Journal of STEM Teacher Education

Volume 45
Issue 3 *JITE Winter*

Article 4

March 2017

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Abstract

Due to the large number of individuals retiring over the next ten years a critical shortage of people available to work within the manufacturing industry is looming (Dychtwald, Erickson, & Morison, 2006). This shortage is exacerbated by the lack of a properly educated workforce that meets the demands of the 21st century manufacturer (Judy & D'Amico, 1997). Combine these two issues and the result is a steady reduction in qualified candidates for the millions of jobs available in the manufacturing industry. The purpose of this research was to identify if a knowledge gap exists between the manufacturing industry and the educational institutions charged with education of the production workforce. Although the majority of manufacturers and educators indicated there was a gap between the educational institutions and the manufacturer's needs, this research did not uncover a significant gap between the educational institutions and the manufacturers specific to their understanding of the attributes, skills and adult basic education level of a highly skilled production employee.

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Introduction

Working in the manufacturing sector since 1990 the first author has watched the industry change, in a relatively short time, from primarily being dominated by North American manufacturers to a global market that is driven by innovation, cost, quality, and the ability to change rapidly. Manufacturers in the United States are competing against low cost foreign suppliers with government subsidized materials that are driving retail prices of products far below most domestic manufacturer's cost. In addition, the rising cost of energy and health care in the U.S. are compounding the struggle to remain profitable (The Manufacturing Institute [TMI], 2006). Despite all of these challenges and contrary to many American's perceptions that manufacturing in the U.S. is a declining industry, more goods are produced in the United States now than at any other time in U.S. history with close to $1.5 trillion contributing to the Gross Domestic Product (GDP) in 2005. The manufacturing workforce employs 14.3 million people with another 6 million in related industries that support manufacturing. This translates to approximately 10% of the entire workforce generating 15% of the GDP from 2001 through 2005 (TMI, 2006).

The significance of understanding the economic impact that manufacturing has on our overall health as a nation can be directly related to our greatest strengths, which are to remain competitive through a diverse and flexible workforce that reacts quickly to changes in the market and competition (Judy & D'Amico, 1997). The skills required to be successful in manufacturing today have changed not only for the professional but for the production workforce too. Change is a part of our culture in manufacturing and the current rate at which the educational and training systems change is far too slow to meet the demand. Postsecondary vocational schools continue to produce students with inadequate employability skills and universities continue to have low enrollment for engineers and scientists while the local community colleges struggle for proper funding (National Association of Manufacturers [NAM], 2005).

Due to the large number of individuals retiring over the next ten years a critical shortage of people available to work within the

manufacturing industry is looming (Dychtwald, Erickson, & Morison, 2006). This shortage is exacerbated by the lack of a properly educated workforce that meets the demands of the 21st century manufacturer (Judy & D'Amico, 1997). Combine these two issues and the result is a steady reduction in qualified candidates for the millions of jobs available in the manufacturing industry. A coordinated effort between the manufacturing industry, educational institutions, and the government is our only hope in developing a workforce that is able to meet the demand of manufacturing in the 21st century.

The purpose of this research was to identify if a knowledge gap existed between the manufacturing industry and the educational institutions charged with education of the production workforce throughout the Front Range of Colorado. One of the areas explored was perception of needed hard skills and soft skills. The term *hard skill* was used to describe the skills typically associated with accomplishing specific tasks related to machining, welding, painting, mechanical assembly, electrical assembly, inspection and testing. These skills are often simple to observe, measure, and quantify. The term *soft skill* (also described as "employability skills") was used to describe the skills typically associated with interpersonal communication, problem solving, initiative, attendance, attitude, and character. These skills are often difficult to observe, measure, and quantify.

Research Questions

1. Are there differences between manufacturers and educators perceptions related to soft skills, hard skills, and adult basic education requirements of the 21st Century production workforce?
2. How can the attitudes of participants from the educational and manufacturing settings be described?
3. Is there a different perception of the future of manufacturing between educators and manufacturers?

Workforce Availability

The United States annual average unemployment rate in 2007 was 4.6%, with a labor force of 154 million people. This translates to 7 million people out of work and currently looking for jobs (U.S. Department of Labor, 2008). Without an understanding of the statistics, one could assume that there are too many people looking for jobs and not enough jobs to fill the need. While this assumption may have been true in recent history, it does not accurately address the underlying issue of our nation's future labor shortage, which is compounded by inadequate workforce skills specific to the manufacturing industry. Of the 154 million people that are active participants in the labor force, many do not have appropriate skills nor do they understand how to obtain skills required to remain employed in 21st Century manufacturing jobs. A benchmark study completed by The Manufacturing Institute included over 800 manufacturers throughout the United States. Their results indicated "Ninety percent of respondents indicated a moderate to severe shortage of qualified skilled production employees" (NAM, 2005, p. 4). The importance of production and the support of manufacturing in the United States is an issue grossly misunderstood by many outside the manufacturing industry. The U.S. Department of Labor (2006) statistics reported that production is the fourth largest occupation out of 22 and in 2005 over 10.2 million jobs in the United States were directly related to production.

