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Abstract

The purpose of this study was to determine how two-year colleges have responded to the transformation towards a greater percentage of high-skilled workers in manufacturing industry. About 147 two-year colleges in Great Lakes and Plains States were investigated, and the study found that graduation trends in the programs and regions studied have declined, and in some cases, states and schools have lost their capacity to offer certain programs.

Introduction

Manufacturers in the United States are struggling to recruit and hire the number of high-skilled worker needed to maintain productivity and to compete globally. While the total number employed in the manufacturing sector is shrinking, the demand for high-skilled workers has increased. According to Deitz and Orr (2006), "Technology and increased globalization have, on the one hand, reduced the number of low-skilled jobs and, on the other, provided opportunities for high-skilled manufacturing employment to expand" (p. 7). The transformation of the nature of jobs in manufacturing has thrust manufacturers into the midst of a severe shortage of qualified workers. A 2005 survey by the National Association of Manufacturers (NAM) found that "the vast majority of American manufacturers are experiencing a serious shortage of qualified employees, which in turn is causing significant impact to business and the ability of the country as a whole to compete in the global economy" (The Manufacturing Institute, 2005, p. 1).

Employers have historically relied on the public education system as a source of candidates for skilled positions. In recent years, critics have blamed the secondary and postsecondary education systems for not adequately preparing students for the workforce. Critics also hold the education systems culpable for directing students away from jobs in the manufacturing sector. This study investigated how two-year colleges have responded to the transformation toward a greater percentage of high-skilled workers in manufacturing. Long-term and short-term graduation trends in manufacturing-related programs in two-year colleges in the Great Lakes and Plains Region states were analyzed. These trends will contribute to the understanding of the role of two-year institutions in filling the gap for high-skilled manufacturing workers.

Review of the Literature

In the United States economy, manufacturing represents 11% of all employment, though it constitutes less than 5% of all establishments. Employment in manufacturing has decreased from 17.2 million jobs in 1996 to 14.2 million jobs in 2005 (Bureau of Labor Statistics, 2005). The manufacturing sector of the total workforce has dropped sharply, from 20% of the total workforce in 1979 to nearly 11% today (Deitz & Orr, 2006, p. 1). Much of the loss in total employment can be attributed to increased labor productivity and international trade. According to Deitz and Orr, manufacturers are using "less labor per unit output in the production process" (p. 2). International trade and competition from countries that have low labor input costs have forced many domestic manufacturers to become more labor efficient or shut down production operations. This has resulted in the overall decline in total employment in the manufacturing sector, and has created a growing number of high-skilled jobs and increased demand for high-skilled workers. According to Deitz and Orr "the jobs-creating and job-displacing effects of trade and technology have led to a reallocation, or restructuring of the types of jobs performed in the manufacturing sector" (p. 2).

The restructuring of manufacturing jobs has affected employment trends in some of geographical regions of the country more than others. For example, the New England, Middle Atlantic, and South Atlantic Regions combined for a loss of almost two million manufacturing jobs between 1983 and 2002. New England had 34% loss, Middle Atlantic Region had a 33.5% loss, and the South Atlantic Region had an 8.8% loss in manufacturing employment. New England and the Middle Atlantic Regions' percentage

of high-skilled jobs increased due to large-scale reductions in low-skilled jobs rather than the adding on new high-skilled jobs. In the two Regions that are subject of these this study, the Great Lakes States (Illinois, Indiana, Michigan, Ohio, and Wisconsin) lost almost half a million manufacturing jobs, and there were modest gains in the Plains States (Deitz & Orr, 2006). Both regions saw an increase in the number of high-skilled manufacturing positions during the period 1983 to 2002, and the percentage share of high skilled workers increased in both regions. The increased share of high-skill jobs was attributed more to the adding of new high-skill jobs than an increased percentage resulting merely from a reduced portion of low-skill jobs.

The Plains States (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) increased its overall manufacturing employment by 12% and raised its high-skill shares of manufacturing employment by 60.9% because of an expansion in the high-skill employment. The Great Lakes region raised its high-skill share to 29.2 % of workers by adding high-skill jobs in sufficient numbers to offset much of the loss of low-skill jobs and retained its 24% share of overall manufacturing sector jobs and the distinction of having the largest manufacturing workforce of any region. According to Deitz and Orr, at the end of 1983-2002 period, North Central region "could still claim the most manufacturing workers and the most high-skilled manufacturing workers (p. 7).

These trends suggest that there have been significant changes in the nature of jobs and employment in the manufacturing sector. The drive to compete in a global economy by becoming more efficient in the use of technology and labor has resulted in the restructuring jobs. This profound change in the nature of manufacturing jobs has created a high demand for education and training for high-skilled workers. However, there is strong evidence that, education and training providers have not adequately responded to the increasing demand for high-skilled workers.

