Skilled Workforce in the 21st Century

Study Developed By

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From the Authors:

The purpose of this study is to explore the upcoming changes that are viewed by many as the 'Skilled Workforce Crisis.' The importance of the "Skilled Workforce in the 21st Century" research and study project is that it has been developed independently and without funding from any particular interest. Its authors felt that it was important to the R&M industry to fully understand what we saw as the real issues related to the present evolution of business and R&M.

Through the initial concept and development of this project, we had similar views as those presented by almost all of the studies that were reviewed in-depth for this study and in general, as other articles, studies and materials have been presented recently. However, by taking a look into the history of business, the workforce and R&M, a different pattern emerged. In fact, it almost appears that if many of the other studies' recommendations are enforced through academia and the government there may be more harm than good as these efforts attempt to hold back business and the skilled workforce progression through this latest evolution. What we are seeing, in our time, is quite similar to occurrences at the turn of both the 19th and 20th Centuries as the attempts to stop or slow the industrial revolution, scientific management and the assembly line actually generated more harmful chaos then helped. In today's global competitive climate such chaos and hesitation can irreparably damage an economy.

Just as our forefathers could not fully predict their future with the invention of the steam engine, cotton gin, electric motor, lightbulb, interchangeable parts, scientific management, the assembly line, the philosophy of human resources, automation, computers, etc., we do not dare to predict what business or R&M will evolve into. However, we have identified a distinct pattern emerging within the flow of information relating to the changes in our skilled trades and industry/manufacturing. While this report is specifically aimed at the emerging Skilled Trade Evolution, the pattern of the