The Welding Industry:

A National Perspective on Workforce Trends and Challenges

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Weld-Ed
National Center for Welding Education and Training

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Executive Summary

Report Goals and Research Tasks

This report, completed for Weld-Ed, the National Center for Welding Education and Training, provides a snapshot of the employment needs of the Welding Industry and insights into the educational system in place to meet those needs. The purpose of this report is to examine national and state labor market information to identify:

- the long and short-term employment needs of the industry;
- the wage distribution of workers in the industry;
- the impact of projected retirements on the industry; and
- the pipeline of new entrants to the workforce as evidenced by career and technical education programs completers in programs that teach welding.

Weld-Ed requested specific analysis of four welding industry occupations: Welder, Welding Technician, Welding Inspector, and Welding Engineer. State and national data is available only for Standard Occupational Classification (SOC) occupations; therefore, the four titles requested by Weld-Ed were mapped to five related SOC occupations: *Welders, Cutters, Solderers, and Brazers; Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders; Engineering Technicians, Except Drafters, All Other; Inspectors, Testers, Sorters, Samplers, and Weighers;* and *Materials Engineers*. As Welding Technicians, Inspectors, and Engineers are only subsets of the larger SOC occupations, the majority of this report focuses on the two SOC occupations that relate to the occupation Welder.

Research Findings

Comparing the projected long-term demand for welders with the projected supply of welding program completers illustrates an average shortfall of approximately 500 welders per year. This number, however, may be larger for a variety of reasons related to both supply and demand. For example, welding is actually a skill applied in more than 25 trades or occupations. Although welding is not the primary job function for these occupations, the need for knowledge of welding science and related welding skills may contribute to an even larger demand for welding than the occupational data indicate. Similarly, estimates on the supply-side may be smaller than the data indicate. For example, high school career programs that teach welding may be geared to career exploration rather than workforce preparation. Moreover, there is no data to document that an individual who completes a welding program actually enters the welding industry.

While the national outlook provides a strong case for the need for welders, actual demand for welders varies greatly by state. For example, for *Welders, Cutters, Solderers, and Brazers*, Texas projects 1905 annual job openings, whereas Vermont projects only 12. Welding demand also varies by type. For example, Florida projects the fourth highest number of annual job openings for *Welders, Cutters, Solderers, and Brazers*. Florida is not, however, in the top ten states with highest annual job openings for *Welding, Soldering, and Brazing Machines Setters, Operators, and Tenders*. Due to variations in demand, it is recommended that workforce development efforts to increase supply of welders be focused in states and regions where there is greatest demand. Moreover, the specific welding skills that education and training programs teach must relate to the types of welding skills needed in a particular region.

Next Steps/Recommendations

This report provides a foundation for further action to determine why there is a shortage of workers skilled in welding and to identify targeted workforce development strategies to adequately address the need. Strategies to identify the causes of shortages and the regions experiencing shortages may include:

- The development of a competency model based on 21st century skill requirements
- A methodology or blueprint for identifying and addressing short-term, regional demand
- Commitment to continued monitoring of long-term projected outlook

Workforce development and education and training strategies to address the need for and strengthen the supply of qualified welders may include:

- Long-term educational program planning based on occupational projections data
- Welding program evaluation tools
- Career guidance products
- Plans to recruit and certify welding instructors

These recommendations can contribute to strengthening the national welding industry workforce, which ultimately benefits business, job seekers, and current employees throughout the United States. This report is intended to inform the process of achieving the outcomes of the Weld-Ed National Skill Panel.

Introduction

The Weld-Ed National Skills Panel has undertaken an initiative to strengthen the welding industry through workforce development. Workforce development focuses on identifying employer demand for skilled workers, recruitment and retention efforts, and workforce preparation as evidenced by education and training objectives and outcomes. In support of the panel's initiative, this paper will provide labor market information from existing national and state data resources to identify:

- the long and short-term employment needs of the industry;
- the wage distribution of workers in the industry;
- the impact of projected retirements on the industry; and
- the pipeline of new entrants to the workforce as evidenced by career and technical education programs completers in programs that teach welding.

As noted in the definition provided in the research paper Vision for the Welding Industry, welding is a skill or process that is used widely across several occupations and industries. The Department of Labor's *Occupational Outlook Handbook* indicates that more than 462,000 Americans were employed as welding, soldering, and brazing workers in 2006. However, this figure does not provide a complete picture of the number of 'welders' because it does not include occupations for which welding is an important skill, such as ironworkers, boilermakers, and pipefitters.

> **WELDING, *the fusing of the surfaces of two workpieces to form one*, is a precise, reliable, cost-effective, and "high-tech" method for joining materials. No other technique is as widely used by manufacturers to join metals and alloys efficiently and to add value to their products. Most of the familiar objects in modern society, from buildings and bridges, to vehicles, computers, and medical devices, could not be produced without the use of welding.**
>
> **Source: American Welding Society, *Vision for the Welding Industry*.**

That 'welding' is a skill applied in more than 25 trades or occupations and a process utilized in many industries makes it difficult to evaluate the Welding Industry using traditional sources of labor market information.[1] Since the primary purpose of this study is to determine the demand for workers skilled in the welding craft, data about the occupations and industries that require qualified or certified welding skills was gathered and analyzed. Most of this data comes from federal and state statistical agencies and is codified in two systems: the Standard Occupational Classification (SOC) and the North American Industry Classification System (NAICS).

[1] Source: American Welding Society, *Vision for the Welding Industry*.

I. Welding Demand as Measured by Occupational Projections and Wages

The Weld-Ed panel requested an analysis of four welding occupations: Welder, Welding Technician, Welding Inspector, and Welding Engineer. These occupational titles are not Standard Occupational Classification (SOC) titles. Therefore, the first step required identifying the appropriate SOC classification code. The O*NET Code Connector was used to identify the SOC occupation most closely related to the titles provided by Weld-Ed.

The O*NET Code Connector provides detail about the O*NET-SOC occupation description, a list of tasks, information on related occupations (developed by O*NET), occupation family (other similar O*NET codes), and detailed work activities.[2] These pieces of information were analyzed to determine which occupation codes are the best matches for our purposes. Using the 'Keyword' search feature of the Code connector, the following SOC occupations were identified.

Weld-Ed Title	SOC Occupation
Welder	***Welders, Cutters, Solderers, and Brazers* (51-4121)**
	***Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders* (51-4122)**
Welding Technician	***Engineering Technicians, Except Drafters, All Other* (17-3029)**
Welding Inspector	***Inspectors, Testers, Sorters, Samplers, and Weighers* (51-9061)**
Welding Engineer	***Materials Engineers* (17-2131)**

Welders are included in the SOC occupations *Welders, Cutters, Solderers, and Brazers* and *Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders*. The former primarily perform hand-held welding, while the latter weld with machines that must be set-up or programmed. Welding Technicians are included in the occupation *Engineering, Technicians, Except Drafters, All Other.* Welding Inspectors are represented in the SOC occupation *Inspectors, Testers, Sorters, Samplers, and Weighers*, and Welding Engineers are included in the *Materials Engineers* occupation. As Welding Technicians, Inspectors, and Engineers are only subsets of the larger SOC occupations, the majority of this report focuses on the two SOC occupations that relate to the occupation Welder. Data for all five SOC occupations are available in the appendices.

National Employment Projections and Wage Data

The long-term outlook for welding occupations is best described by the occupational projections produced by the Bureau of Labor Statistics (BLS) and each of the states. Long-term projections are used by education and training program planners to estimate the location and size of programs needed to fill the projected demand.

[2] See (http://www.onetcodeconnector.org/).

The following table lists 2006-2016 national long-term employment projections and 2007 hourly and annual mean wage data for the five selected occupations. The occupations are listed in order of decreasing percent employment change. Percent employment change indicates how fast employment is expected to increase or decrease during the projection period. The larger the positive percent change, the faster employment is growing. Likewise, the larger the negative percent change, the faster employment is declining.

Table 1: National Employment Projections (2006-2016) and Wage Data (2007)[3]

National Employment Projections & 2007 Wage Data			Percent Change	Job Openings	Hourly Mean	Annual Mean
Occupations	2006	2016				
Welders, Cutters, Solderers, and Brazers	409,000	429,700	5%	10,730	$16.33	$33,960
Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	52,800	54,400	3%	1,280	$15.96	$33,200
Engineering Technicians, Except Drafters, All Other	81,800	83,400	2%	1760	$26.80	$55,730
Inspectors, Testers, Sorters, Samplers, and Weighers	491,400	456,800	-7%	7,280	$15.86	$32,980
Materials Engineers	21,600	22,500	4%	590	$37.90	$78,840

Of the five selected occupations, *Welders, Cutters, Solderers, and Brazers* is the fastest growing with 5% projected employment growth between the years 2006-2016. This represents slower than average growth (3% to 6%) compared to all other SOC occupations. *Materials Engineers* and *Welding, Soldering, and Brazing Machine Setters, Operator, and Tenders* are also growing at a slower than average rate. *Engineering Technicians, Except Drafters, All Other* are projected to experience little or no change (-2% to 2%). *Inspectors, Testers, Sorters, Samplers, and Weighers* are projected to decline slowly or moderately (-3% to -9%).

Generally, a large positive percent change is an indicator of favorable employment prospects while a large negative percent change is an indicator of more unfavorable employment prospects. Percent change, however, only takes into account growth—the creation of new jobs. It does not take into account the need to replace workers who will die, retire, or otherwise permanently leave the occupation. Job openings, on the other hand, take into account growth as well as replacement needs. Data in the above table reflect large numbers of job openings (primarily due to anticipated replacement need) even though occupations may show no growth, or even decline. The following state-level data show total job openings including jobs due to growth and jobs due to replacement.

[3] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); National employment projections – Occupation Profiles in ACINet (http://www.careerinfonet.org/).

State Employment Projections and Wage Data

While the projections period for national data is 2006-2016, the projections period for state data is 2004-2014.[4] Although the data for state and national employment trends are not on the same ten-year projection period, both sets of data reflect a comparable long-term outlook. Therefore, it is acceptable to use the data sets together. The state projections are produced by the individual states and do not 'sum' to the national totals.

The following table is a summary of findings highlighting the two main welding occupations. The table includes the top ten states with the highest projected positive percent change in employment. A complete listing of state and national employment trends and wage data is available in Appendix A.

Table 2: Top Ten States with Highest Positive Percent Change[5]

51-4121 - Welders, Cutters, Solderers, and Brazers (Welders)								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
NV	1,410	2,120	51%	72	40	111	$19.11	$39,750
WY	1,360	1,980	46%	62	38	100	$19.44	$40,440
HI	960	1,330	38%	37	27	64	$24.55	$51,060
UT	4,310	5,540	29%	123	122	245	$16.43	$34,170
AZ	4,500	5,630	25%	112	128	240	$15.48	$32,190
ND	1,820	2,270	25%	45	52	97	$15.89	$33,060
AR	5,890	7,130	21%	124	166	290	$14.30	$29,750
MT	1,020	1,240	21%	21	29	50	$21.35	$44,420
CO	3,670	4,420	20%	74	104	178	$17.19	$35,750
MS	6,270	7,460	19%	119	177	296	$15.18	$31,560
51-4122 - Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders (Welders)								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
NV	140	220	51%	7	4	11	$14.08	$29,290
WY	50	80	50%	3	1	4	$13.50	$28,090
AR	720	910	27%	19	21	40	$13.59	$28,270
MS	270	310	19%	5	7	12	$13.12	$27,290
UT	230	280	19%	5	7	11	$13.33	$27,720
AZ	460	530	16%	7	13	20	$15.87	$33,000
TX	2,350	2,700	15%	35	65	100	$13.56	$28,210
IA	1,340	1,520	13%	18	38	56	$15.60	$32,450
GA	1,270	1,430	13%	16	36	52	$13.83	$28,770
OR	270	310	13%	4	9	12	$15.58	$32,400

[4] See Technical Notes on page 26.

