0	0	0	0.0%
	Total	**9,487**		**1,645**	**2,839**	**-32**	**4,452**	**100.0%**
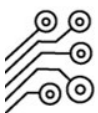
[9] Chmura Economics, 2022Q3 Dataset.

Core Pathway Occupation Employment and Wage Detail

To identify the core occupations in critical need within the Semiconductor Industry, the occupational mix of the industry was analyzed from a perspective of total current employment, forecast total employment demand, the importance of each occupation to the industry as whole, and the share of occupational employment being found within th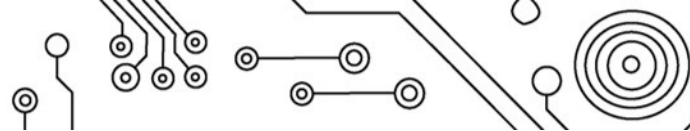e Semiconductor Industry. Thirty-six occupations were identified as uniquely necessary to the Semiconductor Industry's current strength and future growth; these occupations have 3.0% or more of their statewide employment within the Semiconductor Industry, or represent 1.0% or more of the total share of Semiconductor Industry employment. Collectively, to maintain current economic output, these occupations alone will need 3,178 additional skilled, trained workers over the next five years. Occupations in the table below that are shaded in yellow are those that have a high share of occupational employment in the industry, while those shaded in orange are those with a high share of total Semiconductor Industry employment.[10]

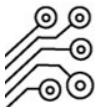**Core Semiconductor Industry Occupations of Employment and Baseline 5-Year Forecast, 2022Q3**

| Rank | SOC | Occupation | Current | | | | 5-Year Demand | | | |
			Industry Empl	Share of Total Industry Empl	Share of Occ Empl in Semi	Avg Ann Wages	Exits	Transfers	Empl Growth	Total Demand
1	51-9141	Semiconductor Processing Technicians	331	3.5%	88.1%	$38,900	68	122	-1	189
2	51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	1,274	13.4%	16.2%	$36,200	305	419	-2	723
3	17-2061	Computer Hardware Engineers	123	1.3%	15.9%	$108,500	13	26	0	38
4	17-2072	Electronics Engineers, Except Computer	235	2.5%	14.3%	$108,400	31	46	17	95
5	17-3023	Electrical and Electronic Engineering Technologists and Technicians	276	2.9%	13.4%	$64,800	66	75	-14	127
6	17-3026	Industrial Engineering Technologists and Technicians	411	4.3%	13.2%	$66,400	72	127	-1	198
7	51-2021	Coil Winders, Tapers, and Finishers	12	0.1%	11.0%	$36,400	3	4	-1	5
8	51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	23	0.2%	9.6%	$36,600	7	7	-2	12
9	51-8099	Plant and System Operators, All Other	28	0.3%	8.8%	$51,000	4	11	-1	13
10	51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	49	0.5%	6.8%	$45,500	7	18	-3	23
11	51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	55	0.6%	5.8%	$41,200	10	18	-3	25
12	17-2112	Industrial Engineers	689	7.3%	5.6%	$102,000	85	140	51	275
13	17-3012	Electrical and Electronics Drafters	24	0.3%	5.4%	$84,600	4	7	0	11
14	17-2131	Materials Engineers	23	0.2%	5.2%	$124,900	3	5	0	8
15	51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal/Plastic	10	0.1%	5.1%	$56,000	3	3	-1	5
16	11-9041	Architectural and Engineering Managers	208	2.2%	5.0%	$167,800	21	52	0	72
17	17-2071	Electrical Engineers	194	2.0%	4.6%	$109,500	26	38	11	75
18	19-2032	Materials Scientists	5	0.1%	3.9%	$119,900	0	2	0	2
19	17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	11	0.1%	3.8%	$54,300	2	3	0	5
20	51-9194	Etchers and Engravers	6	0.1%	3.7%	$55,200	2	2	0	3
21	41-9031	Sales Engineers	43	0.5%	3.7%	$113,700	6	16	0	22
22	51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	394	4.2%	3.5%	$43,900	77	143	-40	180

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[10] Chmura Economics, 2022Q3 Dataset.

Rank	SOC	Occupation	Current				5-Year Demand			
			Industry Empl	Share of Total Industry Empl	Share of Occ Empl in Semi	Avg Ann Wages	Exits	Transfers	Empl Growth	Total Demand
23	17-2199	Engineers, All Other	60	0.6%	3.0%	$125,100	7	12	0	19
24	15-1252	Software Developers	430	4.5%	1.0%	$122,500	41	110	31	182
25	51-2092	Team Assemblers	327	3.5%	1.3%	$37,100	61	113	-34	140
26	51-1011	First-Line Supervisors of Production and Operating Workers	238	2.5%	1.7%	$68,600	43	79	-1	122
27	11-1021	General and Operations Managers	183	1.9%	0.3%	$152,700	21	58	0	79
28	17-2141	Mechanical Engineers	149	1.6%	2.4%	$97,900	15	29	0	44
29	13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	140	1.5%	2.1%	$76,600	21	49	-7	63
30	43-5071	Shipping, Receiving, and Inventory Clerks	124	1.3%	0.8%	$42,200	24	41	-7	59
31	51-4041	Machinists	122	1.3%	1.1%	$53,400	23	41	-1	64
32	11-3051	Industrial Production Managers	118	1.2%	2.3%	$127,600	13	29	0	41
33	13-2011	Accountants and Auditors	117	1.2%	0.4%	$94,400	17	33	0	50
34	49-9071	Maintenance and Repair Workers, General	110	1.2%	0.4%	$65,000	22	31	0	53
35	43-5061	Production, Planning, and Expediting Clerks	101	1.1%	1.6%	$56,800	20	36	0	55
36	49-9041	Industrial Machinery Mechanics	97	1.0%	1.2%	$68,800	19	28	10	56
		All Other Occupations	2,635	0	3025.7%		467	829	-30	1,266
		Total	**9,470**	**100.0%**	**0.3%**		**1,642**	**2,834**	**-30**	**4,444**

Of the 36 core occupations of employment in the Semiconductor Industry in Minnesota, 25 are uniquely concentrated in Minnesota to a higher degree than seen in the nation overall. The core occupations collectively have a location quotient of 1.10, indicating a 10% overrepresentation of these roles in Minnesota compared to a typical community in the United States. On average, the Core Semiconductor Occupations pay about $83,600 per year—about $20,000 above the average wage statewide across all positions. These occupations have a collective unemployment rate of 1.5%, or 4,636 professionals nationwide who are trained in these occupations but not employed as of 2022Q3 estimates. These occupations saw significant growth over the past year, increasing in total employment by 5.3%; however, the forecast for the coming year is more restrained for this pathway at just 0.2% forecast growth due to impacts of a constrained talent pool. Over the next five-year period, an estimated 146,239 additional professionals will be needed in these core occupations across all industries, with about 4,444 of these being needed in the Semiconductor Industry specifically under a baseline forecast.[11]
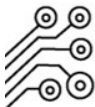
[11] Chmura Economics, 2022Q3 Dataset.

Core Semiconductor Industry Occupations of Employment Across All Industries in Minnesota, 2022Q3

SOC	Occupation	Current						1-Year History		1-Year Forecast		5-Year Forecast		
		Empl	Avg Ann Wages[2]	LQ	Unempl	Unempl Rate	Online Job Ads[3]	Empl Change	Ann %	Empl Change	Ann %	Total Demand	Empl Change	Ann % Change
11-1021	General and Operations Managers	65,062	$110,700	1.07	817	1.3%	824	3,913	6.4%	292	0.4%	30,310	1,476	0.4%
15-1252	Software Developers	41,203	$116,900	1.20	210	0.5%	3,479	4,778	13.1%	722	1.8%	18,389	3,739	1.8%
13-2011	Accountants and Auditors	28,987	$84,000	1.02	370	1.3%	1,839	689	2.4%	82	0.3%	13,017	413	0.3%
49-9071	Maintenance and Repair Workers, General	28,275	$52,500	0.94	358	1.3%	3,226	978	3.6%	88	0.3%	14,333	443	0.3%
51-2092	Team Assemblers	26,021	$41,800	1.15	987	3.8%	125	1,218	4.9%	-453	-1.7%	11,889	-2,189	-1.7%
43-5071	Shipping, Receiving, and Inventory Clerks	15,540	$44,600	0.98	488	3.2%	484	497	3.3%	-151	-1.0%	7,443	-739	-1.0%
51-1011	First-Line Supervisors of Production and Operating Workers	13,794	$73,600	1.08	118	0.9%	1,494	450	3.4%	-27	-0.2%	6,900	-132	-0.2%
17-2112	Industrial Engineers	12,298	$102,200	2.09	36	0.3%	1,038	643	5.5%	77	0.6%	4,242	392	0.6%
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	11,313	$49,600	1.01	205	1.8%	483	562	5.2%	-190	-1.7%	5,515	-918	-1.7%
51-4041	Machinists	10,687	$56,200	1.59	204	1.9%	468	337	3.3%	16	0.1%	5,777	79	0.1%
49-9041	Industrial Machinery Mechanics	7,908	$67,200	1.05	75	1.0%	125	392	5.2%	100	1.3%	4,147	514	1.3%
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	7,838	$43,500	1.47	174	2.2%	329	204	2.7%	-6	-0.1%	4,419	-29	-0.1%
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	6,792	$77,800	1.08	116	1.7%	310	189	2.9%	-63	-0.9%	3,113	-308	-0.9%
43-5061	Production, Planning, and Expediting Clerks	6,477	$58,500	0.87	73	1.2%	181	281	4.5%	16	0.2%	3,678	81	0.2%
17-2141	Mechanical Engineers	6,313	$93,200	1.11	88	1.4%	455	298	5.0%	-3	0.0%	1,844	-13	0.0%
11-3051	Industrial Production Managers	5,084	$124,000	1.28	44	0.9%	296	252	5.2%	-2	0.0%	1,789	-10	0.0%
17-2071	Electrical Engineers	4,214	$107,700	1.13	18	0.5%	719	147	3.6%	4	0.1%	1,332	21	0.1%
11-9041	Architectural and Engineering Managers	4,168	$162,900	1.12	46	1.1%	1,764	109	2.7%	-1	0.0%	1,453	-3	0.0%
17-3026	Industrial Engineering Technologists and Technicians	3,117	$65,600	2.57	43	1.4%	182	72	2.4%	1	0.0%	1,514	3	0.0%
17-3023	Electrical and Electronic Engineering Technologists and Technicians	2,055	$70,100	1.04	36	1.8%	231	-35	-1.7%	-9	-0.4%	1,031	-45	-0.4%
17-2199	Engineers, All Other	1,981	$116,200	0.62	18	1.0%	64	9	0.5%	0	0.0%	632	-1	0.0%
17-2072	Electronics Engineers, Except Computer	1,637	$109,400	0.78	7	0.5%	128	-19	-1.1%	9	0.6%	568	48	0.6%
41-9031	Sales Engineers	1,169	$111,400	0.96	5	0.4%	85	-11	-0.9%	4	0.3%	637	20	0.3%
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	948	$42,600	1.44	21	2.2%	14	18	2.0%	-12	-1.3%	411	-59	-1.3%
17-2061	Computer Hardware Engineers	777	$116,500	0.51	4	0.7%	47	12	1.5%	2	0.2%	254	8	0.2%
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	720	$48,800	1.16	20	2.8%	8	-5	-0.7%	-7	-1.0%	338	-34	-1.0%
17-3012	Electrical and Electronics Drafters	441	$77,900	1.02	3	0.8%	44	-10	-2.1%	-1	-0.3%	193	-7	-0.3%
17-2131	Materials Engineers	438	$109,100	1.03	9	2.0%	25	8	1.9%	1	0.1%	152	3	0.1%

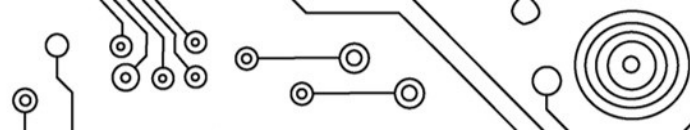| SOC	Occupation												
51-9141	Semiconductor Processing Technicians	376	$42,400	0.66	12	3.0%	13	8	2.3%	0	-0.1%	214	-1	-0.1%
51-8099	Plant and System Operators, All Other	319	$56,900	1.09	12	3.8%	1	12	3.8%	-1	-0.4%	160	-6	-0.4%
17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	288	$64,400	1.22	4	1.4%	95	-3	-1.2%	-2	-0.7%	126	-9	-0.7%
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	236	$44,300	1.72	3	1.4%	17	-57	-19.4%	-5	-2.2%	121	-25	-2.2%
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	196	$52,300	0.69	3	1.6%	24	0	-0.1%	-3	-1.7%	108	-16	-1.7%
51-9194	Etchers and Engravers	172	$45,300	1.15	4	2.3%	1	-6	-3.2%	0	-0.1%	91	0	-0.1%
19-2032	Materials Scientists	132	$107,500	0.93	3	2.0%	5	-5	-3.8%	0	0.3%	56	2	0.3%
51-2021	Coil Winders, Tapers, and Finishers	112	$44,700	0.49	3	2.3%	7	-3	-2.3%	-2	-2.2%	46	-12	-2.2%
	Core Semiconductor Industry Occupations	**317,087**	**$83,600**	**1.10**	**4,636**	**1.5%**	**18,629**	**15,924**	**5.3%**	**476**	**0.2%**	**146,239**	**2,683**	**0.2%**
	Total - All Occupations	3,038,766	$63,700	1.00	68,550	2.3%	180,228	91,312	3.1%	9,139	0.3%	1,800,961	45,970	0.3%

These core occupations had moderate wage gains over the past three years.[12] Entry-level wages across Core Semiconductor Occupations on average exceed the average entry-level wages observed across all occupations statewide by about $20,400 annually.[13]

Core Semiconductor Occupation Wages, Average Annual in Minnesota, in Order of Average Wage, 2022Q3

SOC	Occupation	Mean	Entry Level	Experienced	Percentiles				
					10%	25%	50% (Median)	75%	90%
11-9041	Architectural and Engineering Managers	$162,900	$108,100	$190,400	$100,400	$125,700	$158,700	$192,200	$241,100
15-1252	Software Developers	$116,900	$82,200	$134,200	$76,600	$93,300	$108,300	$133,300	$164,600
17-2061	Computer Hardware Engineers	$116,500	$80,100	$134,600	$78,800	$86,000	$105,600	$131,400	$164,700
17-2199	Engineers, All Other	$116,200	$79,000	$134,800	$71,900	$93,000	$112,000	$132,700	$163,500
17-2131	Materials Engineers	$109,100	$78,600	$124,300	$76,000	$86,200	$104,600	$131,400	$158,300
11-3051	Industrial Production Managers	$124,000	$77,400	$147,300	$73,900	$86,700	$107,800	$143,600	$182,700
17-2072	Electronics Engineers, Except Computer	$109,400	$74,100	$127,100	$70,700	$82,900	$102,900	$129,800	$158,400
17-2071	Electrical Engineers	$107,700	$72,100	$125,500	$67,900	$82,500	$104,100	$129,100	$152,600
19-2032	Materials Scientists	$107,500	$70,500	$126,000	$65,000	$83,100	$106,100	$134,500	$166,100
17-2112	Industrial Engineers	$102,200	$67,700	$119,500	$63,200	$78,200	$98,500	$124,400	$139,700
17-2141	Mechanical Engineers	$93,200	$66,000	$106,800	$61,200	$75,200	$87,200	$104,200	$127,700
41-9031	Sales Engineers	$111,400	$63,200	$135,400	$63,100	$69,900	$104,300	$136,600	$170,000
13-2011	Accountants and Auditors	$84,000	$53,100	$99,500	$49,500	$61,500	$77,700	$99,600	$126,300
17-3012	Electrical and Electronics Drafters	$77,900	$53,100	$90,300	$49,500	$60,900	$74,400	$85,300	$99,800

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[12] Methodology for estimating wages changed between the 2021 and 2022 reports and are new as of the 2022Q3 dataset used here. They are estimated for the most current quarter of data available (2022Q3) using a combination of data from the Bureau of Labor Statistics and Chmura RTI wages, and no longer lag by a calendar year.
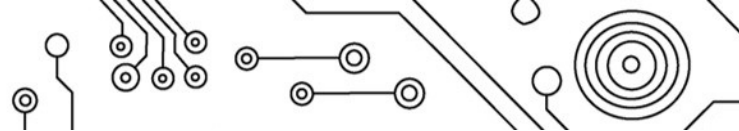[13] Chmura Economics, 2022Q3 Dataset.

Core Semiconductor Occupation Wages, Average Annual in Minnesota, in Order of Average Wage, 2022Q3

SOC	Occupation	Mean	Entry Level	Experienced	Percentiles				
					10%	25%	50% (Median)	75%	90%
51-1011	First-Line Supervisors of Production and Operating Workers	$73,600	$51,500	$84,700	$48,700	$57,600	$68,100	$82,800	$100,700
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	$77,800	$49,800	$91,800	$46,200	$57,900	$74,100	$94,800	$118,000
49-9041	Industrial Machinery Mechanics	$67,200	$49,800	$75,800	$47,300	$55,300	$64,700	$76,600	$85,900
17-3023	Electrical and Electronic Engineering Technologists and Technicians	$70,100	$48,900	$80,700	$46,800	$54,200	$65,400	$80,800	$96,800
17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	$64,400	$48,600	$72,400	$47,400	$52,500	$63,100	$76,000	$83,200
17-3026	Industrial Engineering Technologists and Technicians	$65,600	$47,500	$74,700	$46,300	$51,300	$61,900	$76,300	$88,500
11-1021	General and Operations Managers	$110,700	$47,400	$142,300	$40,500	$59,400	$95,000	$143,200	$195,500
51-8099	Plant and System Operators, All Other	$56,900	$45,100	$62,900	$42,900	$49,200	$54,300	$59,000	$70,600
43-5061	Production, Planning, and Expediting Clerks	$58,500	$42,300	$66,700	$39,400	$47,700	$53,800	$65,200	$79,600
51-4041	Machinists	$56,200	$40,400	$64,100	$38,600	$44,800	$53,600	$63,500	$74,400
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	$52,300	$39,700	$58,500	$38,500	$43,000	$50,400	$55,800	$66,000
49-9071	Maintenance and Repair Workers, General	$52,500	$36,800	$60,300	$34,700	$41,300	$49,900	$61,100	$68,900
51-2021	Coil Winders, Tapers, and Finishers	$44,700	$36,100	$49,000	$35,100	$38,800	$44,600	$49,300	$53,600
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	$48,800	$35,900	$55,300	$33,500	$40,800	$48,600	$54,700	$65,200
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	$49,600	$35,600	$56,600	$33,700	$39,900	$48,300	$56,300	$64,200
51-9194	Etchers and Engravers	$45,300	$34,800	$50,500	$33,200	$38,000	$42,900	$51,600	$60,500
43-5071	Shipping, Receiving, and Inventory Clerks	$44,600	$33,300	$50,200	$31,100	$37,300	$42,000	$49,400	$58,900
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	$43,500	$33,000	$48,700	$31,200	$36,400	$41,100	$49,300	$58,600
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	$44,300	$32,600	$50,100	$31,100	$35,900	$41,500	$48,000	$57,700
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	$42,600	$31,900	$47,900	$30,800	$34,600	$40,300	$48,000	$53,100
51-9141	Semiconductor Processing Technicians	$42,400	$31,700	$47,700	$31,000	$34,000	$40,700	$48,900	$53,200
51-2092	Team Assemblers	$41,800	$30,700	$47,300	$29,900	$33,200	$40,000	$48,200	$53,200
	Core Semiconductor Industry Occupations	**$83,600**	**$51,800**	**$99,500**	**$47,900**	**$59,700**	**$76,700**	**$99,800**	**$124,900**
	Total - All Occupations	**$63,700**	**$31,400**	**$79,800**	**$29,100**	**$35,700**	**$49,800**	**$75,000**	**$108,400**

Source: JobsEQ®
Wage data represent the average for all Covered Employment

An Origin-Gateway-Target Model for a Semiconductor Career Pathway

The Origin-Gateway-Target Model described below offers an approach to understanding the critical occupations in the Semiconductor Industry on a career pathway trajectory, from entry-level to advanced. Origin Occupations are roles that have average wages that fall below $42,500 across all industries of employment, typically do not require an industry credential or postsecondary degree, and historically have seen low demand. However, with the tight talent shortage nationwide, even Origin Occupations are

Target Occupations
High wage (above statewide average)
*High-skill (*require some credential)
High-demand (2/4 indicators: under 3% unempl, higher than average 5-year growth, total 5-year demand >50% of current empl, high job posting volume)
    *Often also high occupation gap and award gap

Gateway Occupations
Mid-wage ($42,500 – $63,700 statewide average)
Low-middle skills (typically HS diploma, some OJT)
Sufficient demand (typically 3-5% unemployment and/or high volumes of current opportunities)

Origin Occupations
Low wage (<$42,500/year)
Low skill (no credential required)
Low demand (historically over 5% unemployment, low growth, low replacement demand, and/or low job postings)

typically seeing high demand volumes due to the difficulty finding talent, particularly for positions that tend to have high turnover rates. There are only two occupations out of the 36 core positions in the Semiconductor Industry that classify as Origin Occupations, making clear the need to look outside the industry for sourcing entry-level talent.