In the future, demographics will contribute to the issues of workforce development as opposed to our current economic conditions that drive today's unemployment rates (Employment Policy Foundation [EPF], 2001). Annual growth of the U.S. population continues to decrease and is currently at 1.1% (American Society for Training & Development [ASTD], 2003). The Bureau of Labor Statistics anticipates the total growth of the labor force from 2005 through 2014 will average less than 1% per year (U.S. Bureau of Labor Statistics [BLS], 2006). The result will be at least 58 million job openings available by 2010, potentially falling more than 4.8 million workers short of meeting this demand (ASTD, 2003). Daniel Eisenberg (2002) stated that "over the next 30 years, 76

million baby boomers will be retiring, with only 46 million "Gen Xers" entering the labor force" (p. 30).

The workforce continues to change not only in population growth but also in diversity. The U.S. Census Bureau reported within forty years the non-Hispanic white person will make up 54.5% of the population as opposed to 71.4% in 2000. The Hispanic population will grow from 11.5% to 23.1%, African Americans from 12.2% to 13.2%, Asian and Pacific Islanders from 3.9% to 8.4% (ASTD, 2003). As the diversity of our nation's population continues to change, so must our education and training requirements for the 21st century workforce.

As we continued to research the nation's dilemma with regard to workforce development, the magnitude of the availability issue was enlightening. Statistically, we are headed for a workforce shortage based on current population growth and immigration estimates regardless of the workforce skill level. Population growth can be influenced by public policy on immigration and a potential surge in newborns, however, it is likely that statistical trends are correct and the shortage of available workers will exist. A graphical summary of the workforce availability issue is shown in Figure 1.

The graph is clear, we are most likely heading for a major workforce shortage in many industries as the years progress regardless of the skill and education level of the labor force. In order to offset the reduction in individuals available to participate in the workforce, a strong focus is required to clearly identify the education and training needs of the existing and future workforce to be capable of meeting the demands of the 21st century. The development of workforce education and training programs need to ensure diversity, innovation, productivity, and flexibility are all addressed in order to fulfill the requirements of the "Human Capital Challenge" (EPF, 2003).

21st Century Manufacturing Workforce

Earlier we stated production was the fourth largest occupation in the United States and employs over 10.2 million people in the

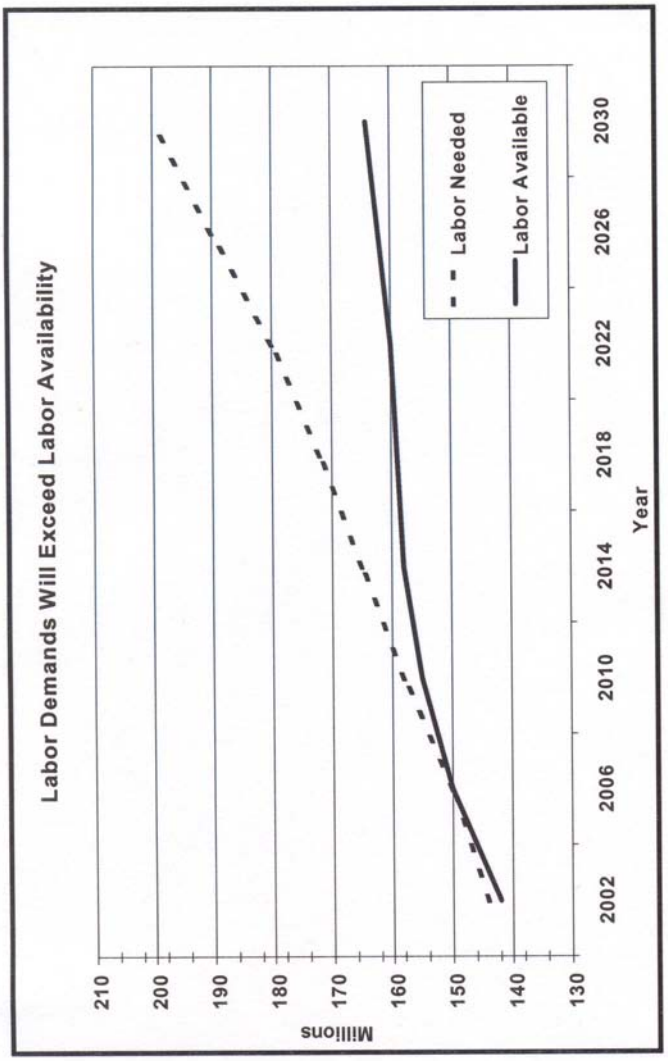

Figure 1. (Employment Policy Foundation [EPF], 2001, p. 5)