[5] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); State employment projections (2004-2014; % change) – Occupation Profiles in ACINet (http://www.careerinfonet.org/), (Growth; Replacement; Job Openings) – Occupational Supply Demand System (http://www.occsupplydemand.org).

When identifying where the greatest need for welders lies, it is important to take into consideration projected growth, especially for long-term workforce planning. Projected growth alone, however, does not provide a complete picture in terms of need. For example, the two states projecting the largest growing need for welding occupations, Nevada and Wyoming, anticipate fewer annual job openings than states projecting lower growth rates, such as Arizona.

State-level data provides a more targeted view of labor market demand that might be masked if only national-level data is taken into consideration. For example, see the table below illustrating the top ten states with highest projected positive percent change for *Inspectors, Testers, Sorters, Samplers, and Weighers*.

Table 3: Top Ten States with Highest Positive Percent Change for Welding Inspectors[6]

51-9061 - Inspectors, Testers, Sorters, Samplers, and Weighers (Welding Inspectors)								
State	2004	2014	Percent Change	Annual Growth	Annual Replacement	Annual Job Openings	Hourly Mean	Annual Mean
WY	460	700	53%	24	10	34	$19.82	$41,230
NV	2,120	2,840	34%	72	48	120	$15.72	$32,690
UT	4,050	4,890	21%	84	92	176	$15.69	$32,630
AZ	7,190	8,370	17%	119	164	282	$15.16	$31,540
AK	382	437	14%	6	9	14	$24.70	$51,380
ID	1,300	1,470	13%	17	29	46	$13.49	$28,060
WA	8,340	9,350	12%	101	205	306	$20.13	$41,870
CO	5,030	5,610	12%	58	114	172	$16.98	$35,320
TX	34,600	37,900	10%	330	790	1,120	$14.98	$31,170
WI	21,230	23,400	10%	218	483	701	$15.42	$32,070

In these ten states, *Inspectors, Testers, Sorters, Samplers, and Weighers* is growing at an average (7% to 13%), faster than average (14% to 20%), or much faster than average (21% or higher) rate. Nationally, the occupation is projected to decline slowly or moderately (-3% to -9%).[7] For local or regional program planning, data at a state or sub-state level should be used where available to estimate occupational demand.

Numbers displayed in the Job Openings column are the average annual openings over the ten-year projection period. Job Openings is an estimate of annual openings that includes both turnovers that result from workers leaving the occupation (replacement) and new jobs that are created (growth). It is important to take numbers of annual job openings into consideration in addition to percent change, because size of employment in an occupation plays a significant role in terms of projected need. For example, occupations that have a large number of employees and high replacement need may only have a small, or even negative percent change. Conversely, occupations with a large

[6] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); State employment projections (2004-2014; % change) – Occupation Profiles in ACINet (http://www.careerinfonet.org/), (Growth; Replacement; Job Openings) – Occupational Supply Demand System (http://www.occsupplydemand.org).

[7] See Table 1 for national projections.

percent change may only be creating a small number of new jobs or have only a small number of annual job openings.

The following table is a summary of findings highlighting the two main welding occupations with the highest number of projected annual job openings.

Table 4: Top Ten States with Highest Numbers of Job Openings for Welders[8]

51-4121 - Welders, Cutters, Solderers, and Brazers (Welders)								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
TX	40,900	48,400	18%	750	1,155	1,905	$15.71	$32,670
HI	29,800	33,100	11%	330	840	1,170	$16.74	$34,820
MT	16,090	17,680	10%	159	454	613	$18.12	$37,700
FL	13,450	15,300	14%	185	380	565	$15.75	$32,760
IN	14,190	15,240	7%	105	401	506	$15.98	$33,230
OH	17,370	16,930	-3%	0	491	491	$16.23	$33,750
PA	16,500	16,600	1%	8	466	474	$16.49	$34,290
MI	14,910	15,380	3%	47	421	468	$18.94	$39,400
GA	10,040	11,540	15%	152	281	433	$14.38	$29,900
NC	10,040	11,450	14%	141	284	425	$15.91	$33,090
51-4122 - Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders (Welders)								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
MI	5,860	5,370	-8%	0	166	166	$18.77	$39,030
KY	2,540	2,850	12%	31	72	102	$14.03	$29,180
TX	2,350	2,700	15%	35	65	100	$13.56	$28,210
CA	2,700	2,800	4%	10	80	90	$14.44	$30,020
OH	2,830	2,640	-7%	0	80	80	$16.14	$33,570
PA	2,500	2,450	-3%	0	71	71	$15.50	$32,240
WI	2,390	2,380	0%	0	67	67	$16.31	$33,930
IN	1,960	2,020	3%	6	56	61	$14.44	$30,030
TN	1,820	1,890	4%	7	52	59	$13.24	$27,540
IA	1,340	1,520	13%	18	38	56	$15.60	$32,450

As discussed above, it is important to take into account annual job openings in addition to projected percent change because annual job openings may be high, even when percent change is low. For example, three states in the table above show negative percent change, yet are in the top ten states with highest numbers of annual job openings:

[8] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); State employment projections (2004-2014; % change) – Occupation Profiles in ACINet (http://www.careerinfonet.org/), (Growth; Replacement; Job Openings) – Occupational Supply Demand System (http://www.occsupplydemand.org).

- Michigan (*Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders*)
- Ohio (*Welders, Cutters, Solderers, and Brazers; Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders*)

Though welding occupations are not growing in these states, there is a high replacement need due to workers who will die, retire, or otherwise permanently leave the occupation.

While the national outlook provides a strong case for the need for welders, actual demand for welders varies greatly by state. For example, for *Welders, Cutters, Solderers, and Brazers*, Texas projects 1905 annual job openings, whereas Vermont projects only 12. Welding demand also varies by type. For example, Florida projects the fourth highest number of annual job openings for *Welders, Cutters, Solderers, and Brazers*. Florida is not, however, in the top ten states with highest annual job openings for *Welding, Soldering, and Brazing Machines Setters, Operators, and Tenders*. Due to variations in demand, it is recommended that workforce development efforts to increase supply of welders be focused in states and regions where there is greatest demand. Moreover, the specific welding skills that education and training programs teach must relate to the types of welding skills needed in a particular region.

Short-Term Demand

The above section illustrates how long-term state and national projections may be used to identify demand for welders. BLS does not produce short-term projections for occupations. Short-term demand for occupations is difficult to forecast. Per Dr. Harvey Goldberg, Department of City and Regional Planning at the University of North Carolina, Chapel Hill: "For these short-term projections *cyclical* factors play more important roles than secular or structural factors in affecting employment levels. These cyclical factors are difficult to take into account in most of the projection techniques."[9] Short-term demand for occupations is more accurately defined by local or regional experts. We attempted to locate a consistent and reliable source of state and sub-state data for short-term occupational demand. Although several states produce short-term projections, state data differs in its level of detail and dates for the projection period. There is no national program for this data set. Therefore, we did not produce tables showing short-term occupational outlook for Welders and related occupations.

There is, however, one available source of information that may illustrate short-term demand. Job postings for welding occupations illustrate immediate demand for workers with welding skills. The following chart captures the job postings from JobCentral.com for one day in May 2008. There are more than 6,000 welding openings nationally and more than 1,000 are added each week.

Table 5: Welding Openings by Occupation[10]

Occupation	Jobs Listed on Average Day	New Jobs Listed Per Week
Welders	5500	950
Welding Technicians	440	70
Welding Inspectors	150	20-25
Welding Engineers	365	60

[9] Source: Goldstein, Harvey, Ph.D. (2005). *Projecting State and Area Industry Employment.*
[10] Source: Snapshot of job postings from JOBcentral on May 9, 2008 (http://www.jobcentral.com/).

The data from large job boards can be analyzed for regional differences to target those areas where welders are needed most.

Occupational Wage Data

The following table is a summary of findings highlighting for the two main welding occupations the top ten states with the highest 2007 mean wages. To compare mean wages across states for all selected SOC occupations, see Appendix B.

Table 6: Top Ten States with Highest Mean Wages for Welders[11]

Top Ten States with Highest Mean Wages								
51-4121 - Welders, Cutters, Solderers, and Brazers								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
AK	630	730	17%	11	17	28	$25.05	$52,100
HI	960	1,330	38%	37	27	64	$24.55	$51,060
MT	1,020	1,240	21%	21	29	50	$21.35	$44,420
MA	4,030	3,830	-5%	0	110	110	$19.68	$40,930
WA	7,230	8,140	13%	90	221	311	$19.58	$40,730
WY	1,360	1,980	46%	62	38	100	$19.44	$40,440
NV	1,410	2,120	51%	72	40	111	$19.11	$39,750
MI	14,910	15,380	3%	47	421	468	$18.94	$39,400
GA	2,540	2,540	0%	0	72	72	$18.61	$38,700
NC	1,750	1,710	-3%	0	49	49	$18.39	$38,260
51-4122 - Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders								
State	**2004**	**2014**	**Percent Change**	**Annual Growth**	**Annual Replacement**	**Annual Job Openings**	**Hourly Mean**	**Annual Mean**
AL	N/A	N/A	N/A	N/A	N/A	N/A	$20.80	$43,270
KY	270	300	12%	3	8	11	$20.42	$42,470
DE	120	110	-15%	0	4	4	$20.07	$41,740
CO	330	350	7%	2	10	12	$19.32	$40,180
NY	1,080	1,010	-6%	0	30	30	$19.11	$39,750
MI	5,860	5,370	-8%	0	166	166	$18.77	$39,030
MA	1,020	950	-6%	0	30	30	$18.19	$37,840
CT	540	530	0%	0	15	15	$18.02	$37,480
ME	214	182	-15%	0	6	6	$17.62	$36,640
IA	1,880	1,840	-2%	0	53	53	$17.28	$35,940

[11] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); State employment projections (2004-2014; % change) – Occupation Profiles in ACINet (http://www.careerinfonet.org/), (Growth; Replacement; Job Openings) – Occupational Supply Demand System (http://www.occsupplydemand.org).

An analysis of wage data adds to a more complete picture of the welding industry. Wage data can be used to determine whether businesses are paying enough to remain competitive and retain workers. Low wages may be a possible cause of labor shortages and/or a disincentive to enter the industry. In addition to identifying supply-side barriers, wage data may contribute to strengthening the supply of workers with welding skills. For example, wage data may be used in developing career guidance and recruitment materials such as welding industry career pathways that illustrate advancement potential in the industry.

II. Outlook of the Industries Employing Welders

As defined by the North American Industrial Classification System (NAICS), the Welding Industry is not an industry. However, we can examine the industries which employ welding-related occupations. As noted in the *Occupational Outlook Handbook 2008-2009 Edition* produced by the Bureau of Labor Statistics, about two out of three welding jobs are found in three NAICS subsectors of the Manufacturing industry:

- *Fabricated Metal Product Manufacturing* (332000);
- *Machinery Manufacturing* (333000); and
- *Transportation Equipment Manufacturing* (336000).

There are notable concentrations of welders in other industry subsectors as well. The *Specialty Trade Contractors* (238000) subsector of the *Construction* industry employs an additional ten percent of welders, and the *Repair and Maintenance* (811000) subsector of the *Other Services* industry employs another five percent. Therefore, our industry data will focus on the following five subsectors which employ more than 80% of welding-related workers:

- *Specialty Trade Contractors* (238000);
- *Fabricated Metal Product Manufacturing* (332000);
- *Machinery Manufacturing* (333000);
- *Transportation Equipment Manufacturing* (336000); and
- *Repair and Maintenance* (811000).