Gateway Occupations generally offer average annual wages that fall between $42,500 and $63,700, and seek middle-skilled talent. Often this is an industry credential, certificate, or two-year degree, but in some cases within manufacturing, production, and construction fields this could also mean an apprenticeship, extended on-the-job training, or a high school diploma. Prior to the pandemic and the worsening talent shortage, these roles historically had unemployment rates in the 3-5% range, but like Origin Occupations, have seen a drying up of the available pool of unemployed talent since 2020.

Target Occupations offer average annual wages above the statewide average ($63,700 annually), typically require some form of credential, and are high demand by satisfying at least two of the following four indicators: either by having an unemployment rate under 3%, expecting higher than average annual forecasted growth under a baseline forecast, needing 50% or more of the existing employed workforce statewide to be replaced due to workforce exits and job changes over the next five years (through 2027), or seeing more than 500 monthly job postings by direct employers statewide. These roles are often forecasting talent shortages (occupation gaps) and postsecondary programs may underproduce talent in comparison to national benchmarks (award gaps).

Among Minnesota's Core Semiconductor Occupations, 21 are high-wage Target Occupations, 13 are Gateway Occupations, and two are Origin Occupations. Occupations found at each tier of the model tie to multiple career paths, with production and engineering occupations being the most prominent, but information technology, accounting, and management also emerge as critical roles for pathway considerations. Beginning with the Origin Occupations, Minnesota is not forecast to see a shortage of Team Assemblers nor Semiconductor Processing Technicians. Typically, neither role requires a postsecondary degree or industry credential. However, other states do offer postsecondary programs for Semiconductor Processing Technicians and have an average nationwide of about 10 degree completions annually per state. With the Semiconductor Industry employing over 88% of all Semiconductor Processing Technicians working in Minnesota, addressing the possible postsecondary award gap may amplify the skills of local Semiconductor Processing Technicians and prepare them for advancement into Gateway and Target Occupations more readily.

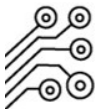**An Origin-Gateway-Target Model for Core Semiconductor Occupations in Minnesota, Ranked by total Volume of Employment in the State, 2022Q3**

Target Occupations (all HW, HD)
General and Operations Managers (HS, OG, AG)
Software Developers (HS, OG, AG)
Accountants and Auditors (HS, OG, AG)
Supervisors of Production Workers (OG)
Industrial Engineers (HS, OG, AG)

Gateway Occupations
Maintenance and Repair Workers, General (HD, OG)
Shipping, Receiving, and Inventory Clerks (AG)
Inspectors, Testers, Sorters, Samplers, and Weighers
Machinists (HD, OG, AG)
Electrical, Electronic, and Electromechanical Equipment Assemblers (HD, AG)

Origin Occupations
Team Assemblers
Semiconductor Processing Technicians (AG)

Origin-Gateway-Target Model Detail for Core Semiconductor Occupations in Minnesota, Ranked by total Volume of Employment in the State, 2022Q3

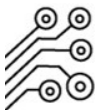| SOC	Occupation	Empl	Mean Ann Wages[2]	High-Wage	High-Skill	High-Demand	D1: 5-Yr Growth	D2: Replacement	D3: Unempl <3%	D4: Posting Volume	Occ. Gap	Award Gap
11-1021	General and Operations Managers	65,062	$110,700	HW	HS	HD	1		1	1	OG	AG
15-1252	Software Developers	41,203	$116,900	HW	HS	HD	1		1	1	OG	AG
13-2011	Accountants and Auditors	28,987	$84,000	HW	HS	HD			1	1	OG	AG
51-1011	First-Line Supervisors of Production and Operating Workers	13,794	$73,600	HW		HD		1	1	1	OG	
17-2112	Industrial Engineers	12,298	$102,200	HW	HS	HD	1		1	1	OG	AG
49-9041	Industrial Machinery Mechanics	7,908	$67,200	HW		HD	1	1	1		OG	AG
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	6,792	$77,800	HW	HS				1			
17-2141	Mechanical Engineers	6,313	$93,200	HW	HS				1		OG	AG
11-3051	Industrial Production Managers	5,084	$124,000	HW	HS				1		OG	AG
17-2071	Electrical Engineers	4,214	$107,700	HW	HS	HD			1	1	OG	AG

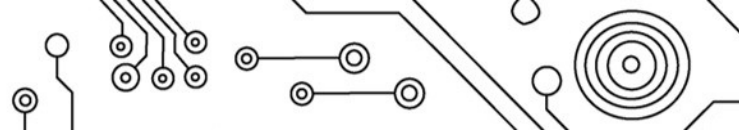| SOC	Occupation	Empl	Mean Ann Wages[2]	High-Wage	High-Skill	High-Demand	D1: 5-Yr Growth	D2: Replacement	D3: Unempl <3%	D4: Posting Volume	Occ. Gap	Award Gap
11-9041	Architectural and Engineering Managers	4,168	$162,900	HW	HS	HD			1	1	OG	
17-3026	Industrial Engineering Technologists and Technicians	3,117	$65,600	HW	HS				1		OG	AG
17-3023	Electrical and Electronic Engineering Technologists and Technicians	2,055	$70,100	HW	HS	HD		1	1		OG	
17-2199	Engineers, All Other	1,981	$116,200	HW	HS				1		OG	AG
17-2072	Electronics Engineers, Except Computer	1,637	$109,400	HW	HS	HD	1		1		OG	AG
41-9031	Sales Engineers	1,169	$111,400	HW	HS	HD		1	1			
17-2061	Computer Hardware Engineers	777	$116,500	HW	HS				1		OG	AG
17-3012	Electrical and Electronics Drafters	441	$77,900	HW	HS				1			
17-2131	Materials Engineers	438	$109,100	HW	HS				1		OG	AG
17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	288	$64,400	HW	HS				1			
19-2032	Materials Scientists	132	$107,500	HW	HS				1			AG
49-9071	Maintenance and Repair Workers, General	28,275	$52,500			HD		1	1	1	OG	
43-5071	Shipping, Receiving, and Inventory Clerks	15,540	$44,600									AG
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	11,313	$49,600						1			
51-4041	Machinists	10,687	$56,200			HD		1	1		OG	AG
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	7,838	$43,500			HD		1	1			AG
43-5061	Production, Planning, and Expediting Clerks	6,477	$58,500			HD		1	1		OG	AG
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	948	$42,600						1			
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	720	$48,800						1			AG
51-8099	Plant and System Operators, All Other	319	$56,900					1				
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	236	$44,300			HD		1	1			
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	196	$52,300			HD		1	1			
51-9194	Etchers and Engravers	172	$45,300			HD		1	1			AG
51-2021	Coil Winders, Tapers, and Finishers	112	$44,700						1			
51-2092	Team Assemblers	26,021	$41,800									
51-9141	Semiconductor Processing Technicians	376	$42,400					1				AG
	Core Semiconductor Industry Occupations (Empl Across All Industries)	317,087	$83,600									
	Total - All Occupations	3,038,766	$63,700									

Indication of "1" in the demand columns indicates satisfaction of the corresponding measure of talent demand. If two or more fields contain a "1," the High-Demand definition is satisfied, resulting in the "HD" flag. "HW" is provided for any occupation whose average annual wages are above the overall average wage statewide, $63,700. "HS" marks occupations that are High-Skill, requiring a credential.

The occupation names used to classify roles are rarely used in the Semiconductor Industry. For this reason, this report looks to online job postings to identify the job titles most in-demand in the industry using the language that firms themselves use. A summary of this information is outlined below.
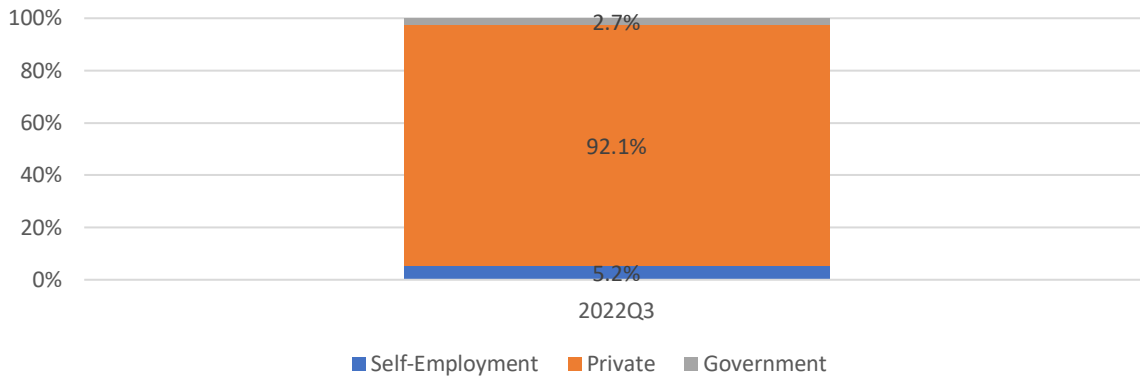
Employment Types

About 92.1% of people employed in Minnesota's Semiconductor Industry's core occupations work for private employers, while an estimated 5.2% are self-employed. The remaining 2.7% work for state, federal, or local government entities.[14]

Employment Types for those working in Core Semiconductor Industry Occupations, Minnesota 2022

Job Posting Trends

Data in this section focuses on jobs newly advertised between January 1 and December 31, 2022 by employers in the Semiconductor Industry across Minnesota. Volume of total job postings, employer types (direct versus staffing), and top employers by unique job posting volumes comes from TalentNeuron; industry detail, skill and certification analysis, wage trends, and posting to hire analysis are from the Lightcast 2023Q1 dataset. Overall, according to TalentNeuron, there were an estimated 1,775 new jobs advertised in 2022 that were advertised by companies in Minnesota's Semiconductor Industry and explicitly stating alignment of the job posting to Semiconductor production, an increase of 67% from the prior 12-month period (2021). Volume of posted positions advertised by staffing and temp agencies indicating alignment to the Semiconductor Industry continued to increase through 2022, now representing about 8% of new job posting activity in 2022. Lightcast estimates a median wage of $23.45 per hour for jobs advertised in jobs within the Semiconductor Industry during 2022, seeing a 41% increase between March 2020 and February 2023.

Specialized skillsets tied to semiconductor production are called out in about 38% of total postings aligned to the Semiconductor Industry, while about 87% of online candidate profiles aligned to the industry (2,253) identify semiconductor production as a skill. Other skillsets in demand from employers in this industry include continuous improvement processes, new product development, automation, electrical engineering, and supply chain management. In addition to detailing further insights on the skills and certifications in demand across the Semiconductor Industry, this section also features how the job titles used by local employers in the industry align to the occupation classifications by SOC code.

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[14] Chmura Economics, 2022Q3 Dataset.

Volume of Minnesota Job Postings Indicating the Semiconductor Industry in 2021 and 2022

Dec 2022
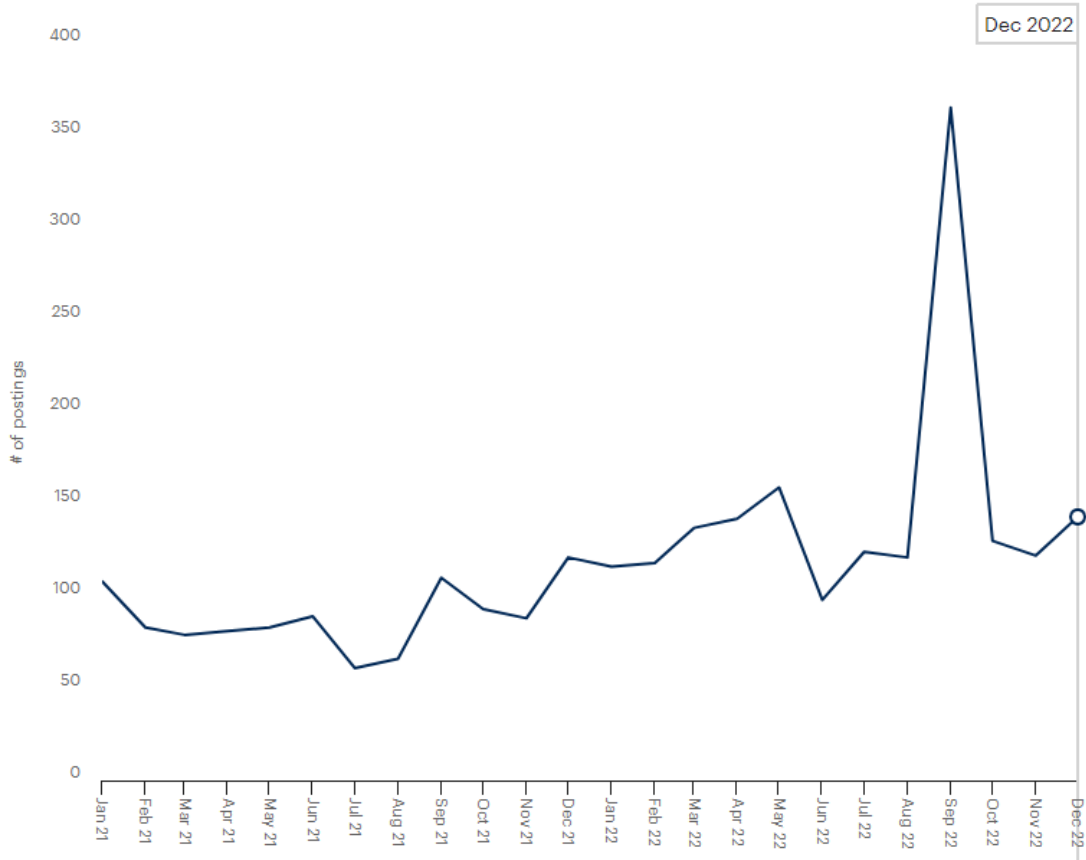
New Unique Semiconductor-Related Job Postings Advertised in Minnesota by Employer Type

Staffing Agencies
8%

Direct
Employers
92%

■ Staffing Agencies ■ Direct Employers

Top Job Titles Used by SOC Code in Semiconductor-Related Job Postings Advertised by Direct Employers between March 6, 2022 – March 5, 2023 in Minnesota

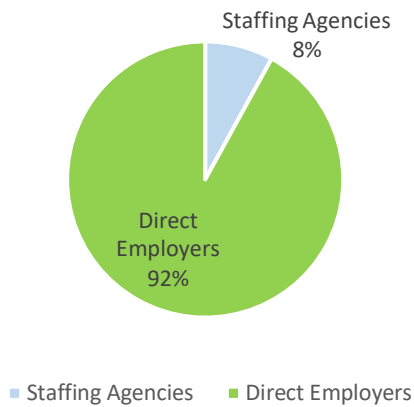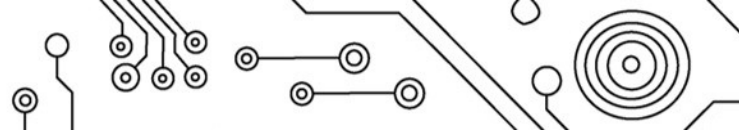| Top 20 Detailed Occupations (6-Digit)	Job Postings	Industry Employment (2022Q3)	Sample Job Titles Used by Minnesota Employers
Industrial Engineers	257	689	Semiconductor Manufacturing Engineer; Semiconductor Processing Engineer; Field Process Engineer; Sustaining Engineer
Electrical and Electronics Engineering Technicians	151	276	Lead Semiconductor Technician; R&D Semiconductor Engineering Technician
Electronics Engineers, Except Computer	145	235	Semiconductor Engineer; Foundry Technology Customer Lead; Field Service Engineer; PCB Applications Design Engineer; Integrated Circuit Designer with Security Clearance
Industrial Engineering Technicians	109	411	Semiconductor Technician; Process Sustaining Technician; Fab Operations Technician; Process Technician
Computer Hardware Engineers	63	123	Advanced Semiconductor Engineer; Lead Semiconductor Engineer; DFT Engineer; Semiconductor Manufacturing Engineer
Software Developers, Applications	58	300	ETL Developer; Senior Software Engineer; Solutions Engineer - Methodics; Software Engineer
Mechanical Engineers	50	149	Field Service Engineer; Senior Mechanical Engineer; Mechanical Test Engineer; Lead Engineer
Computer Occupations, All Other	46	30	Product Engineering and Development; System Software Validation Engineer; Technical Program Manager; Design Technology Architect
Electrical Engineers	43	194	Electrical Engineer; Transistor RnD Engineer; Electrical/Instrumentation and Controls Engineer; Electrical Design Engineer; Electrical Control Engineer
Marketing Managers	40	44	Account Manager - Semiconductor; Senior Director/Head of Business; Senior Director, Foundry Technology Partnerships; Director of Business Development; Senior Business Development Manager
Sales Engineers	34	43	Field Applications Engineer SEM-FIB - Semiconductor; Senior Field Application Engineer; Product Marketing Engineer
First-Line Supervisors of Production and Operating Workers	33	238	Production Scheduler; Plant Production Planer Scheduling Lead; LTD Day Shift Remote Operations Center Operations Manager; Shift Supervisor
Purchasing Managers	33	31	Director of Strategic Semiconductors; Senior Strategic Sourcing Program Manager; Global Commodity Manager; Parts Commodity Manager
Sales Managers	30	49	Sales Manager, Microelectronics; Field Sales Manager; Principal Account Manager; Director of Strategic Industrial Sales; Principal Account Manager
Software Developers, Systems Software	29	130	Semiconductor Engineer; Test Software and Process Development Graduate Intern; FPGA IP Software Development Engineer
Production, Planning, and Expediting Clerks	28	101	Semiconductor Production Scheduler; Planner/Scheduler
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	27	76	Sales and Business Development Specialist; Enterprise Sales Executive; Strategic Inside Sales Representative
Architectural and Engineering Managers	26	208	Senior Semiconductor Engineering Program Manager; Pathfinding Engineering Group Program Manager; Senior Laboratory Project Engineer
Managers, All Other	25	27	Customer Quality Manager; Supply Chain Responsibility Human Rights Project Manager; Senior Project Manager; AI and Digital Supply Chain Expert
Machinists	23	122	Machine Operator; Prototype CNC Mill Machinist; CNC Machinist
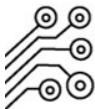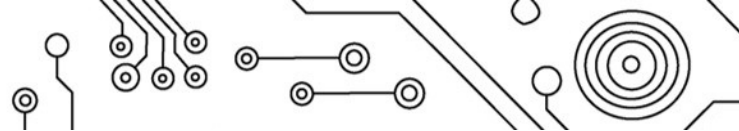
Unique Semiconductor-Related Job Postings by Industry or Employer Type

Industry	Total/Unique (Jan 2022 - Dec 2022)	Posting Intensity	Median Posting Duration
Manufacturing	4,610 / 1,652	3 : 1	33 days
Professional, Scientific, and Technical Services	247 / 157	2 : 1	30 days
Administrative and Support and Waste Management and Remediation Services	266 / 130	2 : 1	20 days
Wholesale Trade	314 / 89	4 : 1	23 days
Construction	78 / 29	3 : 1	19 days
Accommodation and Food Services	74 / 28	3 : 1	31 days
Retail Trade	41 / 15	3 : 1	12 days
Information	13 / 11	1 : 1	16 days
Educational Services	19 / 9	2 : 1	38 days
Health Care and Social Assistance	21 / 8	3 : 1	32 days

Pathway Advertised Salary Range

▲41.1% Mar 2020 – Feb 2023
$24.18 Median

$23.45/hr
Median Advertised Salary
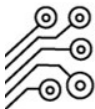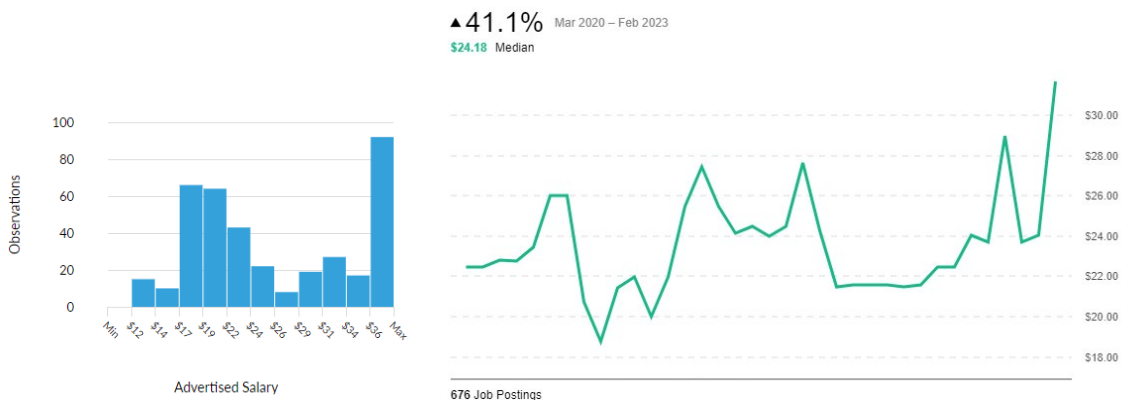
676 Job Postings