manufacturing industry contributing almost $1.5 trillion to the Gross Domestic Product. With statistics like these, why is the image of manufacturing often negative or referred to as a dying industry? Presumably, because many have been impacted by manufacturing or have known someone whose life has been affected by changes in the industry. Jobs are shifting from the manufacture of products to the distribution of services. In the early 20th century, 63% of the workforce produced products and only 37% were in the service industry. The trend has been a continual shift from products to services with recent data indicating that 22% of the workforce is producing goods and 78% in services. By the year 2025, the numbers could be as great as 83% of the workforce in the service industry leaving only 17% making products (Judy & D'Amico, 1997). Manufacturing has endured many challenges over the past few decades and continues to change more rapidly due to intense cost pressure from consumers and an ever expanding global market. This expansion of the global market creates new opportunities but also presents its share of challenges (TMI, 2006). In 2005, U.S. exports totaled 900 billion dollars and manufactured products consisted of more than 60% of these goods. In 2001, a sharp drop in exports impacted the manufacturing industry contributing to a loss of approximately 3 million jobs between 2000 and 2003 and contributed to the recession at the start of the 21st Century (TMI, 2006).

Another challenge for the U.S. manufacturing industry is maintaining a balance between exports and imports commonly associated with the amount of outsourcing of jobs that occur between the U.S. and foreign countries. For example, in 2005, the U.S. exported $806 billion dollars of manufactured goods and imported $1,347 billion dollars of manufactured goods resulting in a $541 billion dollar trade deficit. Although this deficit has started to drop slightly over the past few years this is a response to exchange rates rather than an increase in exports (TMI, 2006). Many of the jobs outsourced to low cost countries have been for production of products using unskilled labor in cost sensitive commodity markets. Judy and D'Amico (1997) discussed this shift in skilled verses unskilled labor reinforcing the issue surrounding outsourcing of low-

wage, unskilled labor jobs to low-cost countries. Their research suggested modifications of U.S. public policy that could reduce the gap created by the reduction of low-skilled workers for the newly created high-skilled jobs often found within the 21st Century manufacturer.

The manufacturing workforce of the 21st Century is comprised of productive, well paid, highly-skilled individuals. The measurement of productivity within the manufacturing industry is a common indicator of performance increasing over 94% between 1987 and 2005 (TMI, 2006). This data could be interpreted two ways. First, manufacturing was less productive in the preceding years leaving much room for improvement. Second, increased productivity could be a result of the increased competition (foreign and domestic) within the industry forcing manufacturers to employ better business practices to achieve improved results. Meckstroth (2003) stated "a main theme of the manufacturing outlook is that the sector will not generate many net additional jobs" (p. 56). He also reinforced that the productivity gain within the manufacturing industry is a direct result of "innovative products and production methods, outsourcing, and downsizing" (p. 56). The dichotomy for the manufacturing industry is they must continue to increase productivity but in doing so will indirectly reduce the number of available jobs. By reducing the number of available jobs, the labor market will remain very tight for highly-skilled workers in a high-wage industry. There will be little room for unskilled, under-educated individuals in the 21st Century manufacturing workforce.

Current Trends in Workforce Education

The crisis regarding our nation's workforce is not limited to the looming shortage of people. The lack of adult education and training programs that meet the requirements of the manufacturing industry and are readily available is part of the crisis too. The issues lie within our ability to adjust public policy on workforce education rapidly enough to meet the demands of the manufacturing industry and the needs of the workforce. *The Skill Gap 2001* published by the National Association of Manufacturers (2001) discussed both the

lack of support from federal programs and where training dollars are actually being allocated. The good news is that companies are spending more time and money on training. The bad news is companies are forced to meet the rising demand for training due to an inadequate workforce.

> …52% of the companies surveyed reported that they are spending more on training than in the past four years. Sixty-one percent are spending one percent or more of payroll, 33% are spending two percent or more, and 17% are spending three percent or more. Most of the training was in-house (62%) while 43% of the training was outside the company and consisted of three major sources that included vocational and technical schools, business associations, and community colleges. (p. 16)

The report noted this was the first time since 1997 business associations were rated as one of the top providers of workforce development (NAM, 2001). This illustrates a trend in adult education that professional organizations are trying to close the gap left by outdated and underfunded workforce education programs. As the requirements for training change, those closest to the "front line" are going to be able to respond much more quickly than those disconnected from the manufacturing industry. If adult education and public policy would approach the issues with the same focus as businesses approach their customers, adult education may be able to adapt more quickly to changes in customer demand. The Employment Policy Foundation (2003) stated in their annual report that future prosperity is not guaranteed to the American workplace; a workplace policy framework that respects diversity, encourages innovation, rewards productivity, and maintains flexibility is necessary. These seem to be clearly defined objectives that could assist educators when developing adult education and training programs as these are the requirements of the 21st Century manufacturer.