Industry/Occupation Matrix

The *Occupational Employment Statistics* (OES) *Survey Industry/Occupation Matrix*, a supporting dataset for the occupational projections process, is useful to show the spread of welding occupations across the industries that are likely to employ them. The Matrix provides useful information to program planners to determine the types of welding and additional skills that might be required of potential workers. The following tables show the industry distributions of the two main welding occupations.[12] Industries with fewer than 50 jobs, confidential data, or poor quality data are not displayed.

[12] Industry distribution for the other three selected SOC occupations may be found in Appendix C.

Table 7: Industry Distribution of Welding Occupations[13]

51-4121 Welders, Cutters, Solderers, and Brazers								
	2006			2016				
Industry	Number	Percent of Industry	Percent of Occupation	Number	Percent of Industry	Percent of Occupation	Percent Change	Numeric Change
Total Employment	409,024	0.27	100.00	429,732	0.26	100.00	5.06	20,708
Specialty trade contractors	23,478	0.48	5.74	27,867	0.52	6.48	18.70	4,389
Fabricated metal product manufacturing	91,656	5.90	22.41	93,574	6.86	21.77	2.09	1,918
Machinery manufacturing	65,266	5.48	15.96	62,743	6.00	14.60	-3.87	-2,523
Transportation equipment manufacturing	58,244	3.30	14.24	59,192	3.59	13.77	1.63	949
Repair and maintenance	19,552	1.57	4.78	22,097	1.52	5.14	13.02	2,545
51-4122 Welding, Soldering, and Brazing Machine Setters, Operators, Tenders								
	2006			2016				
Industry	Number	Percent of Industry	Percent of Occupation	Number	Percent of Industry	Percent of Occupation	Percent Change	Numeric Change
Total Employment	52,803	0.04	100.00	54,397	0.03	100.00	3.02	1,594
Specialty trade contractors	513	0.01	0.97	650	0.01	1.19	26.57	136
Fabricated metal product manufacturing	11,628	0.75	22.02	11,931	0.87	21.93	2.60	303
Machinery manufacturing	9,666	0.81	18.30	9,798	0.94	18.01	1.37	132
Transportation equipment manufacturing	16,311	0.92	30.89	16,123	0.98	29.64	-1.15	-187
Repair and maintenance	614	0.05	1.16	732	0.05	1.35	19.12	117

Three of the five industry subsectors which employ the most welders will experience significant employment losses over the next decade. *Motor Vehicle Parts Manufacturing*, an industry group within *Transportation Equipment Manufacturing*, is ranked 38th out of 50 on a BLS projection of the 50 industries with the greatest decline in employment from 2006-2016. *Metalworking Machinery Manufacturing*, an industry group within the *Machinery Manufacturing* subsector, is 48th. *Cutlery and Handtool Manufacturing*, part of *Fabricated Metal Manufacturing*, is ranked 26th and *Forging and Stamping*, an industry group of *Fabricated Metal Product Manufacturing* is 29th.[14]

[13] Source: Bureau of Labor Statistics. *2006-16 National Employment Matrix.* (http://www.bls.gov/emp/empiols.htm).
[14] Source: America's Career InfoNet, *Industries with Declining Employment.* (http://www.acinet.org/acinet/indview4.asp?printer=&id=8,1&nodeid=48&group=2&showall=no).

At first glance, the data portraying declines in industry employment indicate unfavorable employment prospects. However, the data also show that the welding occupations selected for the study generally are not impacted by the overall decline. The *Fabricated Metal Product Manufacturing, Machinery Manufacturing*, and *Transportation Manufacturing* subsectors are all shrinking in terms of total employment, but only *Machinery Manufacturing* is projected to employ fewer welders.

The *Specialty Trade Contractors* and *Repair and Maintenance* subsectors are projected to grow by 10 and 16 percent respectively by 2016. Welding, soldering, and brazing workers in these industries will outpace this growth with 19 and 13 percent increases.

Although several of the selected NAICS industries which employ the most welders are shrinking, the demand for welding occupations is actually growing in all industries but one. Two of the selected industries are experiencing incredible growth and the Welding Industry will share the benefits of this development. A comparison of the Percent of Industry figures between the 2006 and 2016 employment estimates indicates that in most cases the industry mix will include a larger percentage of welders. This fact is reflected in the occupational projections data discussed in the previous section.

Location Quotients

A Location Quotient is a commonly used economic base analysis method. It compares a local economy to a reference economy to identify characteristics of the local economy. In this study location quotients (LQs) were calculated for the selected NAICS industries to determine which states have concentrations of those industries. We used states as the local economies and the U.S. as the reference economy. The intent is to depict areas or 'hotspots' likely to employ workers with welding knowledge and skills.

This comparison will provide insight into a state's share of employment for the industry sub-sector as compared to the country as a whole. States with an LQ of one or greater for a particular industry have a greater concentration of that industry than the nation. The LQs were calculated using data from the BLS's *Quarterly Census of Employment and Wages*.

Table 8: Top Ten States with Highest Location Quotients by Industry[15]

Specialty Trade Contractors - 238000 (2006)				
	Location Quotients	**Number of Establishments**	**Employment**	**Total Payroll Wages**
United States		550,642	4,838,251	$197,838,987,655
Nevada	2.11	4,727	102,116	$4,283,541,281
Arizona	1.72	10,458	164,441	$5,851,202,730
Utah	1.54	8,437	64,584	$2,125,648,145
Idaho	1.44	5,905	32,950	$979,077,916
Florida	1.43	50,348	421,818	$14,814,704,116
Maryland	1.42	11,494	126,061	$5,742,466,313
Colorado	1.39	14,841	112,813	$4,326,817,966

(Table 8 continued on next page)

[15] U.S. Bureau of Labor Statistics. *Location Quotient Calculator.* (http://data.bls.gov/LOCATION_QUOTIENT/servlet/lqc.ControllerServlet).

Table 8: Top Ten States with Highest Location Quotients by Industry

Specialty Trade Contractors - 238000 (2006)				
	Location Quotients	Number of Establishments	Employment	Total Payroll Wages
Wyoming	1.32	2,143	11,789	$426,013,707
New Mexico	1.23	3,347	32,916	$1,086,568,892
Virginia	1.23	16,185	156,709	$6,080,819,309
Fabricated Metal Product Manufacturing - 332000 (2006)				
	Location Quotients	Number of Establishments	Employment	Total Payroll Wages
United States		60,436	1,549,957	$68,684,212,018
Wisconsin	2.28	2,000	74,622	$3,186,969,479
Ohio	1.87	4,013	116,917	$5,354,058,731
Indiana	1.74	1,801	60,026	$2,425,378,661
Connecticut	1.73	1,368	33,876	$1,835,551,314
Michigan	1.68	3,299	83,292	$3,743,193,614
Illinois	1.61	3,595	114,424	$5,398,029,598
New Hampshire	1.54	413	11,425	$518,026,163
Oklahoma	1.42	1,024	23,138	$933,396,359
Minnesota	1.38	1,683	43,522	$2,062,240,019
Tennessee	1.37	1,183	43,890	$1,904,393,833
Machinery Manufacturing - 333000 (2006)				
	Location Quotients	Number of Establishments	Employment	Total Payroll Wages
United States		30,798	1,178,614	$63,915,883,606
Iowa	2.84	504	36,852	$1,968,742,085
Wisconsin	2.78	1,303	69,487	$3,622,015,626
North Dakota	2.26	103	6,471	$290,573,072
Oklahoma	2.15	561	26,810	$1,251,840,616
Michigan	1.96	2,880	74,061	$4,203,213,562
Ohio	1.77	2,224	84,179	$4,296,536,924
South Dakota	1.76	101	5,797	$221,157,765
Illinois	1.74	2,452	91,117	$5,982,369,929
Indiana	1.74	1,010	45,290	$2,387,181,755
Kansas	1.50	380	17,083	$717,825,842

(Table 8 continued on next page)

Table 8: Top Ten States with Highest Location Quotients by Industry

Transportation Equipment Manufacturing - 336000 (2006)				
	Location Quotients	**Number of Establishments**	**Employment**	**Total Payroll Wages**
United States		15,336	1,786,183	$108,761,177,808
Michigan	3.90	1,346	219,737	$15,928,691,952
Indiana	3.53	684	137,043	$7,617,850,545
Kansas	2.88	261	48,663	$3,210,535,240
Kentucky	2.47	274	56,975	$3,019,899,761
Washington	2.37	503	96,042	$7,849,737,112
Alabama	2.08	306	51,013	$2,813,248,367
Ohio	2.05	860	146,086	$8,942,858,825
Mississippi	2.01	150	28,089	$1,300,709,441
Connecticut	1.96	255	43,813	$3,360,356,986
Tennessee	1.73	378	62,686	$3,155,745,496
Repair and Maintenance - 811000 (2006)				
	Location Quotients	**Number of Establishments**	**Employment**	**Total Payroll Wages**
United States		229,255	1,256,809	$41,904,184,927
Wyoming	1.61	744	3,871	$140,075,636
Louisiana	1.26	3,639	20,799	$692,379,817
Montana	1.23	1,086	4,675	$128,911,823
Utah	1.22	2,456	13,341	$421,383,447
West Virginia	1.21	1,369	7,549	$244,306,588
Nebraska	1.18	1,859	9,732	$298,924,701
New Mexico	1.18	1,561	8,355	$251,611,813
Texas	1.16	15,350	106,005	$3,580,742,121
Arizona	1.11	4,118	27,268	$903,875,730
California	1.11	24,740	162,467	$5,602,139,100

Nevada, the state with the highest projected positive percent change for *Welders, Cutters, Solderers and Brazers* and *Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders*, has the highest LQ for the Specialty Trade Contractors subsector. It is likely that the growth in occupational demand is spurred by the current large-scale construction projects in this state. Wyoming, which ranks second for highest projected positive change for the two main welding occupations, has the highest *Repair and Maintenance* LQ.

Location Quotients also can be calculated for regions of a state to pinpoint the location of the greatest employment demand. They are useful in analysis of local and regional Welding Industries.

Occupational Employment Statistics (OES) Survey

The OES data used as the basis for producing occupational projections is also useful in determining where there are concentrations of industries likely to employ workers requiring welding skills. The employment and wage data from the OES Survey is available for states and large cities or Metropolitan Statistical Areas (MSAs) of the country.

As an example, we have pulled data depicting the metropolitan areas with the highest concentration of workers for *Welders, Cutters, Solderers, and Brazers*.

Table 9: Metropolitan Statistical Areas (MSA) with Highest Concentrations of Welders, Cutters, Solderers, and Brazers[16]

MSA	Employment	Hourly Mean Wage	Annual Mean Wage	Percent of MSA Employment
Houma-Bayou Cane-Thibodaux, LA	2,510	$17.69	$36,790	2.91%
Elkhart-Goshen, IN	3,020	$16.29	$33,890	2.32%
Peoria, IL	2,940	$15.10	$31,410	1.63%
Gainesville, GA	980	$14.55	$30,270	1.41%
Owensboro, KY	660	$13.96	$29,040	1.37%

The data can be sorted to show areas paying the highest wages. As mentioned previously in the discussion around wage data, wages are an important factor when considering possible causes of labor shortages.

Table 10: Metropolitan Statistical Areas (MSA) with Highest Wages for Welders, Cutters, Solderers, and Brazers

MSA	Employment	Hourly Mean Wage	Annual Mean Wage	Percent of MSA Employment
Ann Arbor, MI	140	$26.45	$55,010	0.07%
Fairbanks, AK	70	$25.55	$53,130	0.19%
Honolulu, HI	550	$23.99	$49,900	0.13%
Anchorage, AK	240	$23.40	$48,680	0.15%
Rochester-Dover, NH-ME	130	$22.80	$47,420	0.25%

[16] Source: Bureau of Labor Statistics. Occupational Employment and Wages, May 2007. (http://www.bls.gov/oes/current/oes514121.htm).