Top Common Skills

● Frequency in Job Postings   ● Frequency in Profiles
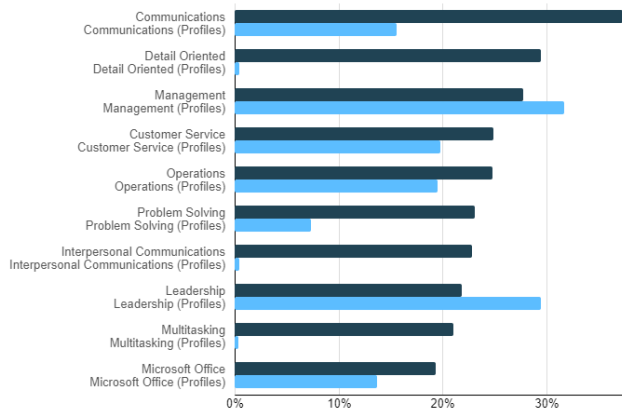
Skills	Postings	% of Total Postings	Profiles	% of Total Profiles
Communications	881	37%	403	16%
Detail Oriented	695	29%	11	0%
Management	654	28%	819	32%
Customer Service	587	25%	512	20%
Operations	586	25%	505	20%
Problem Solving	545	23%	190	7%
Interpersonal Communications	538	23%	11	0%
Leadership	515	22%	763	29%
Multitasking	497	21%	9	0%
Microsoft Office	456	19%	355	14%

Top Specialized Skills

● Frequency in Job Postings   ● Frequency in Profiles
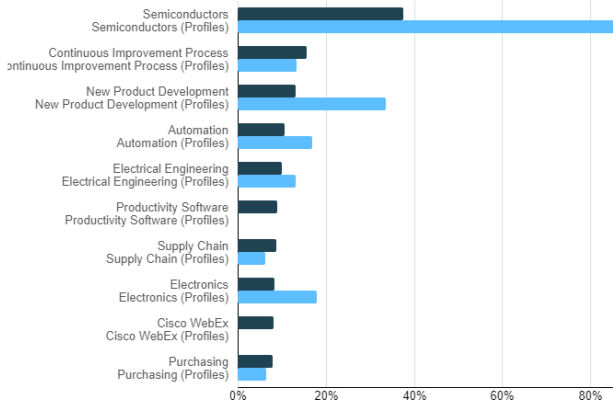
Skills	Postings	% of Total Postings	Profiles	% of Total Profiles
Semiconductors	885	38%	2,253	87%
Continuous Improvement Process	371	16%	346	13%
New Product Development	312	13%	870	34%
Automation	251	11%	435	17%
Electrical Engineering	237	10%	343	13%
Productivity Software	210	9%	0	0%
Supply Chain	207	9%	162	6%
Electronics	198	8%	464	18%
Cisco WebEx	190	8%	0	0%
Purchasing	187	8%	168	6%

Top Certifications and Qualifications

Qualification	Postings with Qualification
Master Of Business Administration (MBA)	61
Security Clearance	53
Enterprise Desktop Administrator (Microsoft Certified IT Professional)	39
Valid Driver's License	33
Secret Clearance	28
American Society For Quality (ASQ) Certified	28
Certified In Production And Inventory Management	20
Certified Quality Engineer	20
Project Management Professional Certification	20
APICS Certified Supply Chain Professional	13
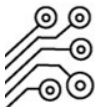
Top Employers Posting Jobs In or Serving the Semiconductor Industry by Volume of New Job Postings, With Change from Prior Year

	Employer	Percent Change between 2021 and 2022
1.	Honeywell	+85%
2.	Benchmark Electronics	-32%
3.	SkyWater Technology Foundry, Inc.	+1,033%
4.	Entegris	+118%
5.	Seagate Technology	+70%
6.	Applied Materials	+76%
7.	Polar Semiconductor, Inc.	+300%
8.	Pro Staff (Staffing/Temp)	New Entrant
9.	Doherty Staffing Solutions (Staffing/Temp)	+667%
10.	Tol-O-Matic, Inc.	+109%

An analysis of talent flows using online talent profiles shows that postsecondary education, computing and software development, and electronics manufacturing are the other industries that attract talent and lose talent from the Semiconductor Industry.

National Talent Gain and Drain into and from the Semiconductor Industry, 2023Q1
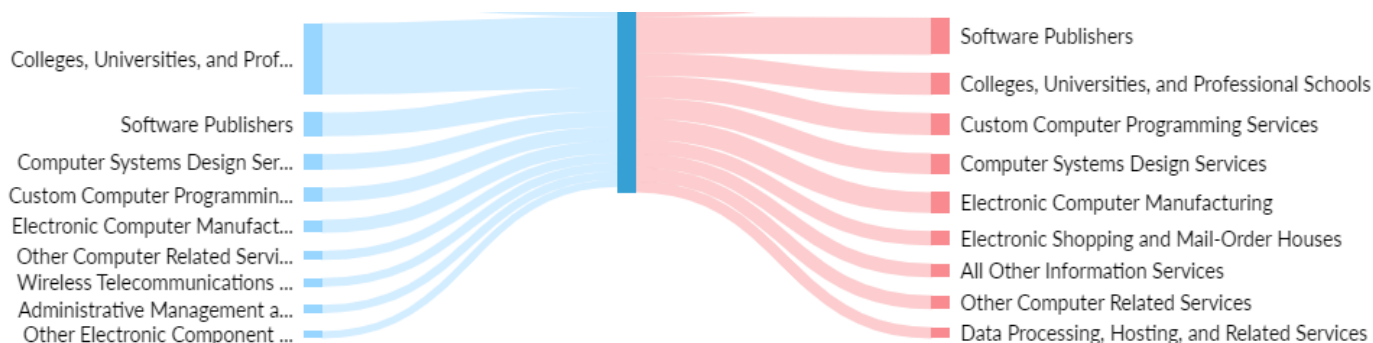
A thorough analysis of the employers advertising postings revealed 59 direct employers in Minnesota advertising semiconductor talent needs in 2022 alone, from Field Applications Engineers to Materials Associates and Technical Sales Specialists.[15] The table below includes the names of the companies advertising job openings in the 2022 calendar year, as well as sixteen additional known Semiconductor Industry employers that did not have postings, but have local presence in Minnesota. These 75 employers are not a comprehensive picture of the industry's reach in Minnesota, but do represent just over half of the estimated 137 Semiconductor Industry employers in the state.

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[15] The methodology used to identify employers advertising for semiconductor talent included a keyword search of "semiconductor" in job postings advertised in Minnesota in 2022 utilizing Lightcast and TalentNeuron, or advertising openings for what was coded as SOC 51-9141 "Semiconductor Technicians" or explicitly coded in one of the seven NAICS codes identified for the Semiconductor Industry. Additional employers not found advertising postings were added by Tom Solomon of SEMI on 2/27/2023.
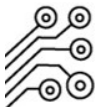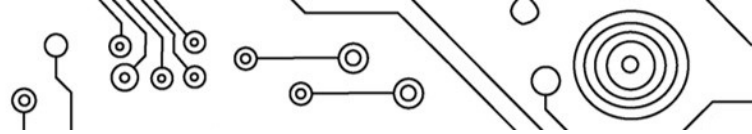
Companies Advertising Demand for Semiconductor Talent in Minnesota, 2022

Company Name	Parent Company/AKA	MN HQ	MN Titles Posted in 2022 (Blank fields indicate no postings for Semiconductor Talent found during time period)	Website (Blank fields indicate no postings for Semiconductor Talent found during time period)	Top City with Job Postings	Additional City with Job Postings
3M		Y	Portfolio Marketing Managers; Application Development Engineers; Quality Engineers	https://www.3m.com/3M/en_US/semiconductor-us/	St. Paul	
Advanced Energy Industries		B	Firmware Engineering Intern; Mechanical Engineer; Electronics Engineer	https://www.advancedenergy.com/	Eden Prairie	
Aetrium Incorporated	Boston Semi Equipment	B				
Agnitron Technology		Y	Automation Technicians; Electrical Technicians; Sales and Marketing Managers; Accountants	https://agnitron.com/	Chanhassen	
Ametek Mocon	MOCON, Inc.	Y		https://www.ametekmocon.com/solutions/industry/industrialspecialitygas	Brooklyn Park	
Applied Materials	Metron Technology	N	Automation Application Engineers; Productivity Engineers	https://www.appliedmaterials.com/	Bloomington	Rochester
ASML	ASM Lithography	N	Assistant Zone Managers; Sales Zone Managers; Field Service Engineers	https://www.asml.com/en/contacts	Eagan	Bloomington
Avnet Inc		N		https://www.avnet.com/wps/portal/us/	Minneapolis	
Banner Engineering Corporation		Y				
Benchmark Electronics	Benchmark	Y	Assemblers; Supply Chain Analysts; Commodity Managers; Design Engineering Technicians; Solderers	https://www.bench.com/winona-minnesota	Rochester	Winona
Boston Scientific		N	Supplier Quality Engineers; Strateic Sourcing Specialists	https://www.bostonscientific.com/en-US/customer-service/ordering/lab-agent.html?gclid=CjwKCAiA9NGfBhBvEiwAq5vSywA2gMsuN0cjCm7gjQ7LGowqQtphHSZ3NzR_IQomeq8sU26rwL2q6RoCcW8QAvD_BwE	St. Paul	Osseo
C & H Technology		Y		https://www.chtechnology.com/	Minnetonka	
Carl Zeiss Industrial Metrology, LLC	Carl Zeiss SMT GmbH	N				
Cascade Microtech, Inc.	FormFactor, Inc.	N				
Celadon Systems	MPI Corporation	Y		https://www.celadonsystems.com/	Burnsville	
Challenge Machine		Y	Prototype CNC Mill Machinist	https://challengemachine.com/semiconductor/	Blaine	Minneapolis
Cirtec Medical Systems	Cirtec Medical	Y	Quality Engineers; Digital IC Design Engineers; Analog IC Design Engineers; Maintenance Shift Supervisors	http://cirtecmed.com/	Minneapolis	Brooklyn Park

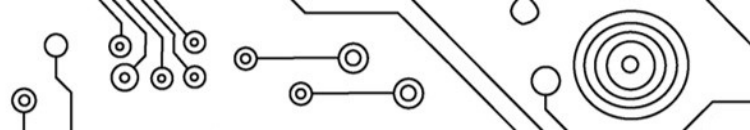| Company Name	Parent Company/AKA	MN HQ	MN Titles Posted in 2022 (Blank fields indicate no postings for Semiconductor Talent found during time period)	Website (Blank fields indicate no postings for Semiconductor Talent found during time period)	Top City with Job Postings	Additional City with Job Postings
CyberOptics Corporation		Y				
Cyient		N	Embedded Software Architects; Software Test Engineers; Directors of Sales and Business Development	https://www.cyient.com/	Minneapolis	
Donaldson Filtration Solutions		Y				
Emerson	Emerson Automation Solutions	N	Design Engineers; Industrial Automation Engineers; Buyer/Planners	https://www.emerson.com/en-us/automation/valves-actuators-regulators/spare-parts?gclid=CjwKCAiA9NGfBhBvEiwAq5vSy4K5dR8ZZxwbtFULeu-33S1rwXgb4I37EviKHBx-Gc8lfHCEkhQjLBoCAPoQAvD_BwE	Elk River	
Evans Analytical Group-Minnesota	Eurofins EAG Materials Science, LLC	N				
ATMI	Entegris, Inc.	N	Packaging Engineners; Project Managers; Supply Chain Managers	https://www.entegris.com/en/home.html	Chaska	Bloomington
FSI International (TEL FSI)	Tokyo Electron Limited (TEL)	N				
Honeywell International	Honeywell Aerospace	N	Semiconductor Engineers; Manufacturing Technicians; ASIC Design Engineers	https://www.honeywell.com/us/en	Minneapolis	
Hutchinson Technology, Inc (HTI)	TDK Corporation	N				
Ichor Systems		N		https://www.ichorsystems.com/	Sauk Rapids	
Johnstech International		Y	Lead CNC Machinists; Shipping and Receiving Clerks; HR Generalists	https://www.johnstech.com/	Minneapolis	
KLA	KLA-Tencor Corporation	N	Field Support Engineers; Customer Support Engineers	https://www.kla.com/	Hopkins	Edina
Kurt Manufacturing		Y	Buyers/Planners; CNC Mill Machinists; Quality Managers	https://www.kurt.com/	Minneapolis	
Lam Research Corporation		N		http://www.lamresearch.com/	Bloomington	
Lattice Semiconductor		N		https://www.latticesemi.com/	Eden Prairie	
LION Precision		Y				
LSI Corp		N		https://www.broadcom.com/	Bloomington	
Marvell Semiconductor	Marvell Technology Inc, Cavium	N	Integration Engieers; Analog/Mixed Signal Design Engineers; Principal Architects; Firmware Engineers; DFT Engineers	https://www.marvell.com/	Rochester	Minnetonka
MCT Worldwide LLC		Y				

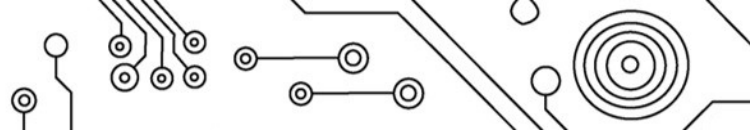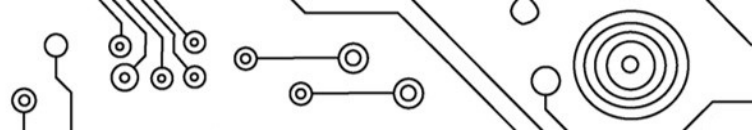| Company Name	Parent Company/AKA	MN HQ	MN Titles Posted in 2022 (Blank fields indicate no postings for Semiconductor Talent found during time period)	Website (Blank fields indicate no postings for Semiconductor Talent found during time period)	Top City with Job Postings	Additional City with Job Postings
Medtronic		Y	Category Managers; Analog IC Design Engineers; IC Design Engineers	https://www.medtronic.com/us-en/index.html	St. Paul	Mounds View
Micro Control Company		Y	Mechanical Assemblers; System Test Technicians; Electrical Assemblers	https://www.microcontrol.com/	Fridley	Minneapolis
Molex	Soligie	N				
MSR-FSR		N	Manufacturing Assembly Technicians; Equipment Maintenance Technicians	https://msr-fsr.com/	Chaska	
Nortech Systems Inc		Y		https://www.nortechsys.com/	Maple Grove	
Northern Lights Semiconductor Corporation		Y		http://www.nlsemi.com/	Plymouth	
NVE Corporation		Y		https://www.nve.com/	Eden Prairie	
Nvent		Y	Fabrication Operators; Semiconductor Technicians	https://www.nvent.com/en-us/search#q=semiconductor&t=Tab_All	Anoka	
Omnetics Connector Corporation		Y		https://www.omnetics.com/home/gclid/cjwkcaia9ngfbhbveiwaq5vsy9yl0wilw1c8_zq6wounfrmpzfzlyj0zfgysa7dkyfyyk_qdsw-bqbocupoqavd_bwe	Coon Rapids	
Onto Innovation	Rudolph Technologies (merger)	N	Planners; VPs of Global Manufacturing; Materials Analysts	https://ontoinnovation.com	Bloomington	
Optomec Inc		N		https://optomec.com/	St. Paul	
OSEMI Inc		Y		http://osemi.com/	Red Wing	
Parker Hannifin Corporation		N				
Peterson-Nora Sales	Small Precision Tools, Inc.	Y				
Polar Semiconductor		Y	Business Systems Managers; Equipment Maintenance Technicians; Metrology Technicians; Equipment Maintenance Technicians; General Secretaries	https://polarsemi.com/	Bloomington	
Raytheon Technologies		N	Electrical Engineers; Maintenance Equipment Operators; Electrical Systems Engineers	https://www.rtx.com/?gclid=CjwKCAiA9NGfBhBvEiwAq5vSywBUl9uAgjQXaURHrrCCHCTAfQxJaQPYGLcY85ZPpXB0CaAaMHdGHhoCSXcQAvD_BwE	Burnsville	
Rogue Wage Software	Preforce	Y	Semiconductor Engineers; Content Leads; Directors of Product Marketing; Service Product Managers	https://www.perforce.com/rogue-wave-software	Minneapolis	
Seagate	Seagate Technology	N	Equipment Engineering Managers; Development Engineers; Vacuum Truck Operators; Engineers	https://www.seagate.com/	Bloomington	Shakopee
SICK, Inc.	SICK AG	N				
Siemens		N	Product Architects; Emulation Engineers; Mobility Consultants; IT Professionals; Hardware Engineers	https://www.siemens.com/us/en/html?gclid=CjwKCAiA9NGfBhBvEiwAq5vSyxXfUJBZs1mbVJBbutK-Pn8LY5b7GdALO6H7L2oqBYq1FscwtV08QhoCqbwQAvD_BwE&acz=1	St. Paul	
Skywater Technology Foundry	Skywater Technology	Y	Failure Analysis Technicians; Dry Etch Process Engineers; Quality Assurance Engineering Technicians	https://www.skywatertechnology.com/	Bloomington	

Company Name	Parent Company/AKA	MN HQ	MN Titles Posted in 2022 (Blank fields indicate no postings for Semiconductor Talent found during time period)	Website (Blank fields indicate no postings for Semiconductor Talent found during time period)	Top City with Job Postings	Additional City with Job Postings
STS International SRL		N	Production Technicians; Production Workers; Clean Room Technicians	https://www.stsint.com/	Bloomington	
SVT Associates		Y		https://www.svta.com/	Eden Prairie	
Syagrus Systems		Y		https://www.syagrussystems.com/	Arden Hills	
Teradyne Inc		N			Fridley	
Texas Instruments Inc		N	Field Applications Engineers; Technical Sales Representatives	https://www.ti.com/	Bloomington	
Therma Holdings	Gilbert LLC	N	Mechanical Technicians; Mechanical Designers; Service Sales Account Representatives; Consulting Electrical Engineers	https://www.therma.com/therma-holdings-cmta-bsh/	Eagan	Minneapolis
TLC Precision Wager Technologies		Y		http://www.tlcprecision.com/	Minneapolis	
TMC Industries Inc		Y		https://tmcindustries.com/	Waconia	
MSP Corporation	Tokyo Electron; TEL Manufacturing and Engineering of America	N	Electrical Engineers; Manufacturing Program Managers; Quality Engineers	https://www.tel.com/	Chaska	
Tolomatic	Tol-O-Matic	Y	Materials Associates; Quality Inspectors	https://www.tolomatic.com/?gclid=CjwKCAiA9NGfBhBvEiwAq5vSy92qPljvOrvVbm9OE3HJjqDN4jRF7t7wqDk719xzSJ-J3uJQhS47qRoClREQAvD_BwE	Medina	Hamel
Trusted Semiconductor Solutions		Y		http://trustedsemi.com/	Brooklyn Park	
TSI Corporation Co. Ltd	MSP a Division of TSI	Y	Technical Sales Specialists; Regulatory Compliance Engineers; Regional Environmental Managers; PCB Designers	https://tsi.com/home/	St. Paul	Shoreview
TUV Product Services	TUV SUD America Inc.	N				
Veeco Instruments	MBE Systems	N	Electrical Engineers; Manufacturing Engineers; Field Service Engineers; Systems Engineers; Manufacturing Assembly Technicians	https://www.veeco.com/	St. Paul	
Vishay Intertechnology	Vishay Hirel Systems, HiRel Systems, Vishay	N	Production Assemblers; Process Engineering Technicians; Design Engineers; Production Supervisors	https://www.vishay.com/	Duluth	Marshall
Watlow Electronic Manufacturing Co	Watlow Winona	N	Manufacturing Systems Managers; Electronic Hardware Engineers; Manufacturing Systems Managers; Controls Engineers; Manufacturing Technicians	https://www.watlow.com/Industries-We-Serve/Semiconductor	Winona	
Westerwood Global		N	Assembly Technicians; Field Technicians; Field Service Technicians; Field Service Engineers	https://westerwoodglobal.com/usa/?sr=1	Chaska	
WinterLogic		N			Roseville	

Talent Supply Detail

Talent Unemployment, Underemployment, and Educational Attainment
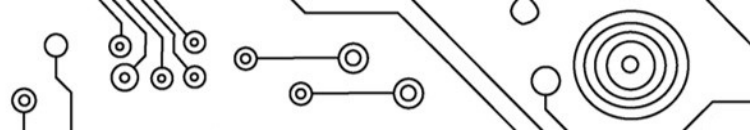
At an overall unemployment rate of 1.5% across the 36 core occupations aligned to the Semiconductor Industry, there are only about 4,636 unemployed professionals from these positions statewide. An additional 57,203 professionals who currently hold one of these 36 core occupations currently be underemployed, meaning they are working in roles for which they are overqualified by education or experience. These professionals may be seeking new career opportunities more closely aligned to their more advanced education and experience in the long-term. For instance, about 34,219 out of the total 62,050 General and Operations Managers working in Minnesota have higher levels of education than typically required for those positions; more professionals in these roles hold a four-year degree, Master's degree, or PhD than required in jobs available with local employers.[16]

Resident Talent Educational Attainment, Underemployment, and Unemployment among Core Occupations in the Semiconductor Industry, Minnesota 2022Q3

SOC	Occupation	Empl (Place of Residence)								Overall Occupation[1]		
		< High School	High School	Some College	2-Year	4-Year	Master's	PhD	Total Empl	Underemployed	Unemployed	Unempl Rate
11-1021	General and Operations Managers	637	6,354	9,117	7,535	28,380	8,655	1,373	62,050	34,219	817	1.3%
11-3051	Industrial Production Managers	81	637	618	577	2,224	766	86	4,989	-	44	0.9%
11-9041	Architectural and Engineering Managers	5	77	129	179	2,123	1,259	265	4,037	-	46	1.1%
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	72	789	944	840	3,157	667	73	6,542	-	116	1.7%
13-2011	Accountants and Auditors	0	389	711	2,132	17,278	6,423	907	27,841	-	370	1.3%
15-1252	Software Developers	45	309	1,181	1,345	21,360	12,076	1,905	38,220	-	210	0.5%
17-2061	Computer Hardware Engineers	0	13	24	51	358	188	48	682	-	4	0.7%
17-2071	Electrical Engineers	2	62	123	255	2,266	1,080	280	4,069	-	18	0.5%
17-2072	Electronics Engineers, Except Computer	1	22	45	92	853	408	106	1,528	-	7	0.5%
17-2112	Industrial Engineers	35	386	628	976	7,175	2,454	381	12,037	-	36	0.3%
17-2131	Materials Engineers	1	9	21	39	245	82	30	427	-	9	2.0%
17-2141	Mechanical Engineers	15	118	199	549	3,707	1,330	241	6,160	-	88	1.4%
17-2199	Engineers, All Other	3	24	59	114	1,020	485	155	1,861	-	18	1.0%
17-3012	Electrical and Electronics Drafters	2	26	56	168	132	27	9	420	144	3	0.8%

[16] Chmura Economics, 2022Q3 Dataset.