Funding Workforce Education

Workforce education has been central to our nation's development since the industrialization era of 1870s. Prior to the formalization of workforce education, the labor force consisted of tradesmen who passed their knowledge through apprenticeships and were often abused or miss-guided in their teachings (Gray & Herr, 1998). Upon review of funding workforce education over the past 100 years the Federal Government has increased contributions from zero in 1870 to $1.2 billion in 2005. Throughout the past 100 years, numerous educational philosophies and "acts" have guided the allocation of funds. Common themes are apparent when one studies the history of workforce education and the economic benefits for our nation and the individual. Judy and D'Amico (1997) noted that as education increases earning potential increases. Trends for the past thirty years show the level of earnings continue to increase. Unemployment data demonstrates as education increases the likelihood of being unemployed decreases rapidly. Current data report of the seven million people unemployed, 6.9% have less than a high school education, a sharp contrast to 3.8% of the unemployed who have a high school degree and some college or an associates degree (U.S. Department of Labor, 2006). The data continues to support that as education increases it is good for the individual, the economy, and our nation.

In February 2006, the president published the 2007 budget for our country. To the casual observer it would appear that everything is on track. What more could one ask for when you hear comments like, "we are measuring success not by good intentions or by dollars spent, but rather by results achieved" (U.S. White House, 2006a). The 2007 budget held spending below the 2006 budget (non-military only) and eliminated or significantly reduced the size of hundreds of major programs. Unfortunately, for the Career and Technical Education group, it appeared that it was one of the 142 programs proposed to be cut. Upon review of the Department of Education Budget (Office of Management and Budget, 2006a) the amount spent for Vocational Education was $1.2 billion in 2005, estimated $1.1 billion in 2006 and zero in 2007. The program had been *eliminated*.

To understand why the program was eliminated one must understand how the program was measured. The government developed the Program Assessment Rating Tool (PART) as their method of analyzing the effectiveness of a program based on measurable results. The performance management system was not new to government as it was originally developed based on the Government Performance and Results Act of 1993 to evaluate performance of a program and its ability to meet the budget. New with the PART was the ability to directly measure the performance of a program based on results. The tool was first introduced in 2003 and consists of four sections that have multiple questions that measure 1) Purpose, relevance, and federal role; 2) Strategic planning; 3) Program management; 4) Program results (Office of Management and Budget, 2006c). There are five categories of possible ratings: Effective, Moderately Effective, Adequate, Ineffective, and Results Not Demonstrated. After reviewing PART for Vocational Education State Grants (Ineffective), Tech-prep Education State Grants (Results not demonstrated), and Adult Education State Grants (Results not demonstrated) it was clear why the money was removed from the budget. The PART questionnaire (Office of Management and Budget, 2006b) for the above programs identified obvious pitfalls of programs such as 'clarity of purpose', 'inconsistent definitions of a vocational education student', and 'lack of consistent data collection'. Overall, 793 programs were assessed using the PART method and 72% were performing as opposed to 28% that were considered to be not performing (U.S. White House, 2006b). Specific to the Department of Education, 73 programs were assessed with 27 programs considered performing and 46 programs considered not performing.

The Association for Career and Technical Education website (www.acteonline.org) reported, "June 7, 2006: House Subcommittee Restores Perkins". The house subcommittee was successful in restoring the funding for the Perkins act which supports most of the CTE programs with $1.2 billion and specifically $10.8 billion dollars that supports Workforce Development programs (Association for Career and Technical Education [ACTE], 2006).

While the funding for Vocational Education was eventually restored for another year, the message was clear: funding will continue to be challenged if results are not produced. A clear interpretation of the PART system needs to be understood by all levels of leadership among the Career and Technical Education (CTE) community. Programs need to be held accountable for producing results that not only demonstrate the validity of workforce education but act as an example of continuous improvement for others to benchmark.

Literature Summary

Currently there are over seven million people out of work but the data is clear that as soon as 2010 the number of people available in the workforce will decrease causing a shortage of qualified individuals. The literature does not suggest zero unemployment but it does establish that the workforce will need to be more productive and diverse than previous generations. The median age of the U.S. population is already 35 years and this will only continue to increase as the baby boom population ages (ASTD, 2003). A typical "qualified" candidate will change over the next decade. High school diplomas will be mandatory requirements for most jobs as will post secondary education. Supervisors and managers will need to be fluent in at least one, possibly two foreign languages and respect cultural diversity.

To gain insight on how we can work toward closing the gap, data was collected from manufacturers and educational institutions located throughout the Front Range area of Colorado. Surveys were designed with the intent to capture current trends, opinions, and requirements of both populations regarding workforce development issues for those working with the production workforce.