III. Education Programs & Program Completers

Estimating the potential supply of those with welding skills is a challenging task. Welders learn their craft through formal career and technical education offered by high schools, vocational schools, community colleges, and private trade schools supplemented by on the job training. Per a survey of 25-44 year olds conducted by the Bureau of Labor Statistics, 73 % of *Welders, Cutters, Solderers, and Brazers* have a high school education, 25% have some college education, and an additional 2% have a Bachelor's degree.

The Survey of Welding School Capacity and Output in the United States conducted by the American Welding Society in April 2008 estimates that national enrollment in welding programs is 163,009 students per year, minus mid-term dropouts. It also concludes that the majority of welding programs are not operating at full capacity. The report notes that no information is available on the numbers of welders who have learned the craft through employer sponsored on-the-job training. The reasons for reduced capacity are not discussed. However, low enrollments could be attributed to poor industry image, lack of information about welding as a career opportunity, lack of qualified instructors, or a combination of all these factors.

There is no standardized source for collecting data on the numbers of students who complete a vocational or career and technical education program at the high school level. It is difficult to estimate, therefore, the numbers of potential workers who acquire their skills through that career pathway. The Integrated Postsecondary Education Program (IPEDS) survey conducted by the U.S. Department of Education's National Center for Education Statistics provides data on the numbers of certificates and degrees awarded by postsecondary education institutions. In an effort to determine the available supply of workers, IPEDS data was used. The most recent data available is for program year ending June 2006. Data was retrieved to identify the schools awarding 1 and 2-year certificates, 2 and 4-year degrees in Welding Technology (CIP 48.0508). Table 11 provides a historical perspective of postsecondary completers of Welding Programs by state.

Table 11: Program of Study and Training: 48.0508 Welding Technology/Welder[17]

Men and Women Program Completers															
	2001-02			2002-03			2003-04			2004-05			2005-06		
State	M	W	Total	M	W	Total	M	W	Total	M	W	Total	M	W	Total
U.S. Total	6823	423	7246	8630	438	9068	8953	464	9417	8956	492	9448	9146	512	9658
Alabama	124	11	135	142	9	151	267	17	284	219	13	232	172	14	186
Alaska	31	0	31	23	1	24	25	7	32	23	2	25	21	3	24
Arizona	160	18	178	151	15	166	144	15	159	156	13	169	144	13	157
Arkansas	173	6	179	269	15	284	243	7	250	263	14	277	295	8	303
California	298	23	321	322	22	344	473	20	493	408	13	421	443	28	471
Colorado	75	4	79	89	7	96	138	5	143	127	20	147	161	16	177

(Table 11 continued on next page)

[17] Source: Occupational Supply Demand System. (http://www.occsupplydemand.org/OSD_SupplyState.aspx?CLUSCODE=074A-13&ST=ZZ&PathNo=1&sst=0).

Table 11: Program of Study and Training: 48.0508 Welding Technology/Welder

Men and Women Program Completers															
	2001-02			2002-03			2003-04			2004-05			2005-06		
State	M	W	Total	M	W	Total	M	W	Total	M	W	Total	M	W	Total
Connecticut	14	0	14	18	1	19	24	0	24	20	0	20	34	1	35
Florida	188	8	196	461	22	483	429	24	453	429	18	447	496	15	511
Georgia	571	38	609	676	46	722	911	70	981	967	101	1,068	899	87	986
Hawaii	19	2	21	12	1	13	19	1	20	12	3	15	22	5	27
Idaho	57	4	61	64	3	67	54	1	55	50	2	52	63	4	67
Illinois	352	18	370	560	44	604	473	24	497	541	19	560	416	26	442
Indiana	15	0	15	30	0	30	14	0	14	16	1	17	20	0	20
Iowa	58	2	60	56	1	57	98	1	99	79	5	84	126	7	133
Kansas	141	13	154	178	21	199	163	4	167	219	15	234	167	15	182
Kentucky	131	16	147	168	4	172	281	8	289	382	15	397	483	3	486
Louisiana	78	6	84	714	32	746	153	13	166	172	5	177	128	5	133
Maine	16	0	16	16	0	16	29	0	29	33	0	33	25	0	25
Michigan	93	2	95	67	4	71	112	6	118	104	6	110	94	6	100
Minnesota	163	7	170	142	5	147	174	9	183	147	10	157	163	8	171
Mississippi	170	17	187	186	2	188	169	5	174	182	7	189	160	13	173
Missouri	51	5	56	58	5	63	83	9	92	76	4	80	98	7	105
Montana	7	1	8	10	0	10	7	1	8	22	1	23	14	0	14
Nebraska	38	7	45	70	4	74	58	1	59	89	3	92	99	3	102
Nevada	2	2	4	12	1	13	16	1	17	9	0	9	7	2	9
New Hampshire	7	0	7	13	1	14	14	2	16	6	0	6	13	0	13
New Jersey	61	0	61	106	0	106	106	0	106	48	0	48	30	1	31
New Mexico	22	4	26	47	3	50	48	4	52	53	4	57	50	5	55
New York	232	15	247	262	5	267	272	6	278	228	4	232	269	6	275
North Carolina	350	28	378	374	19	393	376	16	392	478	33	511	485	20	505
North Dakota	53	0	53	68	1	69	61	1	62	32	0	32	56	4	60
Ohio	760	20	780	622	23	645	581	23	604	231	9	240	278	9	287
Oklahoma	584	17	601	628	20	648	629	27	656	596	21	617	656	30	686
Oregon	31	1	32	42	2	44	42	5	47	40	5	45	39	4	43
Pennsylvania	158	4	162	183	0	183	171	11	182	202	8	210	236	6	242

(Table 11 continued on next page)

Table 11: Program of Study and Training: 48.0508 Welding Technology/Welder

Men and Women Program Completers															
	2001-02			2002-03			2003-04			2004-05			2005-06		
State	M	W	Total	M	W	Total	M	W	Total	M	W	Total	M	W	Total
South Carolina	168	6	174	194	15	209	179	9	188	219	10	229	187	15	202
South Dakota	34	1	35	39	1	40	35	2	37	32	1	33	41	0	41
Tennessee	173	10	183	239	14	253	214	14	228	218	11	229	211	8	219
Texas	554	52	606	630	24	654	749	23	772	886	35	921	877	36	913
Utah	43	3	46	36	0	36	82	7	89	69	6	75	76	6	82
Virginia	25	2	27	29	6	35	47	6	53	27	0	27	25	2	27
Washington	163	14	177	214	21	235	342	39	381	381	25	406	441	45	486
West Virginia	57	19	76	61	1	62	66	2	68	54	11	65	63	3	66
Wisconsin	279	15	294	291	12	303	287	13	300	310	9	319	253	17	270
Wyoming	44	2	46	58	5	63	62	3	65	80	10	90	81	6	87
Puerto Rico	0	0	0	0	0	0	33	2	35	21	0	21	29	0	29

The IPEDS data for the 2005-2006 school program year shows that 692 schools in 47 states reported 9658 program completers. Data collected from the National Crosswalk Service Center indicates that there were 1890 Certificates of Apprenticeship awarded for completion of a Welding Apprenticeship program. Those numbers round up to an approximate 11,500 potential workers trained in Welding Technologies. A comparison of the national projections (occupational demand) to the program completers (occupational supply) indicates a shortfall of approximately 500 for those trained in welding technologies. This shortfall becomes greater when you factor in welding technicians and inspectors that make up a portion of the demand for those trained in welding technologies. This fact is supported by data from large job boards indicating large numbers of 'unfilled' job orders for welders, welding inspectors, and welding engineers.[18]

In addition to comparing the supply-demand data nationally, it is useful to compare data at the state level. The following table shows the 10 states with the largest projected openings for *Welders, Cutters, Solderers, and Brazers* compared to program completers reported in the IPEDS survey.

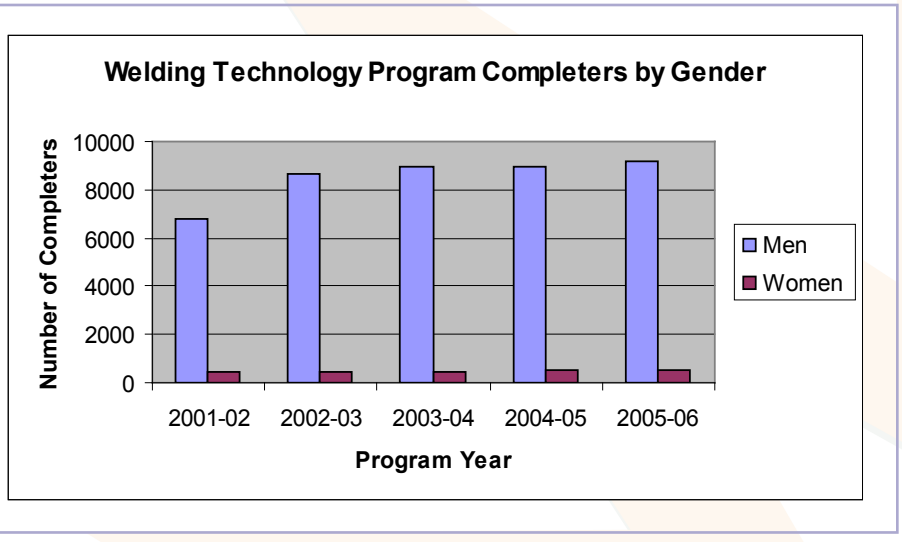
[18] Source: Snapshot of job postings retrieved from JOBcentral (http://www.jobcentral.com/) on May 9, 2008.

Table 12: Openings and Completers Comparison by State[19]

State	Openings	Completers	Difference
Texas	1,905	986	-919
Hawaii	1,170	913	-257
Montana	613	686	73
Florida	565	511	-54
Indiana	506	505	-1
Ohio	491	486	-5
Pennsylvania	474	486	12
Michigan	468	471	3
Georgia	433	442	9
North Carolina	425	303	-122

Efforts to identify specific reasons for the shortfall between completers and openings and recruitment strategies to address the need should be targeted in areas with the greatest discrepancy, such as Texas, Hawaii, and North Carolina.

The data available from IPEDS on postsecondary awards for programs in Welding Technology is available by gender. The chart below shows the disparity between the numbers of men and women who have completed Welding education programs.



Although the number of program completers has risen steadily since 2002, the number of women in welding has remained fairly constant. This data provides insight into an untapped pipeline of potential workers. The Weld-Ed panel might consider strategies to attract more women into the welding professions.

[19] Source: Occupational Supply Demand System. (http://www.occsupplydemand.org/OSD_SupplyState.aspx?CLUSCODE=074A-13&ST=ZZ&PathNo=1&sst=0).

IV. Conclusions

In support of the Weld-Ed Center's goal to increase the number of welders, we looked at available sources of data to frame a picture of the Welding Industry. The Welding Industry remains strong despite the recent economic downturn. Occupational demand for welders and those with a knowledge of welding is evidenced by projected average annual openings due largely to a need to replace workers who retire or leave the occupation. Although there have been reductions in employment numbers in the manufacturing sectors, the employment figures for welders as a percentage of industry have remained stable or increased.

We also learned that we cannot estimate short-term demand with the existing data sources. There is no national program to produce short-term estimates for occupational demand. State estimates vary in the level of detail (some states do not produce short-term occupational estimates), and those states that do produce short-term occupational estimates do not use a consistent timeframe. Conversations with employers and the identification of economic development efforts at regional or local levels produce a better picture of the short-term demand for those with welding skills.