SOC	Occupation	Empl (Place of Residence)								Overall Occupation[1]		
		< High School	High School	Some College	2-Year	4-Year	Master's	PhD	Total Empl	Underemployed	Unemployed	Unempl Rate
17-3023	Electrical and Electronic Engineering Techs	21	236	420	808	404	60	9	1,958	432	36	1.8%
17-3024	Electro-Mechanical and Mechatronics Techs	5	48	57	81	71	11	3	275	78	4	1.4%
17-3026	Industrial Engineering Technologists and Technicians	55	517	627	875	787	120	36	3,016	836	43	1.4%
19-2032	Materials Scientists	0	1	1	2	68	27	27	126	-	3	2.0%
41-9031	Sales Engineers	1	18	55	65	703	194	24	1,059	-	5	0.4%
43-5061	Production, Planning, and Expediting Clerks	62	939	1,109	988	2,424	597	71	6,190	2,675	73	1.2%
43-5071	Shipping, Receiving, and Inventory Clerks	976	5,558	3,192	2,100	2,572	364	85	14,847	2,738	488	3.2%
49-9041	Industrial Machinery Mechanics	369	2,797	1,653	1,953	768	104	25	7,669	826	75	1.0%
49-9071	Maintenance and Repair Workers, General	1,754	9,577	5,956	5,741	3,859	475	104	27,466	3,966	358	1.3%
51-1011	Supervisors of Production and Operating Workers	687	4,275	2,696	2,073	3,030	636	133	13,530	3,347	118	0.9%
51-2021	Coil Winders, Tapers, and Finishers	11	47	21	15	15	2	1	112	16	3	2.3%
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	792	3,047	1,402	1,025	1,148	162	82	7,658	1,172	174	2.2%
51-2092	Team Assemblers	2,403	10,668	5,096	3,599	2,965	363	99	25,192	2,931	987	3.8%
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	28	126	49	17	4	9	0	233	11	3	1.4%
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	23	106	42	15	3	8	0	196	10	3	1.6%
51-4041	Machinists	551	4,111	2,464	2,396	807	52	38	10,419	756	204	1.9%
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	80	326	151	120	33	5	3	718	37	20	2.8%
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	105	438	177	118	87	12	2	939	96	21	2.2%
51-8099	Plant and System Operators, All Other	14	92	86	61	54	3	1	310	55	12	3.8%
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	489	3,121	2,142	2,012	2,522	518	127	10,933	2,752	205	1.8%
51-9141	Semiconductor Processing Technicians	38	156	71	47	46	8	2	369	51	12	3.0%
51-9194	Etchers and Engravers	11	35	29	22	68	6	0	171	55	4	2.3%
	Core Semiconductor Industry Occupations	**9,378**	**55,454**	**41,351**	**38,985**	**112,716**	**39,633**	**6,733**	**304,249**	**57,203**	**4,636**	**1.5%**
	Total - All Occupations	145,099	620,092	454,208	415,288	896,323	301,846	111,745	2,944,602	511,822	68,550	2.3%

Source: JobsEQ® Data as of 2022Q3 unless noted otherwise. Figures may not sum due to rounding. "Overall Occupation" characteristics refer to attributes across all individuals in those occupations, not just those in the demographic categories shown in this table.
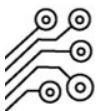
Workforce Demographics

As a whole, the talent employed in the 36 Core Semiconductor Occupations are older than the workforce as a whole in Minnesota. Only 6.5% of the workforce in the 36 Core Semiconductor Occupations is under the age of 25, while 24.3% are 55 years or older. Retirement risk is relatively high with about one in three Semiconductor Industry workers being 55 or older, and an estimated 48% of existing workers in the industry needing to be replaced over the next five years due to job changes or other exits.[17]

Semiconductor Industry Workforce Age Demographics, 2022Q3

3,338

Retiring Soon
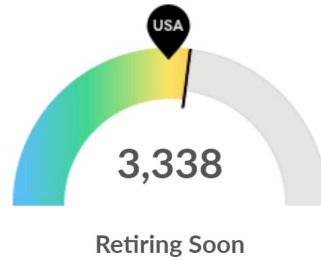
Core Semiconductor Occupation Workforce Age Demographics, 2022Q3
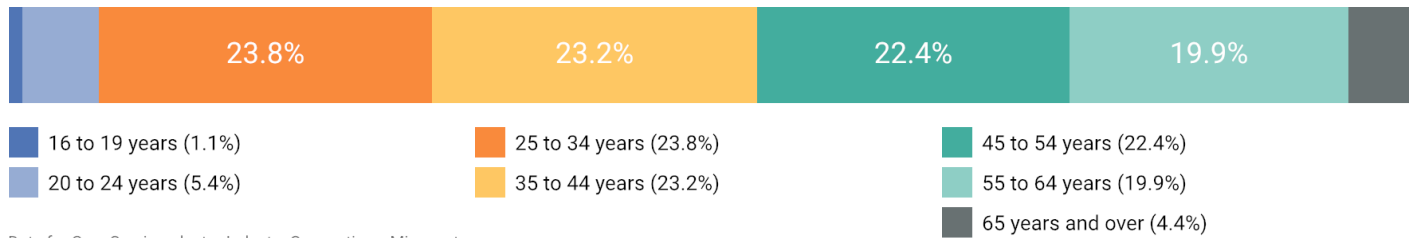
	23.8%	23.2%	22.4%	19.9%	

- 16 to 19 years (1.1%)
- 20 to 24 years (5.4%)
- 25 to 34 years (23.8%)
- 35 to 44 years (23.2%)
- 45 to 54 years (22.4%)
- 55 to 64 years (19.9%)
- 65 years and over (4.4%)

Data for Core Semiconductor Industry Occupations, Minnesota
Source: JobsEQ®. Data as of 2022Q3.

Minnesota's Semiconductor Industry has a slightly higher share of talent that are female than observed nationwide, but even so only about 37.6% of the industry workforce identifies as female; an even smaller share (28.4%) of the talent in the 36 Core Semiconductor Occupations are female.

Semiconductor Industry Workforce Gender Demographics, 2023Q1

3,510

Gender Diversity

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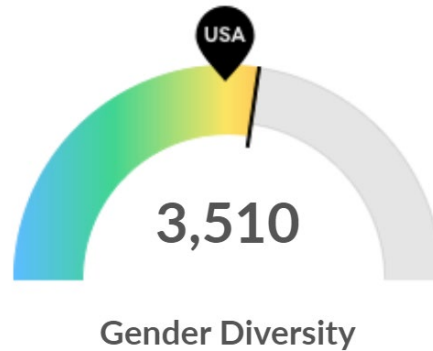
[17] Industry-based demographic data modeled using the Lightcast 2023Q1 dataset. Occupation-based demographic data modeled using the Chmura Economics, 2022Q3 Dataset.

Core Semiconductor Occupation Workforce Gender Demographics, 2022Q3

71.6%	28.4%

- Male (71.6%)
- Female (28.4%)

Data for Core Semiconductor Industry Occupations, Minnesota
Source: JobsEQ®. Data as of 2022Q3.

Racial diversity is low in Minnesota's Semiconductor Industry in comparison with the talent pool nationally, but with an underrepresentation of Black and African American talent compared to the total workforce as a whole. Only 25% of the total Semiconductor Industry workforce in Minnesota are BIPOC talent, and about 19.6% among the core semiconductor occupations; 84.0% of the total pathway's workforce are White, with the next largest cohort being Asian talent representing 8.7% of the workforce. About 3.6% of the pathway's workforce are Hispanic or Latinx.

Semiconductor Industry Workforce Racial Diversity, 2023Q1

USA

2,343

Racial Diversity
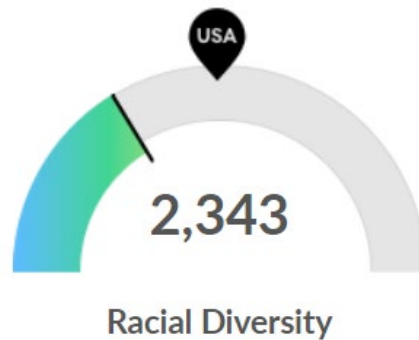
Core Semiconductor Occupation Workforce Race Demographics, 2022Q3

84.0%		8.7%	

- White (84.0%)
- American Indian (0.5%)
- Pacific Islander (0.0%)
- Black (4.2%)
- Asian (8.7%)
- Two or More Races (2.5%)

Data for Core Semiconductor Industry Occupations, Minnesota
Source: JobsEQ®. Data as of 2022Q3.

Core Semiconductor Occupation Workforce Ethnicity Demographics, 2022Q3
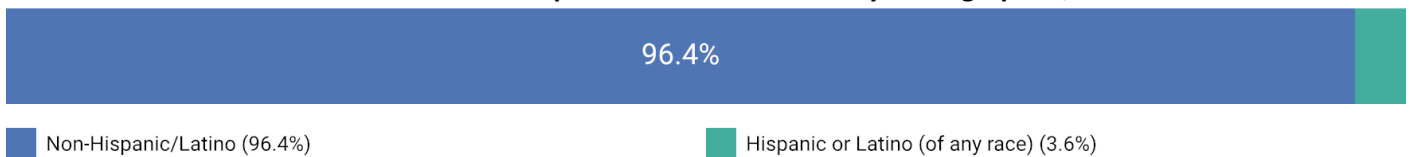
96.4%	

- Non-Hispanic/Latino (96.4%)
- Hispanic or Latino (of any race) (3.6%)

Data for Core Semiconductor Industry Occupations, Minnesota
Source: JobsEQ®. Data as of 2022Q3.

Core Semiconductor Occupation Workforce Race and Ethnicity Demographics by Detailed Occupation, Minnesota 2022Q3

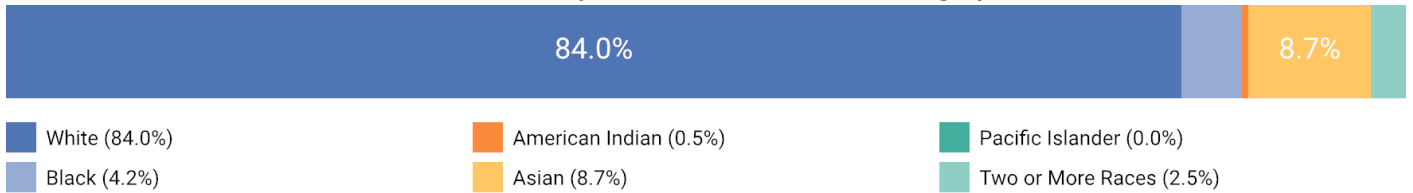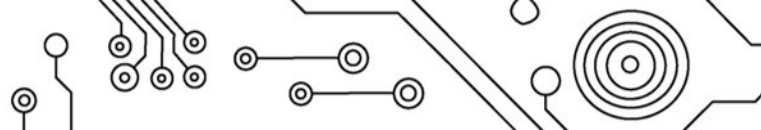| SOC	Occupation	Empl (Place of Residence)							
		White	Black	American Indian	Asian	Pacific Islander	Two or More Races	Hispanic or Latinx	Total Empl
11-1021	General and Operations Managers	89.0%	4.1%	0.3%	3.8%	0.1%	2.8%	2.6%	62,050
15-1252	Software Developers	65.2%	2.7%	0.3%	29.0%	0.0%	2.9%	1.5%	38,220
13-2011	Accountants and Auditors	84.4%	4.3%	0.5%	9.3%	0.0%	1.5%	2.6%	27,841
49-9071	Maintenance and Repair Workers, General	89.6%	4.2%	1.1%	2.2%	0.0%	2.8%	5.6%	27,466
51-2092	Team Assemblers	82.8%	8.0%	0.6%	6.1%	0.1%	2.4%	5.6%	25,192
43-5071	Shipping, Receiving, and Inventory Clerks	83.7%	7.5%	0.7%	4.0%	0.0%	4.0%	8.3%	14,847
51-1011	First-Line Supervisors of Production and Operating Workers	90.0%	5.1%	0.6%	2.4%	0.1%	1.8%	4.4%	13,530
17-2112	Industrial Engineers	83.3%	2.0%	0.2%	11.7%	0.0%	2.8%	1.2%	12,037
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	87.7%	4.9%	0.6%	5.4%	0.0%	1.3%	5.6%	10,933
51-4041	Machinists	93.0%	2.6%	0.6%	2.6%	0.0%	1.2%	4.1%	10,419
49-9041	Industrial Machinery Mechanics	93.1%	2.4%	0.7%	2.5%	0.0%	1.2%	4.6%	7,669
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	75.8%	5.2%	1.0%	14.6%	0.0%	3.3%	4.3%	7,658
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	88.5%	4.3%	0.3%	3.9%	0.0%	3.0%	3.4%	6,542
43-5061	Production, Planning, and Expediting Clerks	86.3%	3.4%	0.6%	6.8%	0.0%	2.9%	3.4%	6,190
17-2141	Mechanical Engineers	84.7%	1.8%	0.3%	9.8%	0.0%	3.4%	2.2%	6,160
11-3051	Industrial Production Managers	89.7%	2.2%	0.4%	6.1%	0.0%	1.5%	2.7%	4,989
17-2071	Electrical Engineers	82.2%	1.8%	0.2%	14.0%	0.0%	1.9%	2.6%	4,069
11-9041	Architectural and Engineering Managers	86.0%	1.9%	0.1%	11.6%	0.0%	0.5%	1.8%	4,037
17-3026	Industrial Engineering Technologists and Technicians	88.6%	4.3%	0.6%	4.2%	0.0%	2.3%	3.3%	3,016
17-3023	Electrical and Electronic Engineering Technologists and Technicians	83.5%	4.9%	0.6%	6.6%	0.0%	4.2%	2.0%	1,958
17-2199	Engineers, All Other	80.0%	2.1%	0.4%	15.0%	0.0%	2.5%	2.5%	1,861
17-2072	Electronics Engineers, Except Computer	82.1%	1.8%	0.2%	14.1%	0.0%	1.9%	2.6%	1,528
41-9031	Sales Engineers	87.5%	4.6%	0.4%	4.3%	0.0%	3.2%	4.5%	1,059
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	79.1%	9.9%	0.7%	7.6%	0.0%	2.7%	7.7%	939
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	87.0%	6.9%	1.0%	3.4%	0.0%	1.6%	5.9%	718
17-2061	Computer Hardware Engineers	67.4%	2.4%	0.2%	28.5%	0.0%	1.5%	1.9%	682
17-2131	Materials Engineers	85.6%	2.0%	0.3%	9.7%	0.0%	2.4%	2.3%	427
17-3012	Electrical and Electronics Drafters	92.6%	1.2%	0.2%	5.2%	0.0%	0.7%	2.1%	420
51-9141	Semiconductor Processing Technicians	79.0%	10.1%	0.7%	7.5%	0.0%	2.6%	8.0%	369
51-8099	Plant and System Operators, All Other	87.7%	5.7%	1.4%	3.4%	0.0%	1.8%	5.6%	310
17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	87.6%	5.0%	0.6%	4.5%	0.0%	2.3%	3.1%	275
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal/ Plastic	83.9%	7.1%	0.9%	5.9%	0.0%	2.2%	6.0%	233
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	84.3%	6.7%	1.1%	5.7%	0.0%	2.2%	5.8%	196
51-9194	Etchers and Engravers	78.2%	11.0%	0.9%	7.1%	0.1%	2.8%	9.2%	171
19-2032	Materials Scientists	79.1%	3.3%	0.0%	17.2%	0.0%	0.4%	1.6%	126
51-2021	Coil Winders, Tapers, and Finishers	71.9%	6.2%	1.2%	17.4%	0.1%	3.3%	4.4%	112
	Core Semiconductor Industry Occupations	**84.0%**	**4.2%**	**0.5%**	**8.7%**	**0.0%**	**2.5%**	**3.6%**	**304,249**
	Total - All Occupations	**85.0%**	**6.0%**	**0.7%**	**5.2%**	**0.0%**	**3.0%**	**5.2%**	**2,944,602**

Fields shaded in green indicate overrepresentation of the race or ethnic group compared to the general workforce.
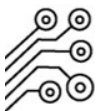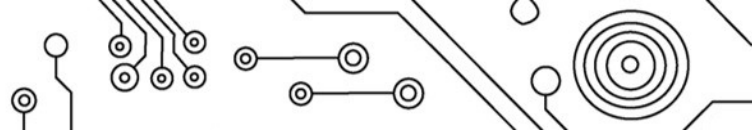
Graduate Demographics

The table below illustrates the number of postsecondary awards conferred by individuals in the 2021 school year from accredited schools and programs aligned to the production, logistics, information technology, and broader STEM occupations in demand in the Semiconductor Industry.[18] Awards conferred from programs in Business, Management, Administration, and Finance were excluded from this table but are represented in the Award Gaps found later in this report. These counts of graduates illustrate the broad landscape of new talent entering the workforce in 2021; further detail by core occupation, pathway, and degree level of attainment are the necessary next step for development of a postsecondary training strategy to meet current and future talent needs in the Semiconductor Industry. In all, there were 6,705 awards conferred from these aligned programs in 2021. Of these, nearly one in four awards were completed by female graduates. Over 14% of awards went to international students. About 19.2% of graduates are BIPOC, while another 5.3% represent either multiple races or did not report a race or ethnicity (61.1% are non-Hispanic white). Note that Minnesota does not have any local Semiconductor Manufacturing Technology programs (CIP 15.0616).