The pool of high skilled workers needed for newly restructured jobs has not increased fast enough to meet the demand. Eisen, Jansinowski, and Kleinert (as cited in The Manufacturing Institute, 2005) reported the following research findings:

1. Today's skill shortages are extremely broad and deep, cutting across industry sectors and impacting more than 80% of companies surveyed;
2. Skill shortages are having a widespread impact on manufacturers' abilities to achieve production levels, increase productivity, and meet customer demands;
3. High-performance workforce requirements have significantly increased as a result of the skills gap shortage and the challenge of completing in a global economy, according to nearly 75%of survey respondents (p. 1).

The 2005 Skills Gap Report found that 80% of all respondents indicated that they were experiencing an overall shortage of qualified workers. The survey revealed the specific nature of these shortages: 90% of the respondents reported a moderate to severe shortages of qualified skilled production workers; 65% reported a moderate or severe shortage of scientists and engineers; and 39% indicated a moderate to severe shortage of qualified unskilled production employees. In addition, 53% of all respondents indicated that, at least 10% of their positions go unfilled because of the lack of qualified candidates (The Manufacturing Institute, 2005, p. 4).

In keeping America Competitive, the National Association of Manufacturers (2003) indicated that the problem was not a lack of employees but rather a "shortage of

highly qualified employees with specific educational background and skills" (p. 1). According to the National Association of Manufacturers, two factors contribute to the shortage of qualified workers: "the interaction of demographics and technology and the failure of educational system to keep up with the needs of manufacturing" (p. 6).

Manufacturing, and many other employment sectors of the economy, have historically relied on the nation's education system to provide basic skills and pre-employment training for workforce. However, research reveals that fewer young people are choosing to enter careers in manufacturing. The National Association of Manufacturers and Deloitte & Touché conducted researched in which focus groups consisting of diverse respondents were asked about their perceptions of manufacturing-related careers. The primary findings of the focus groups were that, the sector's image was perceived "to be heavily loaded with negative connotations and universally tied to a stereotype of the 'assembly line' [and] …it was perceived to be in a state of decline. In addition, most respondents said that people 'just have no idea' of manufacturing's contribution to the American economy" (NAM, 2003, p. 2). Furthermore, the researchers contended that the nation's educational system perpetuates negative perceptions and does little to guide students into the manufacturing sector. According to Keeping America Competitive Report:

> …the United States' educational system exacerbates the negative perception of manufacturing, because it is largely out of step with the career opportunities emerging for young people in today's economy, including those in manufacturing…….Meanwhile, many well-paid and rapidly increasing manufacturing jobs remain unfilled, including those requiring two- and four-year degrees or short-term certification (NAM, 2003, p. 2).

Community and technical colleges have traditionally played an important role in the training of skilled workers in manufacturing-related fields. Many two-year colleges offer credit-based associate degree, diploma, and certificate programs that prepare students to enter the manufacturing sector. Through their workforce training and customized training divisions, the two-year colleges provide credit and non-credit training opportunities for manufacturing employers' incumbent workers. Many two-year colleges are also engaged in state and regionally funded training initiative.

According to the 2005 Skills Gap Survey, community college placement services were used by 27% of the total respondents; 35% turned to technical or vocational schools; and 33% turned to community colleges for incumbent worker training (The Manufacturing Institute, p.15).When asked "How prepared for a typical entry level job in your company are applicants with a certificate from two-year college?" About 92% of respondents, with fewer than 500 employees, said the applicants were adequately prepared (p. 20). Despite the overall criticism of the nation's educational system, the report maintained that, "Manufacturers are seeking help in closing the skills gap and they view the public education system as having potential to be a significant part of the solution" (p.16).

Purpose of the Study

The purpose of this study was to determine how two-year colleges have responded to the transformation towards a greater percentage of high-skilled workers in

manufacturing industry in Great Lakes and Plains States. This purpose was achieved by the following questions:

1. What are the graduation trends in the less-than one-year; one-but-less-than two-year; Associate Degree; and two-but-less-than four-year CIP 48.0501 Machinist programs?
2. What are the graduation trends in the less-than one-year; one-but-less-than two-year; Associate Degree; and two-but-less-than four-year CIP 48.0503 Machine Shop Assistant programs?
3. What has happened to the capacity of the states to continue to deliver these programs?

Definition of Terms

For the purpose of this study, the following terms were used as defined below:

CIP Code 48.0501: Machinist. "A program that prepares individuals to apply technical knowledge and skills to plan, manufacture, assemble, test, and repair parts, mechanisms, machines, and structures in which materials are cast, formed, shaped, modeled, neat-treated, cut twisted, pressed, fused, stamped or worked" (National Center for Educational Statistics, 2007).

CIP Code 48.0503: Machine Shop Assistant. "A program that prepares individuals to apply technical knowledge and skills to fabricate and modify metal parts in support of other manufacturing, repair, or design activities, or as an independent business" (National Center for Educational Statistics, 2007).