There is also a lack of good data on the numbers of secondary education programs completers. Are high school programs that teach welding geared toward career exploration, or are these programs producing graduates who are ready to enter the workforce? The data that does exist for postsecondary education programs show a large variance in the numbers of welders completing certificate and degree programs by state as well as an overall shortfall in terms of meeting projected need. The data also indicate that women are clearly underrepresented in welding programs.

Findings from the comparison of occupational demand figures to the estimated supply of newly trained workers indicate that there is an insufficient number of those with welding skills to fill the demand. If, according to the *Survey of Welding School Output*, there is adequate national capacity to supply industry with welders and supply issues are not the problem, then we need to explore other possible explanations for the vacant positions that are going unfilled according to Internet-based job boards.[20]

Shortages of workers can be explained by comparing occupational demand to the supply of existing and new entrants to the occupation. A mismatch in the demand/supply ratio for welders and related occupations can occur for many reasons, among them:

- Unanticipated short-term demand for workers due to natural or other disasters, unanticipated construction projects, or new employers in an area from economic development efforts;
- Insufficient new entrants into the workforce because vocational programs are producing fewer program completers than demand warrants;
- Geographic disparity that occurs when the training programs are not in the geographic location where workers are in greatest demand;
- Increasing numbers leaving welding and related professions due to retirements or other factors;
- Low or below-average wages; and
- Training programs are not teaching the skills or methods and procedures needed by local employers.

[20] Source: Snapshot of job postings retrieved from JOBcentral (http://www.jobcentral.com/) on May 9, 2008.

Considering the variety of welding techniques, materials welded, and automated processes, another consideration affecting supply of qualified workers is the rigor required of education programs. Program evaluations must ensure that programs address the skills needed by local/and or regional employers. When reviewing programs it is also important to consider teacher credentials. Are the instructors well versed in the latest and necessary welding techniques? Are there sufficient teachers to provide a student/teacher ratio conducive to effective learning?

This report provides a long-term snapshot of the Welding Industry by providing national and state level data for welding occupations, industries that employ welders, and completers of welding technology programs. The data illustrate a demand for and insufficient supply of welders. As part of its mission, the Weld-Ed panel is considering additional research to determine why there is an apparent shortage of those with welding skills and strategies to address the need. This report is intended to inform the process of achieving the outcomes of the Weld-Ed National Skill Panel.

V. Thoughts for Consideration

The Weld-Ed panel has the opportunity to take on the challenge of developing strategies and solutions that will address not only the short-term, but also the long-term need for skilled workers in the Welding Industry. The following thoughts for consideration have grown out of this research.

Strategies to identify causes of and key regions affected by shortages may include:

The development of a competency model based on 21st century skill requirements. The model would serve as a resource for opening discussions with employers and conducting surveys to identify employer needs. The model also would provide a method to document 'soft skills' such as dependability and interpersonal skills, as well as related industry skills such as equipment maintenance and quality control analysis required and often overlooked in the training process. A model serves as a baseline for identifying industry need, as well as, providing a foundation for the development of career pathways.

A methodology or blueprint for identifying and addressing short-term demand. Short-term estimates of occupational demand should place a heavy emphasis on the latest observations and long-term models should rely on long-term trends.[21] Rather than attempting to produce a report of short-term demand using disparate data from dissimilar sources, the Weld-Ed panel might propose to develop a guidebook or blueprint for bringing together the right partners to collaborate around program planning. The blueprint would serve as a resource for bringing together the right partners to focus on the specific type of welding needed and strategic solutions for attracting workers to fill the need.

For example, if a community is planning a large bridge reconstruction effort or if there is a plan to develop a new power plant, the need for welders would best be estimated by the project engineers. Partnering with economic developers and community planners is one way of determining short-term need.

Commitment to continued monitoring of long-term project outlook. Develop and implement a plan to provide continued oversight of supply and demand issues facing the Welding Industry. Use up-to-date long-term projections to provide direction to the Welding Industry.

Workforce development and education and training strategies to address the need for and strengthen the supply of qualified workers may include:

Long-term strategies around educational program planning based on occupational projections data. This strategy would include the development of a decision matrix for use by local/regional program planners to compare projected demand to historical supply to make strategic decisions around expanding or discontinuing programs in Welding Technology.

Welding program evaluation tools. Evaluating existing programs in Welding Technologies using a comparison of local or regional employer skill needs (e.g. automated vs. hand-held welding techniques) to program outcome objectives might be accomplished in several ways. An analysis of placement rates for programs provides an indicator of the success of the program. Programs can also be evaluated by comparing the knowledge and skill areas taught to the requirements of welding certifications.

[21] Source: J. Scott Armstrong, *Principles of Forecasting*, The Wharton School, University of Pennsylvania.

Career guidance products. Evaluate why more young people are not considering welding as a career. After collecting observations from employers and workers in the Welding Industry, develop a campaign to attract more young people into the field. Consider targeting females and disadvantaged populations. Identifying the differences in the requirements of welding in the manufacturing sector, compared to welding in the construction sector might also prove useful when attempting to attract new workers to the field.

Plans to recruit and certify welding instructors. As welders and welding technicians age, they may be less able or willing to perform certain welding tasks. This strategy would include the development of a career pathway culminating with a certified welding instructor and development of a national certification.

Technical Notes

Classification Systems

Federal statistical agencies use the Standard Occupational Classification (SOC) to codify occupations. SOC classifies all workers into one of over 820 occupations for the purpose of collecting, calculating, or disseminating data. It uses a set of 2 to 6 digit codes to classify standardized occupations, with longer codes going to more detailed occupations.

The North American Industry Classification System (NAICS) serves a comparable function for industries and is the premier system for the classification and measurement of economic activity in North America. NAICS assigns each industry a 2 to 6 digit code, with longer codes assigned to more detailed industries. The first two digits of the code designate the industry sector; the third designates the industry subsector; the fourth digit designates the industry group.

The Bureau of Labor Statistics (BLS) releases national long-term occupational projections every 2 years. Projections are produced on a ten-year cycle. The most recent round of projections was released in November 2007 for the period from 2006 – 2016. Current state projections use a base employment estimate from 2004 with a projected need through 2014. State projections are always released about a year after the national numbers. States projections will 'catch up' with national projections in early 2009.

Occupational Employment and Wages

For wage data we utilized the BLS's *Occupational Employment Statistics Survey*. State wage data is available from a survey conducted through a cooperative program – BLS and the states. For each state we gathered hourly and yearly wages for the selected SOC occupations. Metropolitan area wage data comes from the BLS's *Occupational Employment and Wages*, May 2007. You can view wage data for an occupation on the BLS Web site or compare wages for an occupation for national, state, and sub-state areas on CareerInfoNet. See http://www.acinet.org/.

National employment projections for the selected SOC occupations come from the BLS's Office of Occupational Statistics and Employment Projections. State employment projections including growth, replacement and job openings figures comes from the *Occupational Supply Demand System*. See http://www.occsupplydemand.org/.

Industry Outlook

For each of the selected NAICS industries we gathered the number of establishments, employment, and total payroll wages for the ten states with highest Location Quotients. This data was derived from the BLS's *Quarterly Census of Employment and Wages (QCEW)*, which compiles employment and wage data at the national, state, metropolitan area and county levels. We also collected the projected changes in the five selected industries by 2016. This data comes from the BLS's *2006-16 National Employment Matrix* derived from the *Occupational Employment Statistics Survey*. The total projected year occupational employment (2016) represents the sum of employment figures for wage and salary, self-employed, and unpaid family workers. It does not include projected employment due to replacement needs.

Education Programs and Program Completers

Instructional programs are classified using Classifications of Instructional Programs (CIP). CIP, like the SOC uses a set of 2- to 6-digit codes to classify standardized educational programs. The first two digits organize the system into large educational program groups. There is no relationship between the SOC and CIP based on the digits in the codes. Crosswalks available from the National Crosswalk Service Center enable data users to identify programs that are related to occupations.[22] The SOC-CIP crosswalk was used to identify programs of study that are related to the welding occupations.

Information from the Integrated Postsecondary Education Program (IPEDS) survey conducted by the National Center for Education Statistics was used to identify the numbers of completers of welding programs. The most recent data available is for program year ending June 2006. Data was retrieved for Welding (CIP 48.0508) to identify the schools awarding 1- and 2-year certificates, 2- and 4-year degrees in Welding. Those trained in High School are not reported in the IPEDS survey data so there is no count for those who complete a vocational program from a Career and Technical High School.

The *Occupational Supply Demand* system referenced above also assists with the analysis and discussion of supply issues relevant to today's labor market. It is available at http://www.occsupplydemand.org/.

[22] Source: National Crosswalk Service Center, 2008, (http://www.xwalkcenter.org/xwxwalk.html).

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Appendices

Appendix A: Occupational Employment Trend Tables

The following five tables show the selected SOC occupations with national-level data (2006-2016 long-term employment projections and 2007 hourly and annual mean wage data) and state-level data (2004-2014 long-term employment projections, job openings (including growth and replacement), and 2007 hourly and annual mean wage data).[23] The tables are sorted by state. Note: The data for the State Employment Trends and the National Employment Trends are not directly comparable. The projections period for state data is 2004-2014, while the projections period for national data is 2006-2016.

Table 13: State and National Employment Trends and Wage Data for Welders, Cutters, Solderers, and Brazers

51-4121 - Welders, Cutters, Solderers, and Brazers								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
US	409,000	429,700	5%	N/A	N/A	10,730	$16.33	$33,960
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
AL	8,640	10,070	17%	143	244	387	$14.90	$30,990
AK	630	730	17%	11	17	28	$25.05	$52,100
AZ	4,500	5,630	25%	112	128	240	$15.48	$32,190
AR	5,890	7,130	21%	124	166	290	$14.30	$29,750
CA	29,800	33,100	11%	330	840	1,170	$16.74	$34,820
CO	3,670	4,420	20%	74	104	178	$17.19	$35,750
CT	2,540	2,540	0%	0	72	72	$18.61	$38,700
DE	810	840	4%	3	23	26	$18.18	$37,820
FL	13,450	15,300	14%	185	380	565	$15.75	$32,760
GA	10,040	11,540	15%	152	281	433	$14.38	$29,900
HI	960	1,330	38%	37	27	64	$24.55	$51,060
ID	1,700	2,010	18%	31	48	79	$13.51	$28,110
IL	14,400	14,550	1%	14	407	421	$16.36	$34,040
IN	14,190	15,240	7%	105	401	506	$15.98	$33,230
IA	7,500	8,450	13%	95	212	307	$15.19	$31,600
KS	N/A	N/A	N/A	N/A	N/A	N/A	$14.10	$29,330
KY	6,540	7,270	11%	73	185	258	$14.91	$31,020

(Table 13 continued on next page)

[23] Sources: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm); National Employment Projections (2006-2016, % change) and State employment projections (2004-2014; % change) – Occupation Profiles in ACINet (http://www.careerinfonet.org/), (Growth; Replacement; Job Openings) – Occupational Supply Demand System (http://www.occsupplydemand.org).