Survey Method

Two surveys were developed using an on-line electronic questionnaire website called Question Pro (www.QuestionPro.com), one for educators and one for manufacturers. The two survey sample

groups were chosen through a non-probability convenience sample. Both surveys were distributed via internet to a convenience sample of participants contacted December 18, 2006 through February 10, 2007.

For the purpose of this research the Manufacturing Industry population was defined as a company that produces a product from raw materials either chemically, mechanically, or physically and found within the North American Industrial Classification code 31 - 33: Manufacturing (NAICS, 2002a). The survey sample consisted of 10 separate manufacturing companies that met the following criteria:

- Employed 25 Production employees or more (direct hourly labor).
- Production Operations consisted of at least one: Mechanical assembly; electrical assembly; welding; machining; industrial painting.
- Located in the area of Colorado known as the Front Range which consists of the Denver Metro area, Colorado Springs, Pueblo, Boulder, Longmont, Loveland, Ft. Collins, and Greeley.

For the purpose of this research the Educational Institution population was defined as any establishment that provides instruction and training as stated in the North American Industrial Classification code 61: Educational Services (NAICS, 2002b). The survey sample consisted of educational institutions that met the following criteria:

- Their current curriculum supported manufacturer's needs either through academic degree programs, continuing education program, workforce development or certification program.
- Facilities physically located in the area of Colorado known as the Front Range which consist of the Denver Metro area, Colorado Springs, Pueblo, Boulder, Longmont, Loveland, Ft. Collins, and Greeley.

Communication with the survey sample was initially accomplished by a phone call or on-site visit during which the purpose of the research was discussed and a request for their participation was extended. A request for participation e-mail

message was then sent to the sample population with a brief description of the research project and a link to the on-line survey. Once the participants were routed to the survey website, they were informed of the risk associated with the survey (or lack thereof) and asked to continue, which provided informed consent. All participants' anonymity was maintained throughout the survey and data collection. The participants were asked to complete the survey within two weeks of their first notification. A follow-up e-mail was sent three weeks after their first notification reminding them to participate in the survey or thanking them for their participation if they had already completed the survey. Due to anonymity, we were not able to tell if each participant had actually completed the survey so the number of estimated participants to the number of surveys actually completed was monitored to determine the overall response rate. The results were analyzed using descriptive and inferential statistical methods and presented in a summarized format.

Survey Population

Of the 68 people contacted, a total of 36 surveys were completed, 20 from educational institutions and 16 from manufacturing. The breakdown of positions held by the educational institution respondents were seven instructors, five program coordinators, five workforce development professionals, two consultants, and one continuing education professional. The educational institutions included 13 community colleges, four career and technical education institutes, two consulting companies, and a workforce development center. The breakdown of the positions held by the manufacturing industry respondents were seven from operations management, four from human resources, three owners or presidents, and two production supervisors.

Findings

Workforce availability issues are predicted to rise as the demand for qualified workers increase due to the anticipated shortage of individuals that create the labor force. Many industries are currently affected by this shortage and manufacturing is not immune to the resource availability crisis. If manufacturing is to remain competitive and contribute to the economic heartbeat of our nation, it must overcome the skills gap that is currently impacting the performance of the production workforce (TMI, 2006). One of the issues facing manufacturing is the development of a highly skilled production workforce through the use of either educational institutions or manufacturer's internal training programs. Here we present the findings from the surveys.

Research Question #1: *Are there differences between manufacturers and educators perceptions related to soft skills, hard skills, and adult basic education requirements of the 21st Century production workforce?*

The first theme to emerge from the surveys was specific to the attributes of a highly skilled production employee related to soft skills and adult basic education requirements. The only attribute that indicated a statistically significant difference ($p=.009$) was quality focus (see Table 1). The manufacturers placed a higher level of importance on quality focus ranking it the most important attribute as opposed to the educators who ranked it as the fourth important attribute. In fact, educators ranked attitude as the most important attribute. Even with this finding, the overall close ranking of all the preferred attributes demonstrated that the manufacturing and educational respondents generally agree on the attributes that contribute to a highly skilled production employee.

(Note that the calculation of t-values and p-values used within this study are intended for exploratory purposes specific to the differences between the two survey groups that participated in this research and not meant for generalization.)

Table 1.

Indicate the importance of each attribute of a highly skilled production employee.