Research Methodology

The study utilized Ipeds data mining methodology. Data was downloaded from the National Center for Educational Statistics, Integrated Postsecondary Education Data System (IPEDS). The download criteria were:

1. By institution level: Two-but-less than four-year colleges;
2. By region and state: Plains and Great Lakes States;
3. By CIP Code 2000: CIP Codes 48.0503 & 48.0503; and
4. By Degree: Less than one-year programs (<1); One-but-less than two-year programs (1<2); Associate Degree programs (AS); and Two-but-less than four-year programs (2<4).

Data Analysis and the Research Findings

The data for the CIP Codes 48.0501 & 48.0503 for all program categories were downloaded for the 7-year period, starting from 2000 to 2006, and then analyzed and tabulated according to the following classifications:

1. Total number of graduates by CIP Code and Region (Table 1);
2. Graduates by Program Length: Plains Regions (Table 2);
3. Graduates by Programs Length: Great Lakes Regions (Table 3); and
4. Number of Programs by Length (Table 4).

The Formula used in calculating graduation trends was: Percentage Change = (Average 2004-2006/Average of 2000-2003) – 1. This formula added the total number of graduates in the years 2004, 2005, 2006, and then divided that total by the total number

of graduates in 2000, 2001, 2002, and 2003 to determine the most recent trend of graduates compared to the graduates in the earlier years studied. The quotient was then subtracted from 1 to create the percentage change.

Table 1
Total Number of Graduates by CIP Code and Region

									Average		
	Year	2000	2001	2002	2003	2004	2005	2006	Total	2000-03	2004-06	%Change
Plains												
	48.0501	724	565	461	501	399	459	443	3552	562.8	433.7	-22.9%
	48.0503	236	217	181	211	50	51	29	975	211.3	43.3	-79.5%
Great Lakes												
	48.0501	327	266	156	208	136	216	175	1484	239.3	175.7	-26.6%
	48.0503	268	300	384	263	247	153	156	1771	303.8	185.3	-39.0%

Table 2
Graduates by Program Length: Plains Regions

Plains									Average		
	48.0501	2000	2001	2002	2003	2004	2005	2006	Total	2000-03	2004-06	%Change
AS		194	167	176	156	208	142	195	1256	173.3	181.7	4.9%
<1		133	130	58	147	53	188	91	793	117.0	110.7	-5.4%
1<2		344	224	169	152	99	82	119	1179	222.3	100.0	-55.0%
2<4		53	44	58	46	39	47	38	310	50.3	41.3	-17.7%
	48.0503											
AS		72	63	64	99	21	8	7	334	74.5	12.0	-83.9%
<1		62	44	27	43	7	18	9	210	44.0	11.3	-74.2%
1<2		81	80	60	55	19	21	13	329	69.0	17.7	-74.4%
2<4		21	30	30	14	3	4	0	102	23.8	2.3	-90.2%

Table 3
Graduates by Programs Length: Great Lakes Regions

Great Lakes									Average		
	48.0501	2000	2001	2002	2003	2004	2005	2006	Total	2000-03	2004-06	%Change
AS		24	32	17	41	24	36	27	201	28.5	29.0	1.8%
<1		85	38	53	41	21	42	31	311	54.3	31.3	-42.2%
1<2		176	168	75	82	64	105	93	763	125.3	87.3	-30.3%
2<4		42	28	11	44	27	33	24	209	31.3	28.0	-10.4%
	48.0503											
AS		48	45	72	53	29	49	20	316	54.5	32.7	-40.1%
<1		21	44	39	33	48	7	9	201	34.3	21.3	-37.7%
1<2		149	149	182	134	145	79	111	949	153.5	111.7	-27.3%
2<4		50	62	91	43	25	18	16	305	61.5	19.7	-68.0%

Table 4
Number of Programs by Length

Plains									Average		
	48.0501	2000	2001	2002	2003	2004	2005	2006	2000-03	2004-06	%Change
AS		21	18	22	21	23	25	24	20.5	24.0	17.1%
<1		7	5	10	8	6	15	7	7.5	9.3	24.4%
1<2		24	24	24	21	21	11	20	23.3	17.3	-25.4%
2<4		4	5	6	6	5	6	6	5.3	5.7	7.9%
#schools		37	36	37	37	36	39	35	36.8	36.7	-0.2%
	48.0503										
AS		7	7	7	8	3	2	2	7.3	2.3	-67.8%
<1		4	4	3	4	2	4	1	3.8	2.3	-37.8%
1<2		8	9	10	12	7	2	3	9.8	4.0	-59.0%
2<4		3	3	3	2	2	1	0	2.8	1.0	-63.6%
#schools		19	18	17	21	11	7	4	18.8	7.3	-60.9%