Table 13: State and National Employment Trends and Wage Data for Welders, Cutters, Solderers, and Brazers

51-4121 - Welders, Cutters, Solderers, and Brazers								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
LA	16,090	17,680	10%	159	454	613	$18.12	$37,700
ME	1,750	1,710	-3%	0	49	49	$18.39	$38,260
MD	2,470	2,590	5%	12	70	82	$17.43	$36,250
MA	4,030	3,830	-5%	0	110	110	$19.68	$40,930
MI	14,910	15,380	3%	47	421	468	$18.94	$39,400
MN	9,750	10,260	5%	51	276	327	$17.47	$36,330
MS	6,270	7,460	19%	119	177	296	$15.18	$31,560
MO	8,770	9,200	5%	43	248	291	$15.76	$32,770
MT	1,020	1,240	21%	21	29	50	$21.35	$44,420
NE	4,490	4,960	11%	48	127	174	$14.36	$29,860
NV	1,410	2,120	51%	72	40	111	$19.11	$39,750
NH	970	1,060	9%	9	27	36	$17.85	$37,140
NJ	4,400	4,300	-4%	0	120	120	$18.01	$37,460
NM	1,960	2,120	8%	16	56	72	$17.17	$35,710
NY	10,440	10,250	-2%	0	295	295	$17.44	$36,270
NC	10,040	11,450	14%	141	284	425	$15.91	$33,090
ND	1,820	2,270	25%	45	52	97	$15.89	$33,060
OH	17,370	16,930	-3%	0	491	491	$16.23	$33,750
OK	8,250	8,880	8%	63	233	296	$14.59	$30,350
OR	5,010	5,590	12%	58	151	209	$16.19	$33,680
PA	16,500	16,600	1%	8	466	474	$16.49	$34,290
RI	1,040	1,060	2%	2	30	32	$17.56	$36,520
SC	6,640	6,770	2%	14	187	201	$15.87	$33,000
SD	2,240	2,570	15%	33	63	96	$13.44	$27,950
TN	9,780	10,880	11%	110	276	386	$15.02	$31,240
TX	40,900	48,400	18%	750	1,155	1,905	$15.71	$32,670
UT	4,310	5,540	29%	123	122	245	$16.43	$34,170
VT	420	420	0%	0	12	12	$16.28	$33,860
VA	8,270	8,680	5%	41	233	274	$17.32	$36,040
WA	7,230	8,140	13%	90	221	311	$19.58	$40,730
WV	2,730	2,820	4%	10	77	87	$15.86	$32,990
WI	12,000	12,560	5%	56	339	395	$16.62	$34,570
WY	1,360	1,980	46%	62	38	100	$19.44	$40,440

Table 14: State and National Employment Trends and Wage Data for Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders

51-4122 - Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
US	52,800	54,400	3%	N/A	N/A	1,280	$15.96	$33,200
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
AL	N/A	N/A	N/A	N/A	N/A	N/A	$20.80	$43,270
AK	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AZ	460	530	16%	7	13	20	$15.87	$33,000
AR	720	910	27%	19	21	40	$13.59	$28,270
CA	2,700	2,800	4%	10	80	90	$14.44	$30,020
CO	330	350	7%	2	10	12	$19.32	$40,180
CT	540	530	0%	0	15	15	$18.02	$37,480
DE	120	110	-15%	0	4	4	$20.07	$41,740
FL	1,120	1,140	2%	2	32	34	$13.84	$28,780
GA	1,270	1,430	13%	16	36	52	$13.83	$28,770
HI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ID	N/A	N/A	N/A	N/A	N/A	N/A	$15.86	$32,990
IL	1,880	1,840	-2%	0	53	53	$17.28	$35,940
IN	1,960	2,020	3%	6	56	61	$14.44	$30,030
IA	1,340	1,520	13%	18	38	56	$15.60	$32,450
KS	N/A	N/A	N/A	N/A	N/A	N/A	$15.66	$32,570
KY	2,540	2,850	12%	31	72	102	$14.03	$29,180
LA	800	870	9%	7	23	30	$16.96	$35,280
ME	214	182	-15%	0	6	6	$17.62	$36,640
MD	390	410	5%	2	11	13	$16.09	$33,460
MA	1,020	950	-6%	0	30	30	$18.19	$37,840
MI	5,860	5,370	-8%	0	166	166	$18.77	$39,030
MN	680	710	4%	3	19	22	$16.43	$34,170
MS	270	310	19%	5	7	12	$13.12	$27,290
MO	1,210	1,270	5%	6	34	40	$13.71	$28,520
MT	N/A	N/A	N/A	N/A	N/A	N/A	$14.02	$29,150
NE	360	360	0%	1	10	11	$14.19	$29,510

(Table 14 continued on next page)

Table 14: State and National Employment Trends and Wage Data for Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders

51-4122 - Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
NV	140	220	51%	7	4	11	$14.08	$29,290
NH	350	370	6%	2	10	12	$15.31	$31,850
NJ	700	500	-19%	0	20	20	$16.11	$33,500
NM	120	130	0%	1	4	5	$12.07	$25,100
NY	1,080	1,010	-6%	0	30	30	$19.11	$39,750
NC	1,240	1,320	7%	9	35	43	$14.88	$30,940
ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OH	2,830	2,640	-7%	0	80	80	$16.14	$33,570
OK	1,390	1,410	2%	3	40	43	$14.97	$31,130
OR	270	310	13%	4	9	12	$15.58	$32,400
PA	2,500	2,450	-3%	0	71	71	$15.50	$32,240
RI	380	340	-11%	0	11	11	$12.31	$25,600
SC	1,050	930	-12%	0	30	30	$14.92	$31,030
SD	350	380	10%	4	9	13	$14.88	$30,950
TN	1,820	1,890	4%	7	52	59	$13.24	$27,540
TX	2,350	2,700	15%	35	65	100	$13.56	$28,210
UT	230	280	19%	5	7	11	$13.33	$27,720
VT	70	60	-14%	0	2	2	$15.82	$32,900
VA	1,220	1,210	0%	0	34	34	$16.65	$34,630
WA	270	300	12%	3	8	11	$20.42	$42,470
WV	110	120	0%	1	3	4	$14.00	$29,110
WI	2,390	2,380	0%	0	67	67	$16.31	$33,930
WY	50	80	50%	3	1	4	$13.50	$28,090

Table 15: State and National Employment Trends and Wage Data for Engineering Technicians, Except Drafters, All Others

17-3029 - Engineering Technicians, Except Drafters, All Other								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
US	81,800	83,400	2%	N/A	N/A	1760	$26.80	$55,730
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
AL	1,392	1,761	26.50%	37	33	70	$27.20	$56,580
AK	404	461	14.10%	6	9	15	$30.10	$62,610
AZ	872	1,020	17.00%	15	21	36	$24.09	$50,100
AR	N/A	N/A	N/A	N/A	N/A	N/A	$22.55	$46,910
CA	9,600	11,500	19.80%	190	230	420	$27.01	$56,180
CO	1,519	1,854	22.10%	34	37	70	$24.82	$51,630
CT	836	898	7.40%	6	20	26	$27.53	$57,270
DE	47	52	10.60%	1	2	2	$27.91	$58,050
FL	2,767	3,211	16.00%	44	67	111	$24.35	$50,650
GA	1,452	1,833	26.20%	38	35	73	$23.57	$49,020
HI	N/A	N/A	N/A	N/A	N/A	N/A	$33.98	$70,680
ID	323	413	27.90%	9	8	17	$21.75	$45,240
IL	3,289	3,647	10.90%	36	79	115	$27.68	$57,570
IN	N/A	N/A	N/A	N/A	N/A	N/A	$26.33	$54,770
IA	402	468	16.40%	7	9	16	$22.10	$45,970
KS	N/A	N/A	N/A	N/A	N/A	N/A	$27.50	$57,200
KY	759	794	4.60%	4	19	22	$22.45	$46,690
LA	1,433	1,646	14.90%	21	35	56	$26.20	$54,500
ME	563	589	4.60%	3	13	16	$32.16	$66,900
MD	3,714	4,313	16.10%	60	89	149	$31.37	$65,240
MA	1,650	1,880	13.90%	23	37	60	$27.46	$57,120
MI	10,158	10,465	3.00%	31	245	276	$28.44	$59,150
MN	3,526	3,985	13.00%	46	85	131	$25.44	$52,910
MS	519	580	11.80%	6	13	19	$29.08	$60,480
MO	554	536	-3.20%	0	13	1	$25.26	$52,540
MT	N/A	N/A	N/A	N/A	N/A	N/A	$23.97	$49,850
NE	145	158	9.00%	1	4	5	$24.79	$51,550

(Table 15 continued on next page)

Table 15: State and National Employment Trends and Wage Data for Engineering Technicians, Except Drafters, All Others

17-3029 - Engineering Technicians, Except Drafters, All Other								
State and National Employment Trends							2007 Mean Wage	
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
NV	340	508	49.40%	17	8	25	$24.54	$51,030
NH	580	639	10.20%	6	14	20	$21.78	$45,310
NJ	500	450	0.00%	0	10	10	$31.09	$64,660
NM	661	790	19.50%	13	13	26	$26.51	$55,150
NY	2,953	3,094	4.80%	14	71	85	$23.57	$49,020
NC	894	1,001	12.00%	11	21	32	$24.22	$50,370
ND	58	60	3.40%	0	2	2	$20.88	$43,430
OH	N/A	N/A	N/A	N/A	N/A	N/A	$26.00	$54,080
OK	593	652	9.90%	6	14	20	$27.38	$56,960
OR	4,749	5,120	7.80%	37	122	159	$24.62	$51,210
PA	11	13	18.20%	0	1	1	$29.98	$62,350
RI	187	188	0.50%	0	5	5	$25.82	$53,700
SC	N/A	N/A	N/A	N/A	N/A	N/A	$25.44	$52,920
SD	111	116	4.50%	1	3	3	$26.16	$54,400
TN	N/A	N/A	N/A	N/A	N/A	N/A	$26.45	$55,020
TX	N/A	N/A	N/A	N/A	N/A	N/A	$23.00	$47,830
UT	409	506	23.70%	10	10	20	$26.87	$55,890
VT	511	481	-5.90%	0	12	12	NA	NA
VA	3,219	3,600	11.80%	38	78	116	$32.14	$66,850
WA	3,532	4,097	16.00%	57	96	152	$31.40	$65,300
WV	242	259	7.00%	2	6	8	$25.28	$52,570
WI	1,091	1,239	13.60%	15	26	41	$24.27	$50,480
WY	128	155	21.10%	3	3	6	$22.56	$46,930

Table 16: Inspectors, Testers, Sorters, Samplers, and Weighers

51-9061 - Inspectors, Testers, Sorters, Samplers, and Weighers								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
US	491,400	456,800	-7%	N/A	N/A	7,280	$15.86	$32,980
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
AL	10,220	9,880	-3%	0	233	233	$13.26	$27,590
AK	382	437	14%	6	9	14	$24.70	$51,380
AZ	7,190	8,370	17%	119	164	282	$15.16	$31,540
AR	6,890	7,530	9%	63	157	220	$14.01	$29,140
CA	53,300	56,600	6%	330	1,210	1,540	$16.45	$34,220
CO	5,030	5,610	12%	58	114	172	$16.98	$35,320
CT	7,420	7,120	-4%	0	169	169	$18.16	$37,780
DE	670	600	-10%	0	15	15	$15.76	$32,770
FL	14,340	15,190	6%	85	327	412	$14.43	$30,020
GA	15,930	16,460	3%	66	355	421	$14.11	$29,340
HI	440	440	0%	0	10	10	N/A	N/A
ID	1,300	1,470	13%	17	29	46	$13.49	$28,060
IL	22,040	21,090	-4%	0	502	502	$15.53	$32,300
IN	18,590	17,800	-4%	0	423	423	$15.85	$32,970
IA	4,990	5,110	3%	13	113	126	$15.53	$32,300
KS	N/A	N/A	N/A	N/A	N/A	N/A	$17.24	$35,860
KY	10,270	10,310	0%	5	234	238	$14.12	$29,370
LA	6,310	6,250	-1%	0	144	144	$17.51	$36,420
ME	1,890	1,750	-7%	0	43	43	$15.32	$31,870
MD	5,230	5,150	-2%	0	119	119	$17.41	$36,210
MA	10,530	9,420	-11%	0	240	240	$18.49	$38,450
MI	29,010	27,800	-4%	0	660	660	$17.81	$37,050
MN	7,720	7,660	-1%	0	176	176	$15.88	$33,030
MS	4,900	5,400	10%	50	112	162	$13.10	$27,250
MO	8,620	8,170	-5%	0	196	196	$16.86	$35,080
MT	530	540	3%	2	12	14	$14.95	$31,090
NE	2,960	2,950	0%	0	67	67	$15.09	$31,380