Attribute	Ranking		Mean		SD		t-value	p-value
	Edu	Mfg	Edu	Mfg	Edu	Mfg		
Attitude	1	3	4.700	4.438	.571	.743	1.214	.117
Productivity	2	4	4.650	4.438	.049	.727	1.045	.152
Attendance	3	2	4.600	4.688	.598	.479	-.475	.319
Quality Focus	4	1	4.450	4.875	.605	.342	-2.505	.009*
Character	5	5	4.300	4.312	.801	.793	-.047	.482
Problem-Solving Skills	6	7	4.250	4.125	.716	.885	.469	.321
Communication Skills	7	6	4.100	4.250	.718	.856	-.572	.286
Math Skills	8	9	3.450	3.375	.826	.957	.252	.401
Reading Skills	9	10	3.450	3.375	.605	.885	.302	.382
Writing Skills	10	11	3.200	2.875	.696	.957	1.179	.123
Computer Skills	11	8	3.100	3.500	.718	.097	-1.425	.082
Education Level	12	13	2.750	2.563	.639	.512	.953	.174
Work Experience	13	12	2.650	2.688	.671	.602	-.174	.431

Note: Mean, Median, and Mode are scored as 1= Not Very, 2 = somewhat important, 3 = important, 4 = very important, 5 = Extremely Important : Edu – Educational institution participants. Mfg = Manufacturing industry participants

*$p = < .05$

The next theme to emerge from the survey was the current state of the production workforce based on the frequency of common attributes observed by the respondents (see Table 2). The first seven attributes were classified as 'soft skills' and in general, there was little gap between the education and manufacturing rankings. The significant gaps observed between attendance issues (p=.020), good communication skills (p=.038), and productivity issues (p=.027) did not necessarily affect their ranking but indicated the manufacturers were observing these attributes less frequently than educators. The responses from both the educators and manufacturers indicated similar ranking of each attribute but with slightly less optimistic responses from the manufacturers.

The attributes related to adult basic education were adequate computer skills, adequate math skills, and adequate writing skills. Education and manufacturing ranked all of these attributes similarly. However, the educational respondents were more optimistic regarding their frequency of observation. Of the 13 attributes ranked, seven of the attributes were observed less frequently by manufacturers and indicated the first significant gap identified regarding their different perceptions specific to the skills gap. As discussed in the first theme, both groups understood what is expected of a highly skilled production employee, yet data indicated that the educational respondents are observing this behavior more frequently than manufacturing respondents. This could be an indication of disconnect between education and manufacturing or it could also be related to the amount of contact each respondent actually has with the production workforce. For example, educators may spend only two hours a week with the individual and manufacturers could spend forty hours a week with them.

The next theme regarding attributes of the production workforce was related to the hard skills requirements of the local manufacturing industry. We were encouraged by the continuity between the survey groups as each skill was ranked in the same order (see Table 3). Testing and inspection, mechanical assembly, and electronic assembly were ranked as 'very important' skills. Machining was ranked as 'somewhat important' by both groups. Welding and industrial painting were ranked by educators as 'somewhat'

Table 2.

Indicate the frequency of each attribute found in the current production workforce.

Frequency of Attribute	Ranking		Mean		SD		t-value	p-value
	Edu	Mfg	Edu	Mfg	Edu	Mfg		
Good Quality focus	1	1	3.550	3.563	.887	.727	-.045	.482
Positive Attitude	2	2	3.400	3.188	.821	.911	.735	.234
Problem-solving Ability	3	3	3.400	3.125	.754	.719	1.110	.137
Attendance Issues	4	5	3.350	2.813	.745	.750	2.144	.020*
Good Communication Skills	5	7	3.200	2.750	.834	.577	1.834	.038
Solid Character	6	4	3.200	3.000	.834	.730	.755	.228
Productivity Issues	7	8	2.850	2.313	.875	.704	1.993	.027*
Adequate Computer Skills	8	10	2.750	2.000	.910	1.033	2.314	.013*
Prior Work Experience	9	6	2.650	2.813	.671	.750	-.685	.249
Adequate Reading Skills	10	9	2.450	2.063	.945	.854	1.276	.105
Adequate Math Skills	11	11	2.350	1.813	1.040	.834	1.679	.051
Adequate Writing Skills	12	12	2.300	1.688	.979	.793	2.025	.025*
Post Secondary Education	13	13	2.200	1.375	.951	.619	2.994	.003*

Note: Mean, Median, and Mode are scored as 1= Not Very, 2 = sometimes, 3 = normal, 4 = most often, 5 = always
Edu – Educational institution participants. Mfg = Manufacturing industry participants
* $p = < .05$

Table 3.

Based on your understanding of the local manufacturers needs, please Indicate the importance of each "hard" skill of the production workforce.