Great Lakes									Average		
	48.0501	2000	2001	2002	2003	2004	2005	2006	2000-03	2004-06	%Change
AS		7	12	6	13	11	13	16	9.5	13.3	40.4%
<1		6	4	4	4	4	14	8	4.5	8.7	92.6%
1<2		14	17	11	10	12	27	17	13.0	18.7	43.6%
2<4		1	2	2	4	5	5	4	2.3	4.7	107.4%
#schools		24	28	23	26	25	42	33	25.3	33.3	32.0%
	48.0503										
AS		17	15	19	16	12	7	5	16.8	8.0	-52.2%
<1		7	10	12	8	11	3	2	9.3	5.3	-42.3%
1<2		31	31	31	27	27	9	14	30.0	16.7	-44.4%
2<4		2	5	6	4	3	4	4	4.3	3.7	-13.7%
#schools		45	45	46	36	33	18	21	43.0	24.0	-44.2%

Conclusions

Plains States: For the CIP Code 48.0501 Machinist programs, the percent change for all program length graduates was -22.9%. The largest decrease was -55% for graduates in 1<2 year programs. Associate Degree program graduates increased by 4.9%. Iowa (66%), North Dakota (NEW program), and South Dakota (37.5%) had increases in completions. Kansas (-49.5%), Minnesota (-45.4%), Missouri (-17.5%), and Nebraska (-28.7%) had negative trends in completers. The number of colleges providing machinist training programs have remained relatively constant over the study period. The number of colleges, range 35-39, indicates that the Plains region has maintained the capacity to continue to provide machinist training. However, the most recent year studied (2006) had the fewest number of programs (35) of any of the years studied.

For the CIP Code 48.0503 Machine Shop Assistant programs, the number of total graduates showed a significant downtrend with a -79.5% change. Longer-term programs showed larger percentage of declines (AS -83.9%; 2<4 -90.2%) than shorter-term programs. The previous years' average for all graduates was 211.3 compared to the recent years' average of 43.3 completers. Iowa and Nebraska, and to a large extent Minnesota and Missouri, have discontinued providing programs in machine shop assistant and have focused on machinist training. The number of colleges with these programs declined steadily during the years studies (From 19 colleges in 2000 to only 4 in 2006). This represents a significant reduction of regional capacity to prepare machine shop assistants.

Great Lakes States: For the CIP Code 48.0501 Machinist programs, the percent change for all program length graduates was -26.6%. The largest decline in graduates was for programs of <1 years (-42.2%) and 1<2 years (-30.3%). The number of graduates from Associate Degree programs remained steady throughout the period studied. Illinois, Indiana, and Ohio have increased the average number of machinists trained in recent years. Wisconsin had nearly a 50% decline in the average number of completers. Michigan had a negative 36.7% change in completers. The number of colleges providing machinist training have increased in recent years compared to earlier years by 8. The Great Lakes region has maintained its capacity to prepare machinists. However, Wisconsin has declined from 14 colleges in 2000 to 7 in 2006.

For the CIP Code 48.0503 Machine Shop Assistant programs, the number of graduates in the Great Lakes region showed a -39.0% change. Graduates from all length of programs showed declining percent change. All states in the region reporting graduates showed negative percent change in completers. Michigan (-66.0%) and Illinois (-60.4%) showed the largest declines in completers. Wisconsin has the smallest decline of -9.4%. The average number of colleges reporting graduates has declined by 44.2%. In 2000, 45 colleges reported completers. In 2006, only 31 colleges reported completers. The Great Lakes regions appear to have lost significant capacity to train machine shop assistants.

Implications of the Findings

Overall, graduation trends in the programs and regions studied have declined, and in some cases, states and schools have lost their capacity to offer certain programs. But beyond these general conclusions, it is difficult to identify any implications this might have on the manufacturing industry because the demand for graduates in these particular programs was not assessed, and no attempt was made to identify the impacts of

globalization and the declining economy on the manufacturing industry. Similarly, no attempt was made to cross-check with the placement offices in these schools to determine placement percentages of graduands in these programs. While the researches conducted by the National Association of Manufacturers and other interested parties have consistently concluded that there is a shortage of high-skilled workers in the manufacturing sector, they consistently failed to indentify the specific areas of skill-gaps. Therefore, the impacts of these findings on the manufacturing industry and the manufacturing occupational programs in two-years remain undetermined

Recommendations

To be able to make any academic program decisions with these findings, two-year college administrators will need to conduct further research on enrollment trends and motivation factors for student enrollment to determine what exactly are the causes for the decline in graduation trends in these programs. Stable enrollment in these programs is essential because it may lead not only to better graduation trends but also to proper prediction, coordination, and alignment of workforce development needs with industry demands. When this happens, the shortage of skilled workers currently being experienced in the manufacturing industry may be minimized.

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