(Table 16 continued on next page)

Table 16: Inspectors, Testers, Sorters, Samplers, and Weighers

51-9061 - Inspectors, Testers, Sorters, Samplers, and Weighers								
State and National Employment Trends							2007 Mean Wage	
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
NV	2,120	2,840	34%	72	48	120	$15.72	$32,690
NH	3,280	3,160	-4%	0	75	75	$16.20	$33,690
NJ	12,000	10,700	-11%	0	270	270	$16.33	$33,970
NM	1,400	1,400	0%	0	28	28	$17.11	$35,590
NY	21,150	19,480	-8%	0	481	481	$15.85	$32,970
NC	24,780	23,500	-5%	0	564	564	$13.95	$29,010
ND	590	650	10%	6	13	19	$15.71	$32,680
OH	30,570	27,920	-9%	0	696	696	$16.33	$33,970
OK	6,070	6,060	0%	0	138	138	$16.70	$34,740
OR	5,910	6,440	9%	52	143	195	$16.05	$33,390
PA	22,700	20,600	-9%	0	517	517	$16.29	$33,890
RI	1,660	1,530	-8%	0	38	38	$14.60	$30,360
SC	14,380	14,100	-2%	0	327	327	$14.31	$29,760
SD	840	810	-4%	0	19	19	$13.06	$27,160
TN	16,080	16,870	5%	80	366	445	$14.48	$30,120
TX	34,600	37,900	10%	330	790	1,120	$14.98	$31,170
UT	4,050	4,890	21%	84	92	176	$15.69	$32,630
VT	970	880	-9%	0	22	22	$14.90	$30,990
VA	10,670	10,570	-1%	0	243	243	$16.52	$34,370
WA	8,340	9,350	12%	101	205	306	$20.13	$41,870
WV	2,590	2,600	0%	1	59	60	$15.80	$32,870
WI	21,230	23,400	10%	218	483	701	$15.42	$32,070
WY	460	700	53%	24	10	34	$19.82	$41,230

Table 17: State and National Employment Trends and Wage Data for Materials Engineers

17-2131 - Materials Engineers								
State and National Employment Trends							2007 Mean Wage	
	2006	2016	% Change	Growth	Replacement	Job Openings	Hourly	Annual
US	21,600	22,500	4%	N/A	N/A	590	$37.90	$78,840
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
AL	360	490	36%	13	9	22	$39.19	$81,520
AK	23	33	44%	1	1	2	N/A	N/A
AZ	440	520	20%	9	11	20	$33.76	$70,220
AR	90	140	50%	5	2	7	$34.17	$71,060
CA	2,400	2,900	21%	50	60	110	$40.67	$84,600
CO	280	370	30%	9	8	16	$44.38	$92,310
CT	890	920	4%	3	24	27	$39.87	$82,920
DE	20	20	0%	0	1	1	N/A	N/A
FL	480	580	21%	10	13	23	$33.55	$69,790
GA	390	470	21%	N/A	N/A	20	$32.40	$67,400
HI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ID	N/A	N/A	N/A	N/A	N/A	N/A	$30.61	$63,670
IL	880	1,050	19%	17	23	40	$36.83	$76,600
IN	610	660	8%	5	16	21	$35.32	$73,460
IA	230	270	15%	3	7	10	$33.37	$69,410
KS	N/A	N/A	N/A	N/A	N/A	N/A	$36.82	$76,580
KY	200	190	-5%	0	5	5	$35.97	$74,820
LA	350	420	20%	7	9	16	$36.49	$75,890
ME	38	39	0%	0	1	1	$33.83	$70,370
MD	420	500	19%	8	11	19	$46.18	$96,050
MA	810	910	13%	10	20	30	$41.37	$86,040
MI	1,020	1,190	17%	17	27	44	$38.27	$79,590
MN	200	240	19%	4	5	9	$37.09	$77,150
MS	120	150	24%	3	3	6	$32.32	$67,220
MO	240	290	19%	5	7	11	$33.80	$70,310
MT	60	60	0%	0	1	1	$26.34	$54,790
NE	190	210	15%	3	5	8	$33.71	$70,110

(Table 17 continued on next page)

Table 17: State and National Employment Trends and Wage Data for Materials Engineers

17-2131 - Materials Engineers								
State and National Employment Trends							2007 Mean Wage	
State	2004	2014	% Change	Growth	Replacement	Job Openings	Hourly	Annual
NV	70	110	51%	4	2	6	$30.53	$63,490
NH	230	280	20%	5	7	11	$35.64	$74,120
NJ	500	500	11%	5	15	20	$38.26	$79,590
NM	89	100	12%	1	1	2	$37.17	$77,300
NY	940	1,000	6%	6	25	30	$35.05	$72,910
NC	310	350	14%	4	8	12	$34.33	$71,400
ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OH	1,630	1,780	9%	15	42	57	$38.89	$80,890
OK	140	160	12%	2	4	6	$28.93	$60,170
OR	290	300	3%	1	8	9	$37.96	$78,960
PA	1,150	1,250	10%	11	31	42	$36.05	$74,980
RI	50	60	0%	0	2	2	$35.01	$72,830
SC	710	730	3%	2	19	21	$29.49	$61,330
SD	12	13	8%	N/A	N/A	N/A	N/A	N/A
TN	710	940	32%	23	18	41	$42.76	$88,950
TX	2,000	2,550	28%	55	55	110	$39.36	$81,860
UT	170	220	34%	6	4	10	$32.87	$68,380
VT	35	34	-3%	0	1	1	N/A	N/A
VA	200	240	18%	4	5	9	$48.65	$101,190
WA	400	450	10%	4	11	15	$38.73	$80,560
WV	120	120	0%	0	3	3	$28.97	$60,260
WI	530	620	18%	10	14	23	$33.38	$69,420
WY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix B: Occupational Wage Tables

Table 18: National and State 2007 Mean Wages for all Selected SOC Occupations[24]

2007 Mean Wages										
	Materials Engineers		Engineering Technicians		Welders, Cutters, Solderers, & Brazers		Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders		Inspectors, Testers, Sorters, Samplers, & Weighers	
	Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual
US	$37.90	$78,840	$26.80	$55,730	$16.33	$33,960	$15.96	$33,200	$15.86	$32,980
AL	$39.19	$81,520	$27.20	$56,580	$14.90	$30,990	$20.80	$43,270	$13.26	$27,590
AK	N/A	N/A	$30.10	$62,610	$25.05	$52,100	N/A	N/A	$24.70	$51,380
AZ	$33.76	$70,220	$24.09	$50,100	$15.48	$32,190	$15.87	$33,000	$15.16	$31,540
AR	$34.17	$71,060	$22.55	$46,910	$14.30	$29,750	$13.59	$28,270	$14.01	$29,140
CA	$40.67	$84,600	$27.01	$56,180	$16.74	$34,820	$14.44	$30,020	$16.45	$34,220
CO	$44.38	$92,310	$24.82	$51,630	$17.19	$35,750	$19.32	$40,180	$16.98	$35,320
CT	$39.87	$82,920	$27.53	$57,270	$18.61	$38,700	$18.02	$37,480	$18.16	$37,780
DE	N/A	N/A	$27.91	$58,050	$18.18	$37,820	$20.07	$41,740	$15.76	$32,770
FL	$33.55	$69,790	$24.35	$50,650	$15.75	$32,760	$13.84	$28,780	$14.43	$30,020
GA	$32.40	$67,400	$23.57	$49,020	$14.38	$29,900	$13.83	$28,770	$14.11	$29,340
HI	N/A	N/A	$33.98	$70,680	$24.55	$51,060	N/A	N/A	N/A	N/A
ID	$30.61	$63,670	$21.75	$45,240	$13.51	$28,110	$15.86	$32,990	$13.49	$28,060
IL	$36.83	$76,600	$27.68	$57,570	$16.36	$34,040	$17.28	$35,940	$15.53	$32,300
IN	$35.32	$73,460	$26.33	$54,770	$15.98	$33,230	$14.44	$30,030	$15.85	$32,970
IA	$33.37	$69,410	$22.10	$45,970	$15.19	$31,600	$15.60	$32,450	$15.53	$32,300
KS	$36.82	$76,580	$27.50	$57,200	$14.10	$29,330	$15.66	$32,570	$17.24	$35,860
KY	$35.97	$74,820	$22.45	$46,690	$14.91	$31,020	$14.03	$29,180	$14.12	$29,370
LA	$36.49	$75,890	$26.20	$54,500	$18.12	$37,700	$16.96	$35,280	$17.51	$36,420
ME	$33.83	$70,370	$32.16	$66,900	$18.39	$38,260	$17.62	$36,640	$15.32	$31,870
MD	$46.18	$96,050	$31.37	$65,240	$17.43	$36,250	$16.09	$33,460	$17.41	$36,210
MA	$41.37	$86,040	$27.46	$57,120	$19.68	$40,930	$18.19	$37,840	$18.49	$38,450
MI	$38.27	$79,590	$28.44	$59,150	$18.94	$39,400	$18.77	$39,030	$17.81	$37,050
MN	$37.09	$77,150	$25.44	$52,910	$17.47	$36,330	$16.43	$34,170	$15.88	$33,030
MS	$32.32	$67,220	$29.08	$60,480	$15.18	$31,560	$13.12	$27,290	$13.10	$27,250
MO	$33.80	$70,310	$25.26	$52,540	$15.76	$32,770	$13.71	$28,520	$16.86	$35,080
MT	$26.34	$54,790	$23.97	$49,850	$21.35	$44,420	$14.02	$29,150	$14.95	$31,090

(Table 18 continued on next page)

[24] Source: 2007 wage data – Bureau of Labor Statistics (http://www.bls.gov/oes/oes_dl.htm).