Hard Skill	Ranking		Mean		SD			
	Edu	Mfg	Edu	Mfg	Edu	Mfg	t-value	p-value
Testing & inspection	1	1	4.000	4.313	.795	.946	-1.077	.144
Mechanical Assembly	2	2	3.900	3.938	.852	.854	-.131	.448
Electronic Assembly	3	3	3.650	3.313	.813	1.250	.978	.167
Machining	4	4	3.100	2.688	1.021	1.448	1.002	.162
Welding	5	5	2.800	1.813	1.005	1.109	2.798	.004*
Industrial Painting	6	6	2.200	1.625	.951	1.088	1.691	.050

Note: Mean, Median, and Mode are scored as 1= Not Very, 2 = somewhat important, 3 = important, 4 = very important, 5 = Extremely Important. Edu = Educational institution participants. Mfg = Manufacturing industry participants

*p = < .05

important while manufacturers ranked these as 'not very' important skills. There was a significant difference between the groups regarding the least important hard skills (welding; p =.004 and industrial painting; p =.050) that could be a result of the manufacturer's particular requirements and educator's general understanding of the requirements. A larger survey group could yield a clearer picture of the true needs amongst the manufacturing industry located in the Front Range while also shifting the order of ranking.

The final discussion on this topic directly relates to the perception of disconnect between the educational institutions and the manufacturers needs. When asked specifically, both groups indicated they believed there is a gap between the two groups with regard to understanding the manufacturer's educational requirements. However, this survey did not generate substantial evidence that the two groups have different perceptions regarding the attributes of a highly skilled production employee. There was a slight significant difference between the current observations of both groups with manufacturing reporting less frequent observation of the preferred attributes while maintaining a similar ranking as the educational respondents. The attributes specific to hard skills requirements supported continuity between the two groups resulting in a general understanding regarding all of the attributes and skill requirements between the manufacturers and educators.

Research Question #2: *How are the attitudes of participants from the educational and manufacturing settings described?*

A series of questions were presented to education participants to understand their current and preferred method of communication between manufacturers and educational institutions. Educational respondents indicated that advisory panels were the most common form and most preferred method of communication. Not surprisingly, the major limiting factor to improving communication between the two groups was time. We were encouraged by the high number of responses indicating that manufacturing consortiums and quarterly roundtable discussions with plant tours were viable options

to improved communication. A possible improvement to the current advisory panel structure would be to incorporate the use of regional manufacturing consortiums that host roundtable discussions in conjunction with plant tours on a regular schedule. The oversight of the advisory panel can still be maintained in addition to educators and manufacturers meeting face-to-face directly where education of the learner is applied; the manufacturing environment. In a perfect world, one goal is to have the classroom and the manufacturing environment one in the same.

The establishment of a conduit that facilitates the smooth flow of information between the educational institutions and manufacturers will not only improve the educators' understanding of the requirements and desired attributes but also provide an opportunity for manufacturers to improve their educational endeavors as well. This important issue was discussed in the literature review and indicated that manufacturers and business associations were rated as the top providers of workforce development (NAM, 2001). The manufacturing survey supported these findings with over 87% of the respondents indicating they have a dedicated workforce development and training budget. The manufacturing respondents indicated that a majority of the training is focused on hard skill development with a few respondents indicating soft skills training occurred and 78% responded that no training occurred for adult basic education skills. As an indicator of the struggle between hiring a productive employee that meets basic educational requirements and educating an unproductive employee, most manufacturing respondents indicated that a high school degree or GED is required for employment within their organization.

In our experience, training programs within the manufacturing industry are often discussed but seldom pursued, especially for the production workforce. The educational respondents reported that 'lack of time' was the major obstacle to improving communication and also indicated the learner's major obstacle as the 'availability of time'. Within manufacturing, time is also a premium but the most common obstacle is return on investment (ROI). When faced with the dilemma of training verse production, it can be challenging to clearly justify the advantages of the training based on typical ROI

calculations. To off-set this expense, qualified manufacturers can apply for state and federal funding dollars set aside specifically to assist with training and development of their workforce (Uhalde, Seltzer, Tate, & Klein-Collins, 2003). The manufacturing survey respondents implied that less than half are using state funding and only one reported using any federal funding. The manufacturers were also asked if they offered tuition reimbursement programs with 75% indicating 'yes'. Regardless of the obstacles surrounding time and funding, both groups need to work together in the efficient design and implementation of successful workforce development programs.

Research Question #3: *Is there a different perception of the future of manufacturing between educators and manufacturers?*

Another gap explored from this survey was one of perception regarding the expansion or reduction of the manufacturing industry along the Front Range of Colorado. The educational respondents report a decrease in the level of interest in manufacturing while the manufacturing industry reports a slight growth in the hiring of production employees over the next four years. However, this shift is not statistically significant as indicated by the p-value as shown in Table 4.

These limited results appear to mirror research discussed in the literature review from a benchmark study completed in 2005 by The Manufacturing Institute tilted *2005 Skills Gap Report – A Survey of the American Manufacturing Workforce* that found "ninety percent of respondents indicated a moderate to severe shortage of qualified skilled production employees" (NAM, 2005, p 4). The reality of this dichotomy is that manufacturing is in need of a different type of skilled individual not necessarily more individuals. The use of 'un-skilled' production workers within the United States may soon be an outdated term as many of the so-called 'un-skilled' jobs have been outsourced to low cost countries where labor is abundant (Judy & D'Amico, 1997). In addition, the 21st Century manufacturer requires a workforce that is diverse, innovative, productive, and flexible, not one that is full of specialists capable of only a few different tasks (Judy & D'Amico, 1997).

Table 4.

Indicate the estimated number of production employees at your facility by the end of:

# of Production Employees	# of Respondents	
	December 2006	December 2010
Less than 10	2	0
10 – 19	1	1
20 – 49	8	6
50 – 99	3	6
100 – 199	0	1
More than 200	2	2
Mean	3.250	3.812
Median	3	4
Mode	3	3
SD	1.390	1.109
t-value	1.28	
p-value	.108	

Note: Mean, Median, and Mode scored as (1)= less than 10 production employees, (2) = 10 – 19 prod. emp., (3) = 20 – 49 prod. emp., (4) = 50 – 99 prod. emp., (5) = 100 – 199 prod emp., (6) = More than 200 production employees.
p= < *.05*

The issues facing the educational institutions and the manufacturing industry are complex and have been the main theme discussed and researched throughout this study. The final question regarding gaps presented to both survey groups was based on six common issues (see Table 5). The educational respondents ranked available funding as the issue that will create the largest gap for workforce development followed by retirement of qualified workers. Hard skills and low unemployment rate tied for third. Interestingly, the manufacturing industry ranked hard skills as the largest issue followed by low unemployment rate and then available funding. The level of variance within the educational participants indicated they were in agreement with the ranking as there was only a .70 difference between the mean scores. The manufacturing participant's variability was greater with a mean difference of 1.1. This could indicate that educators viewed these issues more similarly than manufacturers did. This difference (or lack of) suggests the educational participants perceived these issues differently than the manufacturing participants and this could contribute to the disconnect between the educational institutions and manufacturing industry. If one were to attempt to interpret the most important issue from the educational responses they would list funding as the number one issue due to the competitiveness caused by the ever-shrinking education budgets. Manufacturing ranked funding as third possibly due to their feeling of more control over their own funding for education based on their revenue growth. The manufacturers' most pressing issue was hard skill training and could be interpreted as a result of the lack of vocational education training found in the current workforce (TMI, 2006).

Conclusion

Although the majority of manufacturers and educators indicated they feel there is a gap between educational institutions and the manufacturer's needs, this research did not uncover a significant difference between the educational institutions and the manufacturers specific to their understanding of the attributes, skills, and adult basic

Table 5.

Over the next four years, what do you feel will create the largest gap between what the manufacturers require and the available production workforce?

Gap	Ranking		Mean		SD		t-value	p-value
	Edu	Mfg	Edu	Mfg	Edu	Mfg		
Available Funding	1	3	3.800	3.250	.894	.931	1.801	.040*
Retirement of Qualified Workers	2	4	3.600	2.938	.940	1.124	1.927	.031*
Hard Skills	3	1	3.450	3.750	.826	.577	-1.231	.113
Low Unemployment Rate	3	2	3.450	3.688	.826	.602	-.963	.171
Soft Skills	5	6	3.100	2.688	.852	.704	1.556	.064
Adult Basic Education	6	5	3.100	2.750	1.021	.856	1.096	.140

Note: Mean, Median, and Mode are scored as 1= No Gap, 2= Slight Gap, 3 = Manageable Gap, 4 = Large Gap, 5 = Extreme Gap
Edu – Educational institution participants. Mfg = Manufacturing industry participants
*p= < .05

education level of a highly skilled production employee. A couple of areas suggest further investigation is necessary. These are measuring the attributes that contribute to a highly skilled production employee, improving communication avenues between manufacturers and educators, developing production workforce training programs, mapping the stakeholders of vocational education, and eliminating causes of inadequate funding. Further research is clearly needed to uncover where the differences and opportunities lie.

A review of literature revealed that vocational education and the manufacturing industry have changed dramatically and understanding workforce education remains a very important issue. Traditional vocational education programs of the 1960's and 1970's that focused on the development of specific skills like woodworking, metal working, and small engine repair were replaced by the school-to-work programs of the 1980's that combined skills with academics. The school-to-work programs started the move of vocational education out of the public school systems and directed it more towards industry training. In the 1990's, the term "vocational education" was changed to "career and technical education" and was supported by a model of career paths focused on soft skills and academics specific to a chosen industry combined with hands-on, job specific training. The fundamental difference between the production workforce of the 1970's and 2007 is the expectation from manufacturers that the individual is skilled in numerous areas, not one specific skill or trade. This requirement of a flexible workforce stems from the success of North American manufacturing's demonstrated ability to rapidly change to the demands of the customer. As the literature suggested, the vision of 21st Century career and technical education should be based on the ability to quickly develop flexible and functional programs that meet the needs of individuals and manufacturers for a given industry.

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