Race and Gender of Graduates Receiving Postsecondary Awards in SY2021 from Minnesota

CIP Code	Description	2021 Total Awards	2021 Males	2021 Females	2021 International Students*	2021 Black or African American, non-Hispanic	2021 American Indian or Alaska Native	2021 Asian, Native Hawaiian or Other Pacific Islander	2021 Hispanic or Latino	2021 White, non-Hispanic	2021 Multiple or unknown race/ethnicity
11.0102	Artificial Intelligence	3	1	2	0	0	0	0	0	2	1
11.0103	Information Technology	480	328	152	117	65	2	67	22	173	34
11.0104	Informatics	1	1	0	0	1	0	0	0	0	0
11.0201	Computer Programming/Programmer, General	272	212	60	19	47	2	36	17	141	10
11.0202	Computer Programming, Specific Applications	97	65	32	1	10	2	7	7	61	9
11.0204	Computer Game Programming	0	0	0	0	0	0	0	0	0	0
11.0401	Information Science/Studies	147	119	28	34	24	0	18	4	61	6
11.0701	Computer Science	1,411	1,143	268	322	78	4	190	41	706	70
11.0902	Cloud Computing	18	14	4	1	5	0	0	0	6	6
14.0101	Engineering, General	51	44	7	2	1	0	2	3	43	0
14.0201	Aerospace, Aeronautical, and Astronautical/Space Engineering, General	110	88	22	24	3	0	3	6	68	6
14.0301	Agricultural Engineering	45	20	25	5	0	0	6	2	31	1
14.0501	Bioengineering and Biomedical Engineering	181	96	85	23	3	0	25	11	105	14

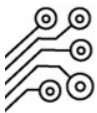| CIP Code	Description	2021 Total Awards	2021 Males	2021 Females	2021 International Students*	2021 Black or African American, non-Hispanic	2021 American Indian or Alaska Native	2021 Asian, Native Hawaiian or Other Pacific Islander	2021 Hispanic or Latino	2021 White, non-Hispanic	2021 Multiple or unknown race/ethnicity
14.0701	Chemical Engineering	191	141	50	48	2	0	13	6	118	4
14.0804	Transportation and Highway Engineering	0	0	0	0	0	0	0	0	0	0
14.0901	Computer Engineering, General	107	93	14	20	4	0	10	5	59	9
14.0903	Computer Software Engineering	52	49	3	15	3	0	3	0	27	4
14.1001	Electrical and Electronics Engineering	335	295	40	125	15	0	17	10	158	10
14.1099	Electrical, Electronics, and Communications Engineering, Other	6	6	0	0	0	0	3	0	3	0
14.1201	Engineering Physics/Applied Physics	11	9	2	1	1	0	0	0	9	0
14.1301	Engineering Science	7	6	1	2	1	0	0	0	4	0
14.1401	Environmental/Environmental Health Engineering	19	14	5	0	0	0	1	0	18	0
14.1801	Materials Engineering	81	53	28	14	1	0	4	7	53	2
14.1901	Mechanical Engineering	582	499	83	84	8	1	26	17	425	21
14.2701	Systems Engineering	19	11	8	2	2	0	1	1	9	4
14.3501	Industrial Engineering	130	79	51	24	7	0	10	4	80	5
14.3601	Manufacturing Engineering	53	38	15	5	4	0	4	1	32	7
14.3901	Geological/Geophysical Engineering	7	5	2	0	0	0	0	0	7	0
14.4201	Mechatronics, Robotics, and Automation Engineering	0	0	0	0	0	0	0	0	0	0
14.9999	Engineering, Other	30	16	14	2	0	0	2	1	22	3
15.0000	Engineering Technologies/Technicians, General	30	26	4	1	6	0	1	0	21	1
15.0303	Electrical, Electronic, and Communications Engineering Technology/Technician	102	94	8	0	6	0	24	2	62	8
15.0305	Telecommunications Technology/Technician	0	0	0	0	0	0	0	0	0	0
15.0403	Electromechanical/Electromechanical Engineering Technology/Technician	0	0	0	0	0	0	0	0	0	0
15.0404	Instrumentation Technology/Technician	37	35	2	0	2	0	2	2	28	3
15.0405	Robotics Technology/Technician	33	28	5	1	2	0	3	1	26	0
15.0406	Automation Engineer Technology/Technician	188	166	22	2	14	1	9	13	141	8
15.0499	Electromechanical Technologies/Technicians, Other	9	9	0	0	0	0	0	0	8	1
15.0612	Industrial Technology/Technician	30	24	6	3	0	0	1	1	20	5
15.0613	Manufacturing Engineering Technology/Technician	106	96	10	2	13	0	14	5	68	4
15.0702	Quality Control Technology/Technician	13	7	6	0	9	0	1	0	3	0
15.0703	Industrial Safety Technology/Technician	0	0	0	0	0	0	0	0	0	0
15.0805	Mechanical/Mechanical Engineering Technology/Technician	1	1	0	0	0	0	0	0	1	0
15.1201	Computer Engineering Technology/Technician	6	6	0	1	0	0	0	0	4	1
15.1202	Computer/Computer Systems Technology/Technician	78	65	13	1	9	0	11	4	49	4
15.1301	Drafting and Design Technology/Technician, General	1	1	0	0	0	0	0	0	1	0
15.1302	CAD/CADD Drafting and/or Design Technology/Technician	171	148	23	3	1	1	11	6	142	7
15.1305	Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD	4	4	0	0	0	0	0	0	4	0
15.1501	Engineering/Industrial Management	47	29	18	29	0	0	7	1	5	5

CIP Code	Description	2021 Total Awards	2021 Males	2021 Females	2021 International Students*	2021 Black or African American, non-Hispanic	2021 American Indian or Alaska Native	2021 Asian, Native Hawaiian or Other Pacific Islander	2021 Hispanic or Latino	2021 White, non-Hispanic	2021 Multiple or unknown race/ethnicity
15.1502	Engineering Design	13	6	7	0	3	0	0	1	8	1
15.1601	Nanotechnology	0	0	0	0	0	0	0	0	0	0
15.9999	Engineering/Engineering-Related Technologies/Technicians, Other	8	3	5	1	2	0	2	0	2	1
30.0801	Mathematics and Computer Science	0	0	0	0	0	0	0	0	0	0
30.7001	Data Science, General	19	10	9	2	3	0	2	0	10	2
40.1001	Materials Science	0	0	0	0	0	0	0	0	0	0
47.0303	Industrial Mechanics and Maintenance Technology/Technician	70	62	8	0	5	0	0	2	61	2
48.0501	Machine Tool Technology/Machinist	99	94	5	0	3	0	2	4	86	4
48.0503	Machine Shop Technology/Assistant	18	18	0	0	0	0	0	1	17	0
48.0508	Welding Technology/Welder	563	488	75	0	8	2	5	29	485	34
52.0202	Purchasing, Procurement/Acquisitions and Contracts Management	16	9	7	0	6	0	1	0	2	7
52.0203	Logistics, Materials, and Supply Chain Management	46	32	14	1	11	0	9	2	22	1
52.0205	Operations Management and Supervision	196	119	77	7	10	0	8	10	153	8
52.0216	Science/Technology Management	49	43	6	3	5	0	5	2	32	2
52.0409	Parts, Warehousing, and Inventory Management Operations	0	0	0	0	0	0	0	0	0	0
52.1301	Management Science	125	64	61	6	13	0	6	6	79	15
52.1801	Sales, Distribution, and Marketing Operations, General	181	96	85	8	6	1	9	13	138	6
	Total	**6,705**	**5,228**	**1,477**	**961**	**422**	**16**	**581**	**270**	**4,099**	**356**
	Percent of Total		**78.0%**	**22.0%**	**14.3%**	**6.3%**	**0.2%**	**8.7%**	**4.0%**	**61.1%**	**5.3%**

IPEDS SY2021 demographics by award conferred. Count of awards may double count individuals who obtained multiple credentials in the same calendar year. *NCES IPEDS refers to international students that do not have resident status in the United States as "nonresident aliens." This title aligns to Federal tax definitions and according to NCES IPEDS refers to "a person who is not a citizen or national of the United States and who is in this country on a visa or temporary basis and does not have the right to remain indefinitely. Note: Nonresident aliens are reported separately, rather than in any of the racial/ethnic categories." They are not included in calculations of BIPOC talent in this report as race and ethnicity information is not provided for these international students. The terminology of "international student" has been used in this report as it is more familiar to a common audience. https://nces.ed.gov/ipeds/report-your-data/race-ethnicity-definitions. For more information, view this article from Berkeley on tax filing status of international students. https://internationaloffice.berkeley.edu/taxes/tax-filing-status
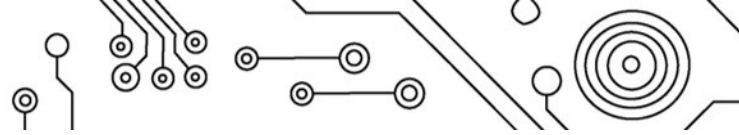
Talent Gap Analysis

Occupation Gaps

By 2027, many Core Semiconductor Occupations will have signification annual shortages in a baseline forecast scenario with the existing talent pipelines in place. In addition, the location of talent in relation to opportunities available may not be fully aligned. Annual shortages below indicate need across all industries of employment.[19]

Estimated Average Annual Core Semiconductor Occupation Gaps over Five Years, Minnesota 2022Q3

Supply Deficit		Supply Surplus	
Software Developers ($109,100)	−451	Team Assemblers ($40,800)	213
General and Operations Managers ($106,300)	−330	Inspectors, Testers, Sorters, Samplers, and Weighers ($48,100)	108
Maintenance and Repair Workers, General ($51,300)	−138	Shipping, Receiving, and Inventory Clerks ($42,900)	43
Industrial Machinery Mechanics ($65,300)	−101	Purchasing Agents, Except Wholesale, Retail, and Farm Products	20
Industrial Engineers ($101,100)	−84	Electrical, Electronic, and Electromechanical Equipment Assemble	4
Accountants and Auditors ($80,700)	−56	Plating Machine Setters, Operators, and Tenders, Metal and Plasti	3
Machinists ($55,700)	−41	Drilling and Boring Machine Tool Setters, Operators, and Tenders,	2
:-Line Supervisors of Production and Operating Workers ($72,700)	−32	Welding, Soldering, and Brazing Machine Setters, Operators, and T	2
Industrial Production Managers ($122,400)	−17	Milling and Planing Machine Setters, Operators, and Tenders, Met:	1
Mechanical Engineers ($90,800)	−14	Coil Winders, Tapers, and Finishers ($43,600)	1

Under an assumption that the Semiconductor Industry demand will continue to represent a similar occupation mix over the next five years, it is possible to estimate the average annual talent shortage for each core semiconductor occupation under a baseline forecast. Appoximately 102 of the total 2,255 five-year shortage of Software Developers statewide will impact the Semiconductor Industry.

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[19] Chmura Economics, 2022Q3 Dataset.

Estimated Average Annual Industry Talent Shortage for each Core Semiconductor Occupation in a Baseline Forecast, Minnesota 2022Q3

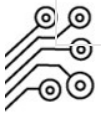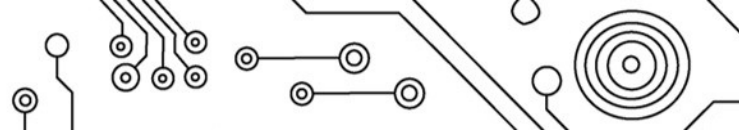| SOC | Occupation | Semiconductor Industry | | All Industries | | | | | | | | |
		Est. Annual Supply Gap	5-Year Supply Gap	Est. Annual Supply Gap	5-Year Supply Gap	Current Empl 2022Q3	Annual Growth Demand	Annual Sep Demand	Total Annual Demand	Projected Empl 2032	Accum. Supply 2032	Accum. Demand 2032
15-1252	Software Developers	(20)	(102)	(451)	(2,255)	41,203	782	2,936	3,718	49,020	18,703	23,214
11-1021	General and Operations Managers	(6)	(32)	(330)	(1,650)	65,062	298	5,770	6,069	68,047	37,645	40,945
49-9071	Maintenance and Repair Workers, General	(2)	(8)	(138)	(690)	28,275	89	2,779	2,868	29,169	18,744	20,120
49-9041	Industrial Machinery Mechanics	(1)	(5)	(101)	(505)	7,908	106	728	834	8,970	4,580	5,592
17-2112	Industrial Engineers	(6)	(31)	(84)	(420)	12,298	80	771	850	13,094	5,886	6,722
13-2011	Accountants and Auditors	(1)	(3)	(56)	(280)	28,987	83	2,522	2,605	29,818	18,562	19,119
51-4041	Machinists	(1)	(3)	(41)	(205)	10,687	16	1,140	1,156	10,847	7,335	7,744
51-1011	First-Line Supervisors of Production and Operating Workers	(1)	(4)	(32)	(160)	13,794	-26	1,406	1,380	13,531	9,115	9,439
11-3051	Industrial Production Managers	(0)	(1)	(17)	(85)	5,084	-2	360	358	5,064	2,545	2,719
17-2141	Mechanical Engineers	(0)	(1)	(14)	(70)	6,313	-3	371	369	6,288	2,951	3,089
17-3026	Industrial Engineering Technologists and Technicians	(1)	(3)	(13)	(65)	3,117	1	302	303	3,124	1,846	1,979
17-2071	Electrical Engineers	(0)	(1)	(12)	(60)	4,214	4	262	266	4,255	2,011	2,126
11-9041	Architectural and Engineering Managers	(0)	(1)	(9)	(45)	4,168	-1	291	291	4,162	2,122	2,208
17-2072	Electronics Engineers, Except Computer	(0)	(1)	(9)	(45)	1,637	10	104	114	1,734	782	868
43-5061	Production, Planning, and Expediting Clerks	(0)	(0)	(7)	(35)	6,477	16	720	736	6,640	4,649	4,720
17-2199	Engineers, All Other	-	-	(4)	(20)	1,981	0	127	126	1,978	942	981
17-2061	Computer Hardware Engineers	(0)	(0)	(2)	(10)	777	2	49	51	792	373	388
17-3023	Electrical and Electronic Engineering Technologists and Technicians	(0)	(0)	(2)	(10)	2,055	-9	215	206	1,966	1,230	1,248
17-2131	Materials Engineers	-	-	(1)	(5)	438	1	30	30	443	226	241
51-9194	Etchers and Engravers	-	-	0	0	172	0	18	18	171	145	140
17-3024	Electro-Mechanical and Mechatronics Technologists and Technicians	-	-	0	0	288	-2	27	25	269	172	171
19-2032	Materials Scientists	-	-	0	0	132	0	11	11	135	85	87
17-3012	Electrical and Electronics Drafters	-	-	0	0	441	-1	40	39	427	266	268
51-8099	Plant and System Operators, All Other	-	-	0	0	319	-1	33	32	307	214	219
51-2021	Coil Winders, Tapers, and Finishers	-	-	1	5	112	-2	12	9	90	90	78
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	-	-	1	5	196	-3	25	22	165	139	130

SOC	Occupation	Semiconductor Industry		All Industries								
		Est. Annual Supply Gap	5-Year Supply Gap	Est. Annual Supply Gap	5-Year Supply Gap	Current Empl 2022Q3	Annual Growth Demand	Annual Sep Demand	Total Annual Demand	Projected Empl 2032	Accum. Supply 2032	Accum. Demand 2032
51-9141	Semiconductor Processing Technicians	0	0	1	5	376	0	43	43	373	301	292
41-9031	Sales Engineers	-	-	1	5	1,169	4	123	127	1,210	862	855
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	-	-	2	10	720	-7	74	68	653	518	499
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	-	-	2	10	236	-5	29	24	188	168	151
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	-	-	3	15	948	-11	94	82	834	643	611
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	1	3	4	20	7,838	-6	889	884	7,781	6,276	6,237
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	0	1	20	100	6,792	-60	684	623	6,189	4,141	3,940
43-5071	Shipping, Receiving, and Inventory Clerks	1	3	43	215	15,540	-144	1,635	1,490	14,096	10,673	10,238
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	4	22	108	540	11,313	-176	1,284	1,108	9,551	9,323	8,247
51-2092	Team Assemblers	7	37	213	1,065	26,021	-419	2,810	2,390	21,827	20,614	18,483
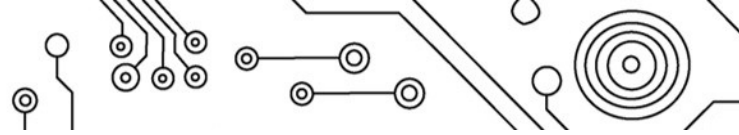
Award Gaps

Minnesota postsecondary institutions are underproducing graduates from programs aligned to all of the 36 core semiconductor occupations when compared to national benchmarks for how many awards are typically conferred per local demand. This award gap coupled with the talent shortages highlighted above suggest that increasing the volume of graduates out of existing these programs, or building new two- and four-year programs that would fill the shortages of new talent needed to enter into the occupations listed below.[20]

Estimated Award Gaps, Minnesota 2022Q3

Occupation	Supply Deficit
General and Operations Managers	−1,153
Software Developers	−537
Industrial Engineers	−251
Engineering Technologists and Technicians	−166
Industrial Production Managers	−65
Shipping, Receiving, and Inventory Clerks	−63
Industrial Machinery Mechanics	−57
Electrical Engineers	−54
, Except Coil Winders, Tapers, and Finishers	−40
Engineers, All Other	−27

Skill Misalignments

Most specialized skills are found more frequently in online talent profiles than in job postings. Among job postings by Semiconductor Industry employers for core semiconductor occupations, continuous improvement processes, the ability to utilize productivity software, and familiarity with Cisco WebEx were listed more frequently in postings than talent profiles. Otherwise, all other specialized skills such as semiconductor manufacturing, electrical engineering, and new product development were featured more prominently by talent than employers seeking workers.

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[20] Chmura Economics, 2022Q3 Dataset.

Percent of 2022 Core Semiconductor Occupation Job Postings and Online Talent Profiles in Minnesota Indicating

Specialized Skills and Software Skills
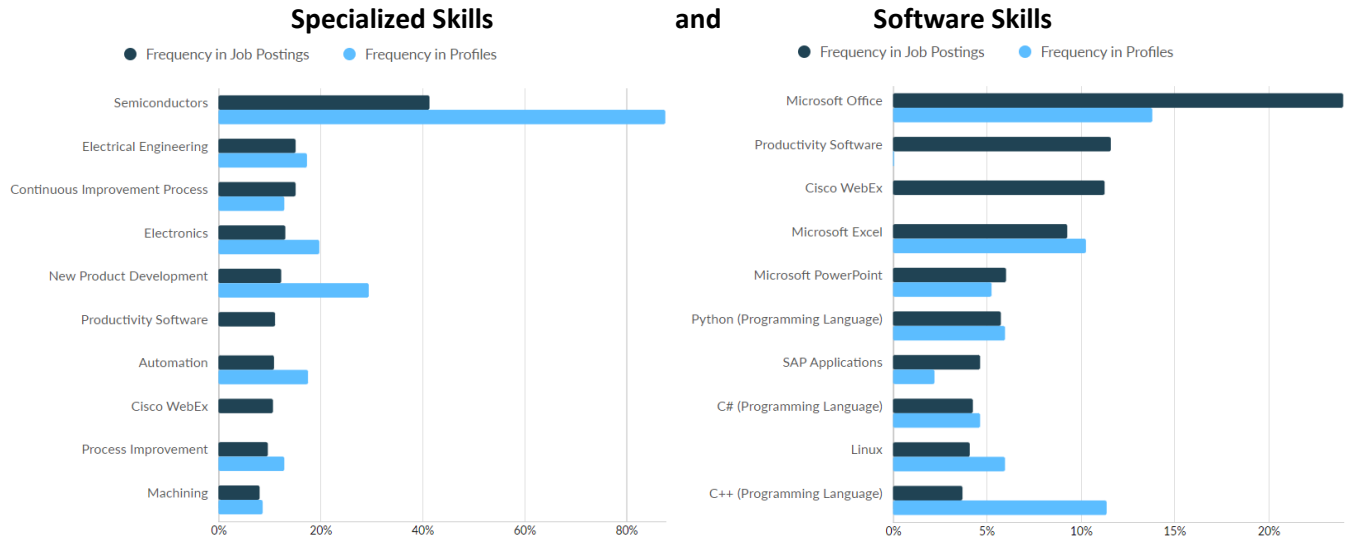
Several baseline requirements, such as customer service, communications, and operations management have been trending up at the close of 2022, while several core skills mentioned above are less frequent now in job postings than in prior years. The chart below indicates skills that have increased in frequency in online job postings between January and December 2022 (shown in green) and those that have declined in frequency (shown in red). Overall, there has been a decrease in focus on technical skills in analog design, integrated circuits, semiconductors, and QA/QC over the year.

Core Semiconductor Occupation Hot and Cold Skills in Demand in Minnesota, 2022
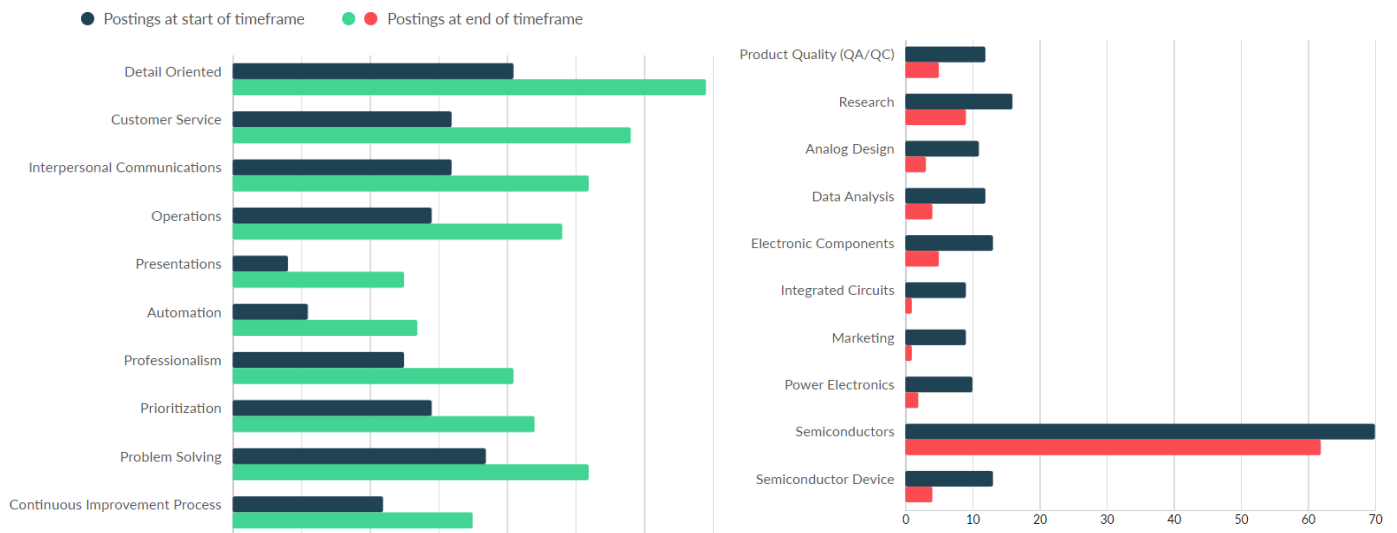
High Need, High Demand Pathways

There were a total of 6,705 awards conferred at 61 different Minnesota postsecondary institutions in programs aligned to the top production, manufacturing, information technology, AI, and logistics needs of the Semiconductor Industry in SY2021. The average school had about 110 completions, ranging from one to 2,087 completions.[21]

61	6,705	Completions Distribution
Institutions	Completions	Average: 109.9
-3% Growth (2017-2021)	9% Growth (2017-2021)	1 ⊦⊦————— 2,087
		Median: 54

Trends in Postsecondary Program Awards Aligned to Critical Semiconductor Talent Pipelines, SY2021
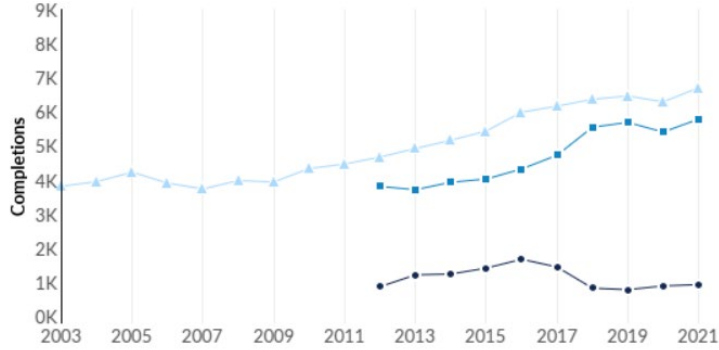
		Completions (2021)	% Completions	Institutions (2021)	% Institutions
●	All Programs	6,705	100%	61	100%
●	Distance Offered Programs	924	14%	26	43%
●	Non-Distance Offered Programs	5,781	86%	55	90%

Over half (52.8%) of all completions were conferred by public four-year institutions, with the University of Minnesota-Twin Cities having the most related awards conferred in SY2021 (2,087).

Postsecondary Program Awards Aligned to Critical Semiconductor Talent Pipelines by Institution, SY2021
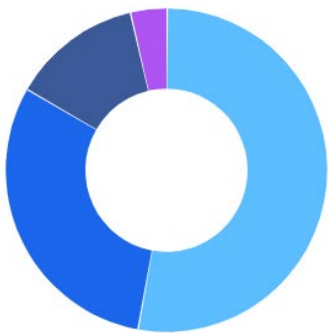
	Institution Type	Completions (2021)	Market Share
●	Public, 4-year or above	3,538	52.8%
●	Public, 2-year	2,044	30.5%
●	Private not-for-profit, 4-year or above	877	13.1%
●	Private for-profit, 4-year or above	246	3.7%

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[21] NCES IPEDS SY2021 data visualized in Lightcast.

Completions by Institution

Institution	Completions (2021)	Growth % YOY (2021)	Market Share (2021)	IPEDS Tuition & Fees (2021)	Completions Trend (2017-2021)
University of Minnesota-Twin Cities	2,087	7.0%	31.1%	$15,254	
University of St Thomas	454	0.0%	6.8%	$48,329	
University of Minnesota-Duluth	332	-4.9%	5.0%	$13,850	
Saint Cloud State University	266	3.9%	4.0%	$9,170	
Minnesota State University-Mankato	264	-7.0%	3.9%	$9,146	
Hennepin Technical College	261	12.0%	3.9%	$5,741	
Metropolitan State University	252	5.4%	3.8%	$9,394	
Capella University	235	-7.8%	3.5%	$14,148	
Anoka Technical College	194	-7.6%	2.9%	$6,075	
North Hennepin Community College	154	63.8%	2.3%	$4,882	
Dunwoody College of Technology	129	-7.2%	1.9%	$23,863	
Ridgewater College	123	12.8%	1.8%	$5,914	
Minnesota State University Moorhead	103	9.6%	1.5%	$9,468	
Minneapolis Community and Technical College	101	74.1%	1.5%	$5,906	
Winona State University	90	18.4%	1.3%	$10,184	
Century College	88	12.8%	1.3%	$5,907	
Minnesota State Community and Technical College	86	11.7%	1.3%	$5,862	
Normandale Community College	84	20.0%	1.3%	$5,789	
Alexandria Technical & Community College	81	2.5%	1.2%	$5,910	
Dakota County Technical College	80	6.7%	1.2%	$6,208	
St Cloud Technical and Community College	80	60.0%	1.2%	$5,874	
Central Lakes College-Brainerd	76	7.0%	1.1%	$5,954	
Minnesota State College Southeast	72	24.1%	1.1%	$6,562	
Saint Paul College	70	25.0%	1.0%	$6,041	
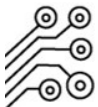
Lake Superior College	68	65.9%	1.0%	$5,616
Riverland Community College	66	164.0%	1.0%	$6,060
South Central College	63	-34.4%	0.9%	$5,966
University of Minnesota-Crookston	62	10.7%	0.9%	$12,514
Mesabi Range College	60	-10.4%	0.9%	$5,788
Pine Technical & Community College	58	-4.9%	0.9%	$4,489
Carleton College	54	-23.9%	0.8%	$60,225
Bemidji State University	52	30.0%	0.8%	$9,806
Minnesota West Community and Technical College	47	27.0%	0.7%	$6,286
Northland Community and Technical College	44	22.2%	0.7%	$6,052
Rochester Community and Technical College	41	-16.3%	0.6%	$5,372
Saint Johns University	33	73.7%	0.5%	$49,842
University of Northwestern-St Paul	32	23.1%	0.5%	$34,180
Hamline University	26	30.0%	0.4%	$46,221
St Olaf College	25	-7.4%	0.4%	$52,670
Anoka-Ramsey Community College	23	21.1%	0.3%	$5,515
Concordia University-Saint Paul	22	37.5%	0.3%	$23,900
Augsburg University	22	0.0%	0.3%	$41,007
Saint Mary's University of Minnesota	20	-9.1%	0.3%	$39,410
University of Minnesota-Morris	17	-22.7%	0.3%	$13,848
Inver Hills Community College	15	25.0%	0.2%	$5,809
Southwest Minnesota State University	13	0.0%	0.2%	$9,482
The College of Saint Scholastica	13	333.3%	0.2%	$39,410
Concordia College at Moorhead	10	25.0%	0.1%	$28,016
Rasmussen University-Minnesota	8	-11.1%	0.1%	$13,558
Bethel University	8	-11.1%	0.1%	$40,080

Postsecondary Program Awards Aligned to Critical Semiconductor Talent Pipelines by Level, SY2021
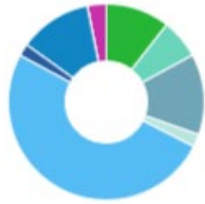
Award Level	Completions (2021)	Percent	
● Award of less than 1 academic year	708	10.6%	▬
● Award of at least 1 but less than 2 academic years	438	6.5%	▬
● Associate's Degree	893	13.3%	▬
● Award of at least 2 but less than 4 academic years	140	2.1%	▌
● Bachelor's Degree	3,378	50.4%	▬▬▬▬
● Postbaccalaureate certificate	136	2.0%	▌
● Master's Degree	801	11.9%	▬
● Post-masters certificate	3	0.0%	▏
● Doctor's Degree	208	3.1%	▌

CIP Code	Description	Cert. < 1 Yr	Cert. 1+ but < 2 Yr	Associate's	Cert. 2+ but < 4 Yr	Bachelor's	Post-Bacc.	Master's	Post-Master's	Doctorate	Total Awards
11.0701	Computer Science	-	-	148	-	1,117	-	118	-	28	1,411
14.1901	Mechanical Engineering	-	-	-	-	477	-	80	-	25	582
48.0508	Welding Technology/Welder	173	309	38	43	-	-	-	-	-	563
11.0103	Information Technology	14	-	30	-	219	68	118	3	28	480
14.1001	Electrical and Electronics Engineering	-	-	-	-	212	-	92	-	31	335
11.0201	Computer Programming/Programmer, General	155	4	105	2	6	-	-	-	-	272
52.0205	Operations Management and Supervision	20	5	-	-	171	-	-	-	-	196
14.0701	Chemical Engineering	-	-	-	-	159	-	9	-	23	191
15.0406	Automation Engineer Technology/Technician	25	35	111	17	-	-	-	-	-	188
52.1801	Sales, Distribution, and Marketing Operations, General	13	10	82	-	76	-	-	-	-	181
14.0501	Bioengineering and Biomedical Engineering	-	-	1	-	80	-	76	-	24	181
15.1302	CAD/CADD Drafting and/or Design Technology/Technician	71	4	92	4	-	-	-	-	-	171
11.0401	Information Science/Studies	4	2	13	-	104	4	20	-	-	147
14.3501	Industrial Engineering	-	-	-	-	102	-	23	-	5	130
52.1301	Management Science	4	-	-	-	23	29	64	-	5	125
14.0201	Aerospace, Aeronautical, and Astronautical/Space Engineering, General	-	-	-	-	76	-	20	-	14	110
14.0901	Computer Engineering, General	-	-	-	-	107	-	-	-	-	107
15.0613	Manufacturing Engineering Technology/Technician	53	-	23	12	17	-	1	-	-	106
15.0303	Electrical, Electronic, and Communications Engineering Technology/Technician	21	6	58	8	9	-	-	-	-	102
48.0501	Machine Tool Technology/Machinist	32	32	14	21	-	-	-	-	-	99

| CIP Code	Description	Cert. < 1 Yr	Cert. 1+ but < 2 Yr	Associate's	Cert. 2+ but < 4 Yr	Bachelor's	Post-Bacc.	Master's	Post-Master's	Doctorate	Total Awards
11.0202	Computer Programming, Specific Applications	45	21	15	-	16	-	-	-	-	97
14.1801	Materials Engineering	-	-	-	-	59	-	8	-	14	81
15.1202	Computer/Computer Systems Technology/Technician	5	2	71	-	-	-	-	-	-	78
47.0303	Industrial Mechanics and Maintenance Technology/Technician	35	1	3	31	-	-	-	-	-	70
14.3601	Manufacturing Engineering	-	-	-	-	27	16	10	-	-	53
14.0903	Computer Software Engineering	-	-	5	-	33	-	14	-	-	52
14.0101	Engineering, General	-	-	-	-	48	1	2	-	-	51
52.0216	Science/Technology Management	-	-	-	-	26	-	23	-	-	49
15.1501	Engineering/Industrial Management	-	-	-	-	1	-	46	-	-	47
52.0203	Logistics, Materials, and Supply Chain Management	-	-	8	-	38	-	-	-	-	46
14.0301	Agricultural Engineering	-	-	-	-	40	-	-	-	5	45
15.0404	Instrumentation Technology/Technician	-	-	35	2	-	-	-	-	-	37
15.0405	Robotics Technology/Technician	1	-	31	-	-	-	1	-	-	33
15.0612	Industrial Technology/Technician	3	-	-	-	27	-	-	-	-	30
14.9999	Engineering, Other	-	-	-	-	-	9	21	-	-	30
15.0000	Engineering Technologies/Technicians, General	-	-	5	-	25	-	-	-	-	30
30.7001	Data Science, General	-	-	-	-	16	-	3	-	-	19
14.2701	Systems Engineering	-	-	-	-	-	-	19	-	-	19
14.1401	Environmental/Environmental Health Engineering	-	-	-	-	19	-	-	-	-	19
11.0902	Cloud Computing	-	-	-	-	18	-	-	-	-	18
48.0503	Machine Shop Technology/Assistant	13	5	-	-	-	-	-	-	-	18
52.0202	Purchasing, Procurement/Acquisitions and Contracts Management	-	-	-	-	-	-	10	-	6	16
15.0702	Quality Control Technology/Technician	11	2	-	-	-	-	-	-	-	13
15.1502	Engineering Design	-	-	-	-	-	-	13	-	-	13
14.1201	Engineering Physics/Applied Physics	-	-	-	-	11	-	-	-	-	11
15.0499	Electromechanical Technologies/Technicians, Other	9	-	-	-	-	-	-	-	-	9
15.9999	Engineering/Engineering-Related Technologies/Technicians, Other	-	-	-	-	-	-	8	-	-	8
14.1301	Engineering Science	-	-	-	-	7	-	-	-	-	7
14.3901	Geological/Geophysical Engineering	-	-	-	-	5	-	2	-	-	7
14.1099	Electrical, Electronics, and Communications Engineering, Other	-	-	-	-	-	6	-	-	-	6
15.1201	Computer Engineering Technology/Technician	-	-	-	-	6	-	-	-	-	6
15.1305	Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD	-	-	4	-	-	-	-	-	-	4
11.0102	Artificial Intelligence	-	-	-	-	-	3	-	-	-	3
15.1301	Drafting and Design Technology/Technician, General	1	-	-	-	-	-	-	-	-	1
15.0805	Mechanical/Mechanical Engineering Technology/Technician	-	-	1	-	-	-	-	-	-	1
11.0104	Informatics	-	-	-	-	1	-	-	-	-	1
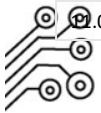
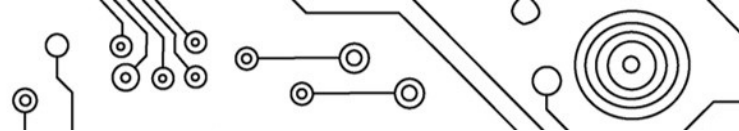| CIP Code	Description	Cert. < 1 Yr	Cert. 1+ but < 2 Yr	Associate's	Cert. 2+ but < 4 Yr	Bachelor's	Post-Bacc.	Master's	Post-Master's	Doctorate	Total Awards
30.0801	Mathematics and Computer Science	-	-	-	-	-	-	-	-	-	-
40.1001	Materials Science	-	-	-	-	-	-	-	-	-	-
15.1601	Nanotechnology	-	-	-	-	-	-	-	-	-	-
15.0703	Industrial Safety Technology/Technician	-	-	-	-	-	-	-	-	-	-
15.0305	Telecommunications Technology/Technician	-	-	-	-	-	-	-	-	-	-
14.4201	Mechatronics, Robotics, and Automation Engineering	-	-	-	-	-	-	-	-	-	-
14.0804	Transportation and Highway Engineering	-	-	-	-	-	-	-	-	-	-
11.0204	Computer Game Programming	-	-	-	-	-	-	-	-	-	-
52.0409	Parts, Warehousing, and Inventory Management Operations	-	-	-	-	-	-	-	-	-	-
15.0403	Electromechanical/Electromechanical Engineering Technology/Technician	-	-	-	-	-	-	-	-	-	-
	Total	708	438	893	140	3,378	136	801	3	208	6,705
	Percent	10.6%	6.5%	13.3%	2.1%	50.4%	2.0%	11.9%	0.0%	3.1%	100.0%

Promising Approaches to Addressing Possible Misalignments

A multi-pronged approach is required to ensure that Minnesota has sufficient talent entering the Semiconductor Industry in the years ahead to sustain necessary growth. First, as a priority of the GreaterMSP Partnership to advance equitable and inclusive economic growth across the greater Minneapolis-Saint Paul Region, featuring opportunities for greater inclusion in the high-wage, high-demand careers in the Semiconductor Industry is paramount. Minnesota's Semiconductor Industry has a higher representation of female talent than observed nationally, but only 28.4% of talent in Core Semiconductor Occupations are female and about 22% of 2021 postsecondary awards were conferred by female graduates. As is true across all occupations of employment in Minnesota, local talent diversity by race and ethnicity is lower in the Semiconductor Industry than in other states, but that diversity is increasing. About 16% of the workforce in Core Semiconductor Occupations are BIPOC by race, and another 3.6% are Hispanic or Latinx. This matches closely to the 19.2% of graduates from related programs that are BIPOC. Unfortunately, Black and African American talent represent a smaller share of the Core Semiconductor Occupation workforce (4.2%) and 2021 graduate pool (6.3%) than their representation across all occupations or postsecondary programs. Additional efforts are needed to expand pathways of opportunity for Black and African American talent in the Semiconductor Industry in particular.

Second, meaningful strategies must be developed in accordance with the realities of 1) immediate talent shortage that cross industry lines, 2) availability of talent outside the semiconductor industry, and 3) factoring in the education, training, and reskilling needs of both the existing talent pool and the new, emergent talent to be developed in years to come. Occupations across the Origin-Gateway-Target career pathway model have been distributed into two groups defined by Lightcast in their *Rebuilding Our Semiconductor Workforce* report published in February 2023. Reskill Occupations are "those that are undersupplied across the entire labor market," meaning that Minnesota's existing talent pool does not have enough workers to fill current or future openings under a baseline forecast. Redeploy Occupations are positions where "there may be enough trained workers in the broader economy but not enough workers going into the Semiconductor Industry specifically. Workers in these roles have the necessary skills to work in the semiconductor industry, they just need to be recruited." The sections that follow emphasize the Reskill Occupations in immediate talent shortage today and the Redeploy Occupations that can be drawn into the Semiconductor Industry's talent pool with some strategic efforts.
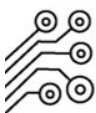
Reskill Occupations

Reskill Occupations are those positions that Minnesota does not have enough local talent to fill existing openings, let alone to meet additional demand that new semiconductor production would require. The long-term solution for these positions is to develop robust education and training pipelines that fill these gaps with higher volumes of graduates from local postsecondary programs, apprenticeships, and industry training programs. In the short-term, these positions need to be filled by talent found in other occupations with similar skill profiles and areas of knowledge, and retrained in rapid fashion to meet existing talent needs. This reskilling approach is both faster and more affordable than the long-term education pipeline approach. Community-based organizations, CareerForce centers, Customized Training, industry dual pipeline, and other training programs are well-equipped to come together to meet short-term needs for Reskill Occupations while also working directly with postsecondary education. Collectively they must work to ensure longer-term alignment of credential and skill attainment of those retrained to the educational experience one would gain in formal postsecondary education, and build in postsecondary credits and stackable credentials where possible.

According to Lightcast's *Rebuilding Our Semiconductor Workforce*, we are likely to see significant shortages of talent in engineer and technician-level technical careers; the report classifies likely shortages into severe, moderate, and minor talent undersupply of talent over the next three to five years.

Reskill Occupation Talent Undersupplied at the National Level, Under Lightcast Analysis of Talent Supply and Demand[22]

Note from the original report: "An occupation that has a Severe undersupply has a demand that is at least 4 times greater than the new supply. A Moderate undersupply means that an occupation's new demand is between 2 to 4 times greater than the new supply. And a Minor undersupply means that the new demand is less than 2 times as great as the new supply."

Many of the same occupations in severe and moderate shortage nationwide are Reskill Occupations in Minnesota as well, but in Minnesota the majority have moderate forecast shortages—calculated here as an estimated 57-67% of the total needed talent supply being available locally through existing talent pipelines to support the workforce needed to double the Semiconductor Industry's total production in Minnesota. This analysis diverges somewhat from Lightcast's analysis, as this study uses a different scale for the tiers of severity of the forecast shortages, and this

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[22] Lightcast. Rebuilding Our Semiconductor Workforce. 2023.

study specifically evaluates undersupply dependent only on the Semiconductor Industry rather than the needed new supply across the entire economy, as the Lightcast report does for Reskill Occupations. The graphic and table below indicates the baseline talent shortage and additional talent need for the Semiconductor Industry alone over the next five years. Minor shortage occupations are largely in the business, management, and administration career pathway and may be successful in drawing talent from other industries, and are largely Origin and Gateway Occupations. Severe shortage occupations are in Information Technology, Operations Management, Maintenance, Market Research, and Financial Management career pathways, which have broad shortages currently across all industries in Minnesota. All but one of the five occupations in most severe shortage are Target Occupations.

Top Volume Reskill Occupation Talent Undersupplied in Minnesota to support Doubling Semiconductor Industry Output over the Next Five Years

Severe — <57% of Talent Supply Available to Double Semiconductor Industry Output by 2027

- SOC 15-1252 Software Developers (382 worker shortfall)—Target Occupation
- SOC 11-1021 General and Operations Managers (151 worker shortfall)—Target Occupation
- SOC49-9071 Maintenance and Repair Workers, General (79 worker shortfall)—Gateway Occupation
- SOC 13-1161 Market Research Analysts and Marketing Specialists (53 worker shortfall)—Target Occupation
- SOC 11-3031 Financial Managers (44 worker shortfall)—Target Occupation

Moderate — 57.1%-67% of Talent Supply Available to Double Semiconductor Industry Output by 2027

- SOC 51-2028 Electrical, Electronic, and Electrical Equipment Assemblers (824 worker shortfall)—Gateway Occupation
- SOC 17-2112 Industrial Engineers (478 worker shortfall)—Target Occupation
- SOC 17-3026 Industrial Engineering Techs (269 worker shortfall)—Target Occupation
- SOC 51-9141 Semiconductor Processing Techs (215 worker shortfall)—Origin Occupation
- SOC 17-3023 Electrical and Electronic Engineering Techs (108 worker shortfall)—Gateway Occupation

Minor — 67.1% or more of Talent Supply Available to Double Semiconductor Industry Output by 2027

- SOC 43-9061 Office Clerks, General (36 worker shortfall)—Gateway Occupation
- SOC 43-4051 Customer Service Representatives (25 worker shortfall)—Origin Occupation
- SOC 43-6014 Secretaries and Administrative Assistants (24 worker shortfall)—Gateway Occupation

The most efficient path to crafting a workforce with aligned, relevant skills in these occupations is to draw on workers from other occupations that share similar skills. By building on the skills of current workers and adding the specific skills needed in the Semiconductor Industry, the industry can quickly ramp up talent into the jobs that need to be filled. This is referred to as "reskilling." Reskilling is frequently accomplished through on-the-job training, in-house training programs at private employers, bootcamps, classroom professional development courses, or talent pipeline programs through state Departments of Labor and Industry. But for the process to be successful, it's important to identify the specific skills necessary in a particular occupation and then determine which workers have those skills, or have the potential to acquire them through additional training and education.

All Reskill Occupation Talent Undersupplied in Minnesota to support Doubling Semiconductor Industry Output over the Next Five Years, Sorted in order of Total Talent Supply Shortfall

SOC	Occupation	All Industries — Baseline 5-Year All-Industry Supply Gap, 2027	Semiconductor Industry — 2022Q3 Industry Empl	Baseline Forecast — Forecast Empl Demand 2027	Baseline Forecast — 5-Year In-Industry Supply Gap by 2027	Doubled Production Forecast — Forecast Empl 2027	Doubled Production Forecast — 5-Year In-Industry Supply Gap by 2027	Doubled Production Forecast — Share of Total Industry Talent Need Met	OGT Pathway Level
51-2028	Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	20	1,274	1,272	3	2,100	(824)	61%	Gateway
17-2112	Industrial Engineers	(420)	689	739	(31)	1,136	(478)	58%	Target
15-1252	Software Developers	(2,255)	430	462	(102)	709	(382)	46%	Target
17-3026	Industrial Engineering Technologists and Technicians	(65)	411	410	(3)	677	(269)	60%	Target
51-9141	Semiconductor Processing Technicians	5	331	330	0	546	(215)	61%	Origin
17-3023	Electrical and Electronic Engineering Technologists and Technicians	(10)	276	262	(0)	456	(180)	61%	Gateway
51-1011	First-Line Supervisors of Production and Operating Workers	(160)	238	237	(4)	392	(158)	60%	Target
17-2072	Electronics Engineers, Except Computer	(45)	235	252	(1)	387	(154)	60%	Target
11-1021	General and Operations Managers	(1,650)	183	183	(32)	302	(151)	50%	Target
11-9041	Architectural and Engineering Managers	(45)	208	207	(1)	343	(136)	60%	Target
17-2071	Electrical Engineers	(60)	194	205	(1)	320	(127)	60%	Target
17-2141	Mechanical Engineers	(70)	149	149	(1)	246	(98)	60%	Target
51-4041	Machinists	(205)	122	122	(3)	201	(82)	59%	Gateway
17-2061	Computer Hardware Engineers	(10)	123	123	(0)	203	(80)	61%	Target
13-2011	Accountants and Auditors	(280)	117	117	(3)	192	(79)	59%	Target
49-9071	Maintenance and Repair Workers, General	(690)	110	109	(8)	181	(79)	56%	Gateway
11-3051	Industrial Production Managers	(85)	118	118	(1)	194	(78)	60%	Target
49-9041	Industrial Machinery Mechanics	(505)	97	107	(5)	161	(68)	57%	Target
43-5061	Production, Planning, and Expediting Clerks	(35)	101	101	(0)	167	(66)	60%	Gateway
51-4121	Welders, Cutters, Solderers, and Brazers	(120)	87	86	(1)	144	(58)	60%	Gateway
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	(40)	86	85	(0)	141	(56)	60%	Target
11-3021	Computer and Information Systems Managers	(245)	78	78	(2)	129	(53)	59%	Target
51-9199	Production Workers, All Other	(20)	81	81	(0)	133	(53)	61%	Gateway
13-1161	Market Research Analysts and Marketing Specialists	(715)	73	76	(5)	120	(53)	56%	Target
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	(15)	76	76	(0)	125	(49)	61%	Target
13-1082	Project Management Specialists	(200)	73	73	(2)	120	(49)	59%	Target
11-3031	Financial Managers	(800)	60	63	(5)	99	(44)	56%	Target
13-1071	Human Resources Specialists	(190)	64	63	(1)	106	(43)	59%	Target
17-2199	Engineers, All Other	(20)	60	60	(0)	98	(39)	61%	Target
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	15	55	52	0	91	(36)	61%	Origin
13-1199	Business Operations Specialists, All Other	(290)	51	51	(2)	84	(35)	59%	Target
11-2022	Sales Managers	(135)	49	49	(1)	81	(33)	60%	Target
13-2051	Financial and Investment Analysts	(105)	49	49	(1)	81	(32)	60%	Target
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	10	49	46	0	80	(32)	61%	Gateway
15-1211	Computer Systems Analysts	(195)	46	45	(1)	76	(31)	59%	Target
13-1081	Logisticians	(200)	44	49	(1)	72	(29)	59%	Target
11-2021	Marketing Managers	(110)	44	44	(1)	72	(29)	60%	Target
41-9031	Sales Engineers	5	43	43	0	71	(28)	61%	Target
15-1253	Software Quality Assurance Analysts and Testers	(145)	34	37	(1)	56	(23)	60%	Target

SOC	Occupation	All Industries	Semiconductor Industry						
			2022Q3	Baseline Forecast		Doubled Production Forecast			
		Baseline 5-Year All-Industry Supply Gap, 2027	Industry Empl	Forecast Empl Demand 2027	5-Year In-Industry Supply Gap by 2027	Forecast Empl 2027	5-Year In-Industry Supply Gap by 2027	Share of Total Industry Talent Need Met	OGT Pathway Level
17-3029	Engineering Technologists and Technicians, Except Drafters, All Other	(20)	34	34	(0)	56	(22)	61%	Target
13-1151	Training and Development Specialists	(115)	32	32	(0)	53	(21)	60%	Target
15-1232	Computer User Support Specialists	0	32	31	0	53	(21)	61%	Target
51-9124	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	(35)	31	31	(0)	52	(20)	60%	Gateway
11-3061	Purchasing Managers	(25)	31	31	(0)	51	(20)	60%	Target
15-1299	Computer Occupations, All Other	(135)	30	29	(0)	49	(20)	60%	Target
13-1111	Management Analysts	(545)	26	26	(2)	43	(19)	57%	Target
51-8099	Plant and System Operators, All Other	0	28	27	0	47	(18)	61%	Gateway
15-1244	Network and Computer Systems Administrators	(80)	28	27	(0)	46	(18)	60%	Target
11-9199	Managers, All Other	(190)	27	27	(1)	45	(18)	59%	Target
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	(35)	26	26	(0)	43	(17)	60%	Gateway
17-3012	Electrical and Electronics Drafters	0	24	24	0	39	(16)	61%	Target
11-3121	Human Resources Managers	(90)	24	24	(0)	39	(15)	60%	Target
15-1231	Computer Network Support Specialists	(165)	23	23	(0)	38	(15)	60%	Target
17-2131	Materials Engineers	(5)	23	23	(0)	38	(15)	61%	Target
	Total (including 769 other occupations not listed above)	(36,450)	9,487	9,457	(228)	15,634	(6,375)	59%	

Beyond expanding talent pipelines, reskilling has the additional advantage of potentially leading the Semiconductor Industry to become more diverse. For example, there's substantial skill overlap between the Welding, Soldering, and Brazing Machine Setters, Operators and Tenders occupation (important to the Semiconductor Industry and forecasting shortages in targets to double Semiconductor Industry output) and the Team Assemblers occupation (which has no baseline talent shortage). In the first occupation, 18.9% of all Minnesota workers are BIPOC by race or ethnicity, while in the next, 22.8% are, and the average annual salary is higher for the first occupation by about $7,000. Increased mobility between the two would help diversify the higher-level Gateway Occupation while also improving workforce equity and opening new doors for more BIPOC talent. For ease of interpretation of strategy possibilities, aligned postsecondary award data for the 2021 school year, the presence of an award gap aligning to the occupation, and demographics of talent and graduates are included in the table below for up to the top five Origin, Gateway, and Target Occupations requiring Reskilling. All Reskill Occupations shown below, regardless of level on the Origin-Gateway-Target Model, are forecasting talent shortages and have lower shares of their 2021 graduate talent that are female or BIPOC talent than the overall graduating pool of talent; the outlook for diversifying the sector is grim if the demographic mix of graduates coming through local programs continue to remain consistent with recent graduate trends.

Reskill Strategy Summary Table, Minnesota 2022

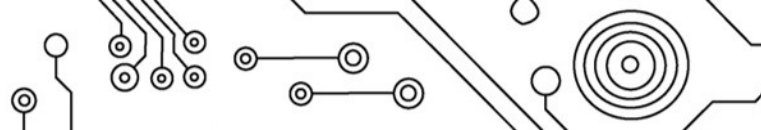| Occupation	Related Programs	2022Q3 Industry Empl	Baseline Talent Shortage	Doubled Production Forecast Talent Shortage	Workforce BIPOC by Race	Workforce Hispanic/ Latinx	Workforce Female	Workforce Over 55	SY2021 Graduates	Award Gap (All Award Levels)	Graduates BIPOC by Race or Ethnicity (All Award Levels)***	Graduates Female (All Award Levels)
Target Occupations												
Industrial Engineers	• Industrial Engineering • Manufacturing Engineering • Engineering/Industrial Management • Systems Engineering	689	Y	(478)	16.7%	1.2%	24.2%	24.9%	249	Y	16.9%	36.9%
Software Developers	13 programs including: • Computer Science • Information Technology • Computer Programming	430	Y	(382)	34.8%	1.5%	18.5%	14.5%	2,607	Y	26.0%	21.9%
Industrial Engineering Technologists and Technicians	• Manufacturing Engineering Technology • Industrial Technology/Technician • Quality Control Technology	411	Y	(269)	11.4%	3.3%	21.4%	23.8%	149	Y	29.5%	14.8%
First-Line Supervisors of Production and Operating Workers	• Operations Management and Supervision	238	Y	(158)	10.0%	4.4%	19.9%	26.6%	196	Y	14.3%	39.3%
Electronics Engineers, Except Computer	• Electrical and Electronics Engineering • Electrical, Electronics, and Communications Engineering, Other	235	Y	(154)	17.9%	2.6%	6.1%	29.9%	341	Y	13.2%	11.7%
Gateway Occupations												
Electrical, Electronic, and Electromechanical Equipment Assemblers, Except Coil Winders, Tapers, and Finishers	• Electrical, Electronic, and Communications Engineering Technology/Technician	1,274	N	(824)	24.2%	4.3%	42.7%	31.2%	102	Y	31.4%	7.8%
Electrical and Electronic Engineering Technologists and Technicians	• Automation Engineer Technology/Technician • Computer/Computer Systems Technology/Technician • Engineering Technologies, General	276	Y	(180)	7.4%	2.0%	11.1%	32.7%	296	Y	23.0%	13.2%
Machinists	• Machine Tool Technology/Machinist • Machine Shop Technology/Assistant	122	Y	(82)	7.0%	4.1%	3.6%	31.3%	117	Y	8.5%	4.3%
Maintenance and Repair Workers, General	• Building/Property Maintenance	110	Y	(79)	10.4%	5.6%	5.1%	29.5%	40	Y	17.5%	10.0%
Production, Planning, and Expediting Clerks	• Parts, Warehousing, and Inventory Management Operations**	101	Y	(66)	13.7%	3.4%	48.1%	27.3%	0	Y	N/A	N/A

Origin Occupations												
Semiconductor Processing Technicians	• Industrial Electronics Technology/Technician** • Semiconductor Manufacturing Technology/Technician**	331	N	(215)	21.0%	8.0%	33.1%	20.3%	0	Y	N/A	N/A
Plating Machine Setters, Operators, and Tenders	N/A	55	N	(36)	20.9%	7.7%	25.6%	26.8%	N/A	N	N/A	N/A
Total Semiconductor Industry (both Reskill and Redeploy); Workforce and Program Demographics for Core Semiconductor Occupations		**9,487**	**Y**	**(6,375)**	**16.0%**	**3.6%**	**28.4%**	**24.3%**	**6,705**	**Y**	**19.2%***	**22.0%**
All Occupations		**3,038,766**			**15.0%**	**5.2%**	**48.3%**	**23.5%**	**29,484**		**37.3%**	**65.6%**

NOTE: Red highlighting indicates lower than overall share of workforce or graduate pool, or existence of occupation or award gap. *Excludes international students (14.3%) and students not reporting race or ethnicity (5.3%). **No existing postsecondary program in Minnesota. ***Excludes international students and multiple or unknown race/ethnicity due to lack of reporting.
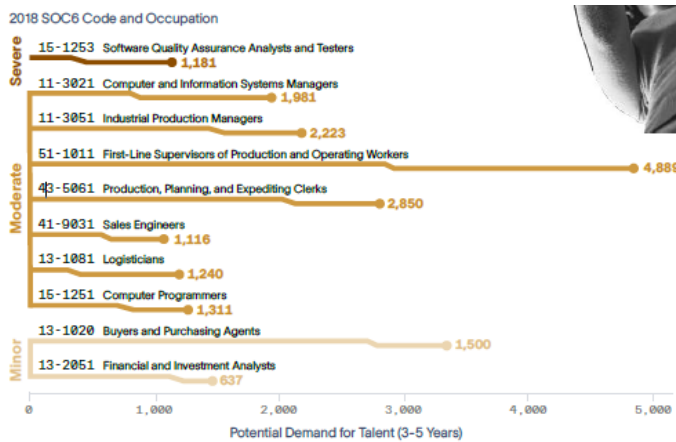
Redeploy Occupations

Redeploy Occupations are roles where there may be enough trained workers in the broader economy across Minnesota, but not enough workers going into the Semiconductor Industry specifically, particularly looking out over the next five years in a scenario where the industry aims to double output, assuming the continued occupational mix of talent going into industries as observed historically. These occupations are forecasting general oversupply of talent in Minnesota's workforce over the next five years, and workers in these roles already have many of the necessary skills to work in the Semiconductor Industry, they just need to be recruited into it.

This also means new workers may be needed to backfill the positions left behind in other industries that may also experience higher-than-expected growth over the next five years, which are also important to Minnesota's local economy, and often support the Semiconductor Industry directly or indirectly. Education institutions and career service providers, which already train individuals in preparation for a wide variety of careers, will need to be mindful of their industry partnerships and career path exposure of their program participants to ensure that every industry is gaining access to the talent needed, while also ensuring that students are exiting programs with the skills necessary to succeed in the Semiconductor Industry. The worker shortfalls highlighted in the graphic below show the additional worker shortage anticipated beyond the redeploying of talent from the talent surplus; meaning, the additional talent that would need to be recruited away from other local industries to fill Semiconductor Industry needs in the forecast scenario of doubling industry output.

Following the methodology established by Lightcast in their report *Rebuilding Our Semiconductor Workforce*, Redeploy Occupations are sorted into two categories: those that usually require a bachelor's degree and those that typically do not. When calculating undersupply, the table below highlights the undersupply (or talent shortage) of the new supply of workers in an occupation within the Semiconductor Industry alone as opposed to the new supply across all industries. Again, the degree of undersupply is dependent on both the potential demand and supply. The thresholds for severe, moderate, and minor undersupply are the same as Reskill Occupations.

Redeploy Occupation Talent Undersupplied at the National Level, Under Lightcast Analysis of Talent Supply and Demand[23]

Top Bachelor's Degree Redeploy Occs

	2018 SOC6 Code and Occupation	Potential Demand for Talent (3-5 Years)
Severe	15-1253 Software Quality Assurance Analysts and Testers	1,181
	11-3021 Computer and Information Systems Managers	1,981
	11-3051 Industrial Production Managers	2,223
Moderate	51-1011 First-Line Supervisors of Production and Operating Workers	4,889
	43-5061 Production, Planning, and Expediting Clerks	2,850
	41-9031 Sales Engineers	1,116
	13-1081 Logisticians	1,240
	15-1251 Computer Programmers	1,311
Minor	13-1020 Buyers and Purchasing Agents	1,500
	13-2051 Financial and Investment Analysts	637

Top Non-Bachelor's Degree Redeploy Occs

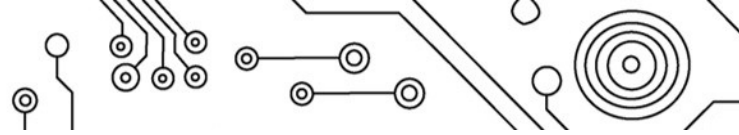|	2018 SOC6 Code and Occupation	Potential Demand for Talent (3-5 Years)
Severe	51-9161 Computer Numerically Controlled Tool Operators	1,267
	49-9041 Industrial Machinery Mechanics	1,743
	43-5071 Shipping, Receiving, and Inventory Clerks	2,983
Moderate	17-3029 Engineering Technologists and Technicians, Except Drafters, All Other	671
	51-4041 Machinists	2,137
	51-9199 Production Workers, All Other	2,044
	51-4193 Plating Machine Setters, Operators and Tenders, Metal and Plastic	1,046
	51-9061 Inspectors, Testers, Sorters, Samplers, and Weighers	8,838
Minor	51-2021 Coil Winders, Tapers and Finishers	617
	51-4122 Welding, Soldering, and Brazing Machine Setters, Operators and Tenders	942

Note from the original report: "Since we are looking at the degree of undersupply in the Industry as opposed to the economy, the thresholds for the Severe, Moderate, and Minor undersupply categories are much higher for the redeploy occupations than the reskill occupations."
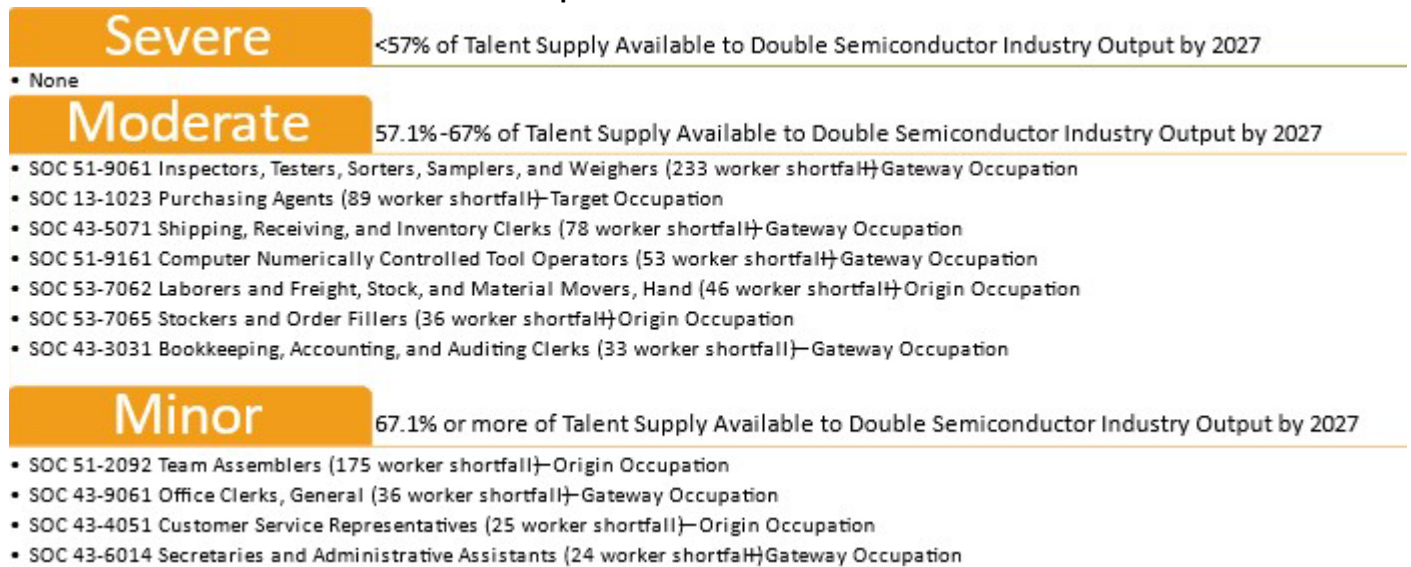
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[23] Lightcast. Rebuilding Our Semiconductor Workforce. 2023.

Overall, there are no Redeploy Occupations that meet the criteria of "severe" talent undersupply (or less than 57% of the Industry's talent need being met over the next five years in the industry doubling forecast scenario), and only one occupation—Computer Programmers (SOC 15-1251)—typically requires a bachelor's degree. Those occupations that were listed in Lightcast's study as Bachelor's Degree Redeploy Occupations largely appear as Reskill Occupations in Minnesota, due to high current talent shortages in these critical roles such as Software Developers, Industrial Production Managers, Supervisors of Production Workers, Sales Engineers, Logisticians, and more. Most Redeploy Occupations have moderate talent undersupply, and are either Origin Occupations in assembly, administrative support, and facilities or stock management, or Gateway Occupations in clerk or machining roles. The potentially more challenging talent shortage to fill is CNC Tool Operators (estimated shortfall of 53 workers over the next five years in Minnesota), which of the Reskill Occupations overall requires a more specific set of skills around programming or machining that are unique to the industry, and may be more difficult to reskill from other industries.
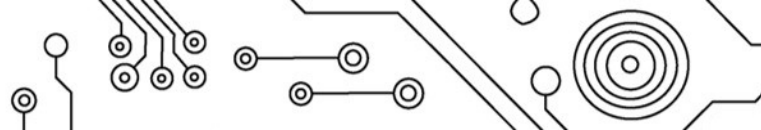
Top Volume Redeploy Occupation Talent Undersupplied in Minnesota to support Doubling Semiconductor Industry Output over the Next Five Years

Severe — <57% of Talent Supply Available to Double Semiconductor Industry Output by 2027

- None

Moderate — 57.1%-67% of Talent Supply Available to Double Semiconductor Industry Output by 2027

- SOC 51-9061 Inspectors, Testers, Sorters, Samplers, and Weighers (233 worker shortfall)—Gateway Occupation
- SOC 13-1023 Purchasing Agents (89 worker shortfall)—Target Occupation
- SOC 43-5071 Shipping, Receiving, and Inventory Clerks (78 worker shortfall)—Gateway Occupation
- SOC 51-9161 Computer Numerically Controlled Tool Operators (53 worker shortfall)—Gateway Occupation
- SOC 53-7062 Laborers and Freight, Stock, and Material Movers, Hand (46 worker shortfall)—Origin Occupation
- SOC 53-7065 Stockers and Order Fillers (36 worker shortfall)—Origin Occupation
- SOC 43-3031 Bookkeeping, Accounting, and Auditing Clerks (33 worker shortfall)—Gateway Occupation

Minor — 67.1% or more of Talent Supply Available to Double Semiconductor Industry Output by 2027

- SOC 51-2092 Team Assemblers (175 worker shortfall)—Origin Occupation
- SOC 43-9061 Office Clerks, General (36 worker shortfall)—Gateway Occupation
- SOC 43-4051 Customer Service Representatives (25 worker shortfall)—Origin Occupation
- SOC 43-6014 Secretaries and Administrative Assistants (24 worker shortfall)—Gateway Occupation

All Redeploy Occupation Talent Undersupplied in Minnesota to support Doubling Semiconductor Industry Output over the Next Five Years, Sorted in order of Total Talent Supply Shortfall
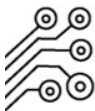
SOC	Occupation	All Industries	Semiconductor Industry						OGT Pathway Level
		Baseline 5-Year All-Industry Supply Gap, 2027	2022Q3 Industry Empl	Baseline Forecast		Doubled Production Forecast			
				Forecast Empl Demand 2027	5-Year In-Industry Supply Gap by 2027	Forecast Empl 2027	5-Year In-Industry Supply Gap by 2027	Share of Total Industry Talent Need Met	
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	540	394	354	22	650	(233)	64%	Gateway
51-2092	Team Assemblers	1,065	327	293	37	539	(175)	67%	Origin
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	100	140	133	1	230	(89)	61%	Target
43-5071	Shipping, Receiving, and Inventory Clerks	215	124	118	3	205	(78)	62%	Gateway
51-9161	Computer Numerically Controlled Tool Operators	65	83	79	1	137	(53)	61%	Gateway
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	645	79	79	5	130	(46)	65%	Origin
43-9061	Office Clerks, General	1,245	70	66	9	116	(36)	69%	Gateway
53-7065	Stockers and Order Fillers	110	56	56	1	92	(36)	61%	Origin
43-3031	Bookkeeping, Accounting, and Auditing Clerks	560	56	53	3	93	(33)	64%	Gateway
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	130	52	52	1	86	(33)	61%	Origin
51-2099	Assemblers and Fabricators, All Other	155	41	37	1	67	(26)	62%	Origin
43-4051	Customer Service Representatives	1,875	56	53	11	93	(25)	73%	Origin
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	960	43	40	4	71	(24)	67%	Gateway
15-1251	Computer Programmers	75	34	31	0	57	(22)	61%	Target
43-1011	First-Line Supervisors of Office and Administrative Support Workers	175	26	25	0	43	(17)	62%	Target
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	70	24	23	0	39	(15)	61%	Gateway
43-6011	Executive Secretaries and Executive Administrative Assistants	630	26	22	2	42	(15)	65%	Target

Female talent represents a majority in the office and administrative support Redeploy Occupations, both in current employment and the most recent graduating classes of students. Diversity by race and ethnicity is lowest in Gateway and Target Redeploy Occupations, and much of the workforce across all levels of the Pathway Model have an older-than-average workforce. Postsecondary strategies are most important for increasing the supply of Computer Programmers, Inventory Clerks, Office Clerks, and Metal Machine Tool Setters, Operators, and Tenders.
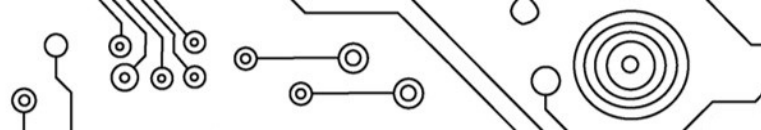
Redeploy Strategy Summary Table, Minnesota 2022

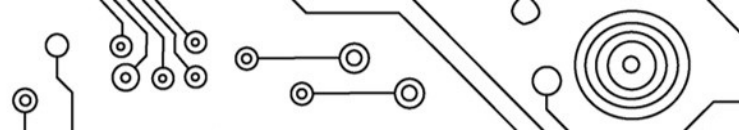| Occupation	Related Programs*	2022Q3 Industry Empl	Baseline Talent Shortage	Doubled Production Forecast Talent Shortage	Workforce BIPOC by Race	Workforce Hispanic/ Latinx	Workforce Female	Workforce Over 55	SY2021 Graduates	Award Gap (All Award Levels)	Graduates BIPOC by Race or Ethnicity (All Award Levels)***	Graduates Female (All Award Levels)
Target Occupations												
Purchasing Agents	• Sales, Distribution, and Marketing Operations, General • Purchasing, Procurement/Acquisitions and Contracts Management	140	N	(89)	11.5%	3.4%	59.8%	25.6%	197	N	18.3%	46.7%
Computer Programmers	11 programs including: • Computer Science • Computer Programming • Management Information Systems, General	34	N	(22)	23.5%	1.7%	16.7%	24.8%	1,911	Y	25.6%	21.5%
Supervisors of Office and Administrative Support Workers	• Office Management and Supervision • Customer Service Management	26	N	(17)	12.4%	3.6%	68.9%	28.9%	120	N	15.8%	56.7%
Executive Secretaries and Executive Administrative Assistants	• Executive Assistant/Executive Secretary	26	N	(15)	7.9%	3.3%	95.9%	33.1%	144	N	24.3%	84.0%
Gateway Occupations												
Inspectors, Testers, Sorters, Samplers, and Weighers	• Quality Control Technology/Technician	394	N	(233)	12.3%	5.6%	39.4%	25.3%	13	N	76.9%	46.2%
Shipping, Receiving, and Inventory Clerks	• Logistics, Materials, and Supply Chain Management	124	N	(78)	16.3%	8.3%	37.1%	22.4%	46	Y	47.8%	30.4%
CNC Tool Operators	• CNC Machinist Technology/CNC Machinist • Machine Shop Technology/Assistant	83	N	(53)	9.8%	1.5%	8.6%	28.0%	273	N	34.1%	6.2%
Office Clerks, General	• General Office Occupations and Clerical Services	70	N	(36)	14.6%	5.0%	82.3%	29.4%	16	Y	37.5%	75.0%
Bookkeeping, Accounting, and Auditing Clerks	• Accounting Technology/Technician and Bookkeeping	56	N	(33)	10.0%	3.3%	83.4%	38.0%	340	N	29.1%	74.1%

Occupation	Program											
Secretaries and Administrative Assistants	• Administrative Assistant and Secretarial Science, General	43	N	(24)	10.0%	3.6%	91.7%	35.1%	136	N	18.4%	96.3%
Cutting, Punching, and press Machine Setters, Operators, and Tenders, Metal and Plastic	• Machine Tool Technology/Machinist • Sheet Metal Technology/Sheetworking	24	N	(15)	7.8%	3.3%	29.2%	29.6%	110	Y	9.1%	5.4%
Origin Occupations												
Team Assemblers	N/A	327	N	(175)	17.2%	5.6%	34.5%	24.7%	N/A	N/A	N/A	N/A
Laborers and Freight, Stock, and Material Movers, Hand	N/A	79	N	(46)	18.2%	7.1%	22.8%	17.7%	N/A	N/A	N/A	N/A
Janitors and Cleaners	N/A	52	N	(33)	18.0%	9.8%	39.3%	33.2%	N/A	N/A	N/A	N/A
Assemblers and Fabricators, All Other	N/A	41	N	(26)	21.2%	5.9%	36.8%	24.0%	N/A	N/A	N/A	N/A
Customer Service Representatives	• Receptionist • Customer Service Support/Call Center/Teleservice Operation	56	N	(25)	17.9%	5.4%	62.5%	18.0%	1	Y	0.0%	100.0%
Total Semiconductor Industry (both Reskill and Redeploy); Workforce and Program Demographics for Core Semiconductor Occupations		**9,487**	**Y**	**(6,375)**	**16.0%**	**3.6%**	**28.4%**	**24.3%**	**6,705**	**Y**	**19.2%***	**22.0%**
All Occupations		**3,038,766**			15.0%	5.2%	48.3%	23.5%	29,484		37.3%	65.6%

NOTE: Red highlighting indicates lower than overall share of workforce or graduate pool, or existence of occupation or award gap. *There is only one program associated with occupations in this career pathway. For this reason, the Graduate and Demographics columns have identical information.
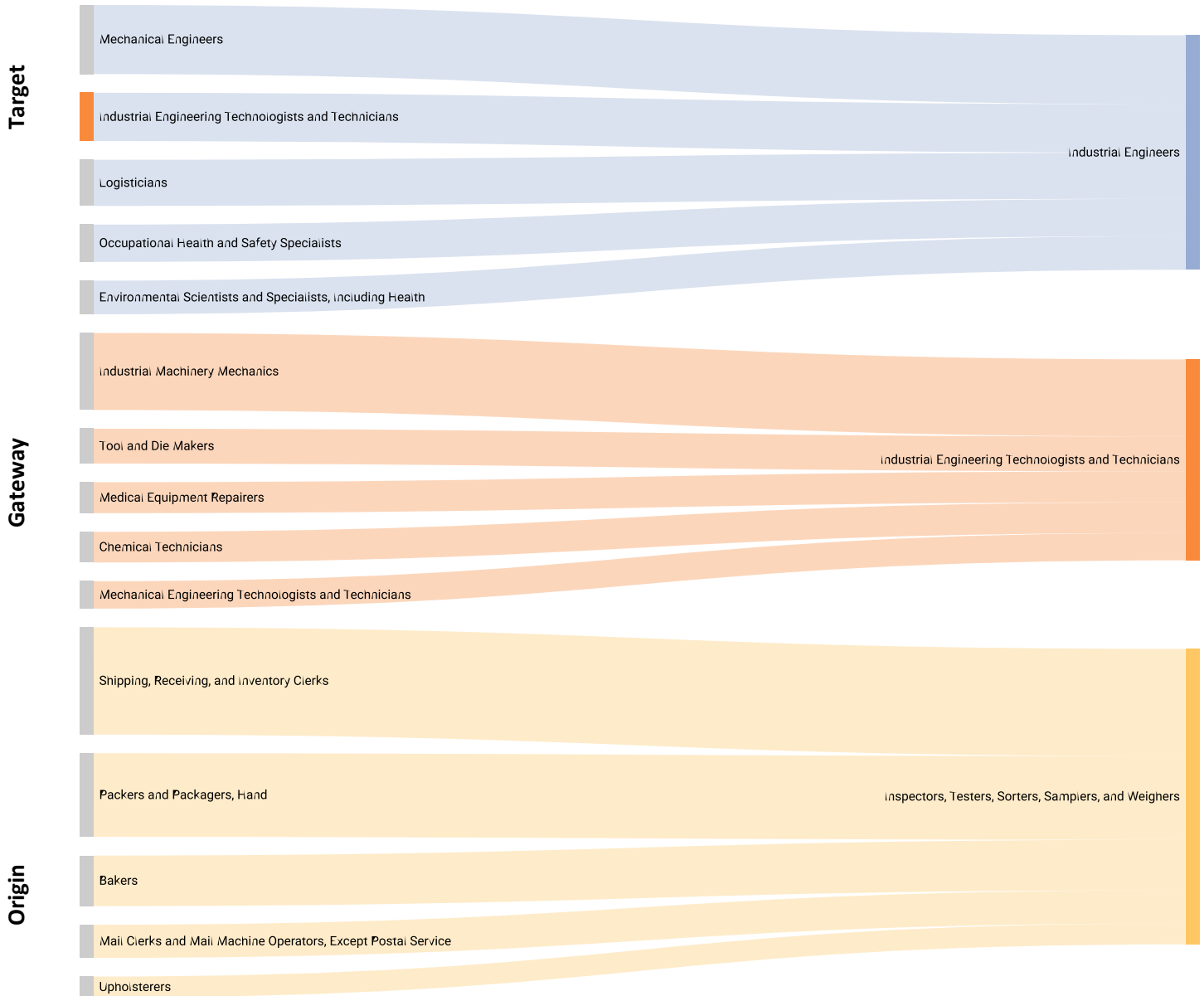
Career Pathway Opportunities

Identifying occupations with related skillsets is one strategy to employ to expand the possible labor pool for talent in occupations of high demand or likely talent shortage. The graphic below offers a selection of feeder occupations with related skillsets and sufficient talent supply to feed into critical Origin, Gateway, and Target occupations in high demand in the Semiconductor Industry. The job titles used by employers in the industry are more specific than these occupation names, which align to SOCs.

Feeder Occupations into Critical Semiconductor Industry Roles by Pathway Level

Target

- Mechanical Engineers
- Industrial Engineering Technologists and Technicians
- Logisticians
- Occupational Health and Safety Specialists
- Environmental Scientists and Specialists, including Health

→ Industrial Engineers

Gateway

- Industrial Machinery Mechanics
- Tool and Die Makers
- Medical Equipment Repairers
- Chemical Technicians
- Mechanical Engineering Technologists and Technicians

→ Industrial Engineering Technologists and Technicians

Origin

- Shipping, Receiving, and Inventory Clerks
- Packers and Packagers, Hand
- Bakers
- Mail Clerks and Mail Machine Operators, Except Postal Service
- Upholsterers

→ Inspectors, Testers, Sorters, Samplers, and Weighers

Although these positions above have the most strongly-related mix of skillsets and experience connected to the occupations on the right, other considerations of diversity, equity, current pressing social trends, and the importance of relevant formal postsecondary education pose additional considerations for feeder occupations.

Conclusion

Minnesota is a strong contender for expansion of its Semiconductor Industry due to strong industry-education partnerships, high labor force participation, high engagement and productivity of workers, and strong concentration of the Semiconductor Industry and other related industries. Minnesota ranks 10th out of 50 states for concentration of local employment in the broad Semiconductor Industry and 11th for total volume of industry employment; the MSP Metro ranks 13th in total volume of Semiconductor Industry employment. And notably, Minnesota is home to the MSA region ranking first nationally in local concentration of Semiconductor Industry employment: Winona, MN (LQ 21.04).

As is true of the nation overall, occupations at all levels of experience in the Semiconductor Industry are experiencing talent shortages, and will require coordination across secondary, postsecondary, and workforce development partners to ensure sufficient and sustainable talent pipelines to support the baseline growth of the industry as well as potential expansion. The top Gateway occupations of likely talent shortages among the Core Semiconductor Occupations necessary to sustain the industry forward are Maintenance and Repair Workers and Machinists, which are likely to see shortages under a baseline forecast model that will impact the industry severely. The top postsecondary program shortages of concern are those that produce Software Developers, Industrial Engineers, Engineering Technologists, Industrial Production Managers, Industrial Machinery Mechanics, and Semiconductor Technicians, all occupations that require reskilling to meet immediate and future needs.

Recruitment, retention, and resilience are critical issues for the Semiconductor Industry, especially with an intention to double the industry's output over the next five years. There are opportunities to redeploy talent from surplus in other industries to meet mild to moderate talent undersupply needs in the Semiconductor Industry, primarily in Origin and Gateway Occupations in machining, administrative support, office management, and product assembly.

In summary, the following were top findings in this analysis:

- **Talent shortages are severe, and growing:** Employers have immediate, pressing hiring needs and lower than ever volumes of applicants, as well as fully-tapped traditional talent pools.
- **Relevant postsecondary programs are numerous, but most are not producing sufficient new graduates to meet demand:** Programs have the largest award gaps among Reskill Occupations, which are most in-need of coordinated postsecondary strategies.
- **A systems-level evaluation of program expansion opportunities and talent skill gaps is needed to ensure the Semiconductor Industry has sufficient homegrown talent to expand over the next five years:** The GreaterMSP Partnership is poised to coordinate the multitude of career pathways that need strategic expansion across the workforce and education ecosystem, provided that member companies and their partners step up to the plate ready to problem-solve how to attract new talent into programs and solve for both short- and long-term talent needs.

FAQ

What is a location quotient?

A location quotient (LQ) is a measurement of concentration in comparison to the nation. An LQ of 1.00 indicates a region has the same concentration of an industry (or occupation) as the nation. An LQ of 2.00 would mean the region has twice the expected employment compared to the nation and an LQ of 0.50 would mean the region has half the expected employment in comparison to the nation.

What is a cluster?

A cluster is a geographic concentration of interrelated industries or occupations. If a regional cluster has a location quotient of 1.25 or greater, the region is considered to possess a competitive advantage in that cluster.

What is separation demand?

Separation demand is the number of jobs required due to separations—labor force exits (including retirements) and turnover resulting from workers moving from one occupation into another. Note that separation demand does not include all turnover—it does not include when workers stay in the same occupation but switch employers. The total projected demand for an occupation is the sum of the separation demand and the growth demand (which is the increase or decrease of jobs in an occupation expected due to expansion or contraction of the overall number of jobs in that occupation).

What is the difference between industry wages and occupation wages?

Industry wages and occupation wages are estimated via separate data sets, often the time periods being reported do not align, and wages are defined slightly differently in the two systems (for example, certain bonuses are included in the industry wages but not the occupation wages). It is therefore common that estimates of the average industry wages and average occupation wages in a region do not match exactly.

What industries comprise the Semiconductor Industry as defined in this report?

The following NAICS codes have been used to identify talent needs and postsecondary pathways:

NAICS	Industry
334413	Semiconductor and Related Device Manufacturing
334412	Bare Printed Circuit Board Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
334419	Other Electronic Component Manufacturing
334417	Electronic Connector Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
333242	Semiconductor Machinery Manufacturing
Total	**Semiconductor Industry**

What is NAICS?

The North American Industry Classification System (NAICS) is used to classify business establishments according to the type of economic activity. The NAICS Code comprises six levels, from the "all industry" level to the 6-digit level. The first two digits define the top level category, known as the "sector," which is the level examined in this report.

What is SOC?

The Standard Occupational Classification system (SOC) is used to classify workers into occupational categories. All workers are classified into one of over 804 occupations according to their occupational definition. To facilitate classification, occupations are combined to form 22 major groups, 95 minor groups, and 452 occupation groups. Each occupation group includes detailed occupations requiring similar job duties, skills, education, or experience.

What is CIP?

The Classification of Instructional Programs (CIP) is a taxonomy of academic programs developed by the US Department of Education. Colleges and universities across the country assign CIP codes to their academic programs. CIP codes are also often assigned to courses, certificates, and degrees.

Where can I learn more about the sources that were used in this report?

Lightcast offers a suite of labor market data analysis tools that are used to analyze candidate profiles and educational data from NCES IPEDS to track program graduate data and estimate talent pool availability. These tools scrape millions of candidate profiles and model skills, credentials, and employment experience to link where talent is located to where talent is in demand.

Chmura JobsEQ is a labor market data analysis tool that provides employment, unemployment, and education data from sources like the Bureau of Labor Statistics, Census Bureau, and NCES IPEDS and models this data at detailed geographic levels. This tool is utilized by RealTime Talent to model alternate forecasts impacted by COVID-19 to show possible future-state talent gaps, award gaps, and optimistic employment growth.

Who created this report?

This report was developed by RealTime Talent for the Transportation Center of Excellence. If you have questions about the data found in this report, or are interested in learning more, please contact the Senior Director of Strategic Research, Erin Olson at erin@realtimetalentmn.org or visit the RealTime Talent website at www.realtimetalent.org