Table 18: National and State 2007 Mean Wages for all Selected SOC Occupations

2007 Mean Wages										
	Materials Engineers		Engineering Technicians		Welders, Cutters, Solderers, & Brazers		Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders		Inspectors, Testers, Sorters, Samplers, & Weighers	
	Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual
NE	$33.71	$70,110	$24.79	$51,550	$14.36	$29,860	$14.19	$29,510	$15.09	$31,380
NV	$30.53	$63,490	$24.54	$51,030	$19.11	$39,750	$14.08	$29,290	$15.72	$32,690
NH	$35.64	$74,120	$21.78	$45,310	$17.85	$37,140	$15.31	$31,850	$16.20	$33,690
NJ	$38.26	$79,590	$31.09	$64,660	$18.01	$37,460	$16.11	$33,500	$16.33	$33,970
NM	$37.17	$77,300	$26.51	$55,150	$17.17	$35,710	$12.07	$25,100	$17.11	$35,590
NY	$35.05	$72,910	$23.57	$49,020	$17.44	$36,270	$19.11	$39,750	$15.85	$32,970
NC	$34.33	$71,400	$24.22	$50,370	$15.91	$33,090	$14.88	$30,940	$13.95	$29,010
ND	N/A	N/A	$20.88	$43,430	$15.89	$33,060	N/A	N/A	$15.71	$32,680
OH	$38.89	$80,890	$26.00	$54,080	$16.23	$33,750	$16.14	$33,570	$16.33	$33,970
OK	$28.93	$60,170	$27.38	$56,960	$14.59	$30,350	$14.97	$31,130	$16.70	$34,740
OR	$37.96	$78,960	$24.62	$51,210	$16.19	$33,680	$15.58	$32,400	$16.05	$33,390
PA	$36.05	$74,980	$29.98	$62,350	$16.49	$34,290	$15.50	$32,240	$16.29	$33,890
RI	$35.01	$72,830	$25.82	$53,700	$17.56	$36,520	$12.31	$25,600	$14.60	$30,360
SC	$29.49	$61,330	$25.44	$52,920	$15.87	$33,000	$14.92	$31,030	$14.31	$29,760
SD	N/A	N/A	$26.16	$54,400	$13.44	$27,950	$14.88	$30,950	$13.06	$27,160
TN	$42.76	$88,950	$26.45	$55,020	$15.02	$31,240	$13.24	$27,540	$14.48	$30,120
TX	$39.36	$81,860	$23.00	$47,830	$15.71	$32,670	$13.56	$28,210	$14.98	$31,170
UT	$32.87	$68,380	$26.87	$55,890	$16.43	$34,170	$13.33	$27,720	$15.69	$32,630
VT	N/A	N/A	NA	NA	$16.28	$33,860	$15.82	$32,900	$14.90	$30,990
VA	$48.65	$101,190	$32.14	$66,850	$17.32	$36,040	$16.65	$34,630	$16.52	$34,370
WA	$38.73	$80,560	$31.40	$65,300	$19.58	$40,730	$20.42	$42,470	$20.13	$41,870
WV	$28.97	$60,260	$25.28	$52,570	$15.86	$32,990	$14.00	$29,110	$15.80	$32,870
WI	$33.38	$69,420	$24.27	$50,480	$16.62	$34,570	$16.31	$33,930	$15.42	$32,070
WY	N/A	N/A	$22.56	$46,930	$19.44	$40,440	$13.50	$28,090	$19.82	$41,230

Appendix C: Industry Distribution of Occupations Tables

Table 19: Industry Distribution of Welding Occupations[25]

Industry Distribution of Welding Occupations								
17-2131 Materials Engineers								
	2006			2016				
Industry	Number	Percent of Industry	Percent of Occupation	Number	Percent of Industry	Percent of Occupation	Percent change	Numeric change
Total Employment	21,616	0.01	100.00	22,482	0.01	100.00	4.01	866
Fabricated metal product manufacturing	773	0.05	3.57	699	0.05	3.11	-9.52	-74
Machinery manufacturing	1,049	0.09	4.85	931	0.09	4.14	-11.31	-119
Transportation equipment manufacturing	2,607	0.15	12.06	2,776	0.17	12.35	6.45	168
17-3020 Engineering Technicians, Except Drafters								
	2006			2016				
Industry	Number	Percent of Industry	Percent of Occupation	Number	Percent of Industry	Percent of Occupation	Percent change	Numeric change
Total Employment	510,990	0.34	100.00	544,990	0.33	100.00	6.65	34,000
Specialty trade contractors	1,910	0.04	0.37	2,082	0.04	0.38	9.04	173
Fabricated metal product manufacturing	5,267	0.34	1.03	4,812	0.35	0.88	-8.64	-455
Machinery manufacturing	19,574	1.64	3.83	18,099	1.73	3.32	-7.54	-1,475
Transportation equipment manufacturing	39,090	2.21	7.65	38,448	2.33	7.05	-1.64	-642
Repair and maintenance	1,935	0.15	0.38	1,974	0.14	0.36	2.00	39
51-9061 Inspectors, Testers, Sorters, Samplers, and Weighers								
	2006			2016				
Industry	Number	Percent of Industry	Percent of Occupation	Number	Percent of Industry	Percent of Occupation	Percent change	Numeric change
Total Employment	491,417	0.33	100.00	456,817	0.27	100.00	-7.04	-34,600
Specialty trade contractors	1,389	0.03	0.28	1,452	0.03	0.32	4.52	63
Fabricated metal product manufacturing	38,196	2.46	7.77	30,593	2.24	6.70	-19.91	-7,604
Machinery manufacturing	25,278	2.12	5.14	20,989	2.01	4.59	-16.97	-4,289
Transportation equipment manufacturing	53,012	3.00	10.79	45,688	2.77	10.00	-13.82	-7,324
Repair and maintenance	6,400	0.51	1.30	7,631	0.53	1.67	19.25	1,232

[25] Source: Bureau of Labor Statistics. 2006-16 *National Employment Matrix.* (http://www.bls.gov/emp/empiols.htmhttp://www.bls.gov/emp/empiols.htm).

Appendix D: Metropolitan Statistical Area Tables

Table 20. Top Metropolitan Statistical Areas for Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders[26]

51-4122 Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders				
Metropolitan Areas with the Highest Concentration of Workers				
Metropolitan Statistical Area	**Employment**	**Hourly mean wage**	**Annual mean wage**	**Percent of MSA employment**
Monroe, MI	370	$26.30	$54,700	0.93%
La Crosse, WI-MN	310	N/A	N/A	0.44%
Springfield, OH	130	$14.70	$30,580	0.27%
Davenport-Moline-Rock Island, IA-IL	490	N/A	N/A	0.27%
Gadsden, AL	90	$9.66	$20,100	0.25%
Top paying Metropolitan Areas				
Metropolitan Statistical Area	**Employment**	**Hourly mean wage**	**Annual mean wage**	**Percent of MSA employment**
Rockford, IL	290	$26.35	$54,810	0.19%
Monroe, MI	370	$26.30	$54,700	0.93%
Detroit-Livonia-Dearborn, MI Metropolitan Division	700	$26.09	$54,270	0.09%
Seattle-Bellevue-Everett, WA Metropolitan Division	60	$24.43	$50,810	0.00%
Albany-Schenectady-Troy, NY	200	$23.43	$48,740	0.05%

N/A = Estimates not released.

[26] Source: Bureau of Labor Statistics. *Occupational Employment and Wages, May 2007*. (http://www.bls.gov/oes/current/oes514122.htm).

Appendix E: Definitions

Education Program Terminology

Classification of Instructional Programs (CIP)

The CIP is a taxonomic coding scheme that contains titles and descriptions of primarily post-secondary instructional programs. It was developed to facilitate NCES' collection and reporting of postsecondary degree completions by major field of study using standard classifications that capture the majority of reportable program activity.

IPEDS

IPEDS is the core postsecondary education data collection program for NCES. Data are collected from all primary providers of postsecondary education in the country in areas including enrollments, program completions, graduation rates, faculty, staff, finances, institutional prices, and student financial aid. These data are made available on their website to students, researchers and others.

Location Quotient Terminology

Analysis Area

Up to three analysis areas may be specified. For most location quotient purposes, the analysis area(s) should be a subset or component of the base area.

Analysis Industry

At least one industry or industry group must be selected to use the location quotient tool.

Area Selection

The location quotient tool calculates location quotients with respect to a base or reference area and from one to three analysis areas.

Base Area

The default base or reference area is the United States Total. This can be readily overridden for special purposes such as intrastate analysis. Users are cautioned that if they select an area other than the U.S. Total as the base area, they may develop location quotients that have little or no economic meaning.

Base Industry

The default base or reference industry is the all-industry total. This can be readily overridden for special purposes such as sector breakdown analysis. Users are cautioned that if they select an industry other than the all industry total, they may develop location quotients that have little or no economic meaning.

Data Period

The reference period for the data to be analyzed. This is currently limited to annual averages. The reduced detail currently available on the database for other time periods would significantly limit the location quotients that could be calculated.

Data Type
This is currently limited to employment.

Establishment Sizes
This is currently limited to the aggregate category of all establishment sizes.

Industry Group
The location quotient calculator makes available three standard industry groups that can be used to study the entire spectrum of industries as classified by NAICS. As the location quotient calculator is currently limited to presenting private sector data, the industry groups do not include the Public Administration sector. The highest level (most aggregated) group is the SuperSector group. The second highest is the Sector group, and the most detailed is the Sub-Sector group.

Industry Selection
The users must designate the group or groups of industries, or the specific industries they wish to have processed by the location quotient tool. The industries are defined under the 2002 version of the North American Industry Classification System.

Location Quotient
Location Quotients (LQs) are ratios that allow an area's distribution of employment by industry to be compared to a reference or base area's distribution. The reference area is usually the U.S., but it can also be a state or a metropolitan area. The reference or base industry is usually the all-industry total. The discussion below assumes the defaults are used. LQs also allow areas to be easily compared to each other.

If an LQ is equal to 1, then the industry has the same share of its area employment as it does in the reference area. An LQ greater than 1 indicates an industry with a greater share of the local area employment than is the case in the reference area. For example (assuming the U.S. as the reference area), Las Vegas will have an LQ greater than 1 in the Leisure and Hospitality industry because this industry makes up a larger share of the Las Vegas employment total than it does for the country as a whole.

LQs are calculated by first, dividing local industry employment by the all industry total of local employment. Second, reference area industry employment is divided by the all industry total for the reference area. Finally, the local ratio is divided by the reference area ratio.

NAICS
The 2002 version of the North American Industry Classification System (NAICS) is the industry coding system used by the location quotient calculator.

Ownership
This is currently limited to private ownership.

Percentage of Employment
Ratio of industry employment to base-industry employment times 100.

Specific Industry
As an alternative to selecting one or more of the standard industry groups, users may designate one or a number of specific industries from the full range of private-sector industries defined under NAICS.

Occupational Projection Terminology

BLS

The Bureau of Labor Statistics is the principal fact-finding agency for the Federal Government in the broad field of labor economics and statistics. http://www.bls.gov/.

Employment Projections

Projections estimate change in industry and occupation employment resulting from industry growth or decline, impact of technology, and changing business practices. The projections have a ten-year span. BLS prepares projections only for the Nation as a whole. Projections of industry and occupational employment are prepared by each State, using input from the BLS National projections.

Growth

Growth refers to the number of new jobs created.

Industry

A group of establishments that produce similar products or provide similar services. For example, all establishments that manufacture automobiles are in the same industry. A given industry, or even a particular establishment in that industry, might have employees in dozens of occupations. The North American Industry Classification System (NAICS) groups similar establishments into industries. NAICS is replacing the former Standard Industrial Classification (SIC) system.

Job Openings

Job openings is an estimate of annual openings that includes both turnover that results from people who leave the occupation (e.g. quit, retire, death) and new jobs that are created.

Numeric Employment Change

Numeric employment change is the difference in the number of jobs between the base and projected years. A positive number means employment is growing due to the creation of new jobs. A negative number indicates employment is declining in the occupation.

Numeric change is important to consider along with percent change, because both types of change are affected by the size of employment in an occupation. Occupations with a large base of numeric employment may be creating large numbers of new jobs yet have a small percent change. Occupations with a small base of numeric employment may be creating a small number of new jobs yet have a large percent change.

Occupation

A set of activities or tasks that employees are paid to perform. Employees that perform essentially the same tasks are in the same occupation, whether or not they work in the same industry. Some occupations are concentrated in a few particular industries; other occupations are found in many industries.

Percent Employment Change

Percent employment change indicates how fast employment is expected to increase or decrease during the projection period. The larger the positive percent change, the faster employment is growing. A large positive percent change is generally an indicator of favorable employment prospects. Likewise, the larger the negative percent change, the faster employment is declining, and the more unfavorable the employment prospects.

Replacements

Replacements are an estimate of the number of jobs that will arise from the need to replace workers who will die, retire, or otherwise permanently leave the occupation.

Standard Occupation Classification (SOC) System

The 2000 Standard Occupational Classification (SOC) system is used by Federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data. All workers are classified into one of over 820 occupations according to their occupational definition. To facilitate classification, occupations are combined to form 23 major groups, 96 minor groups, and 449 broad occupations. Each broad occupation includes detailed occupation(s) requiring similar job duties, skills, education, or experience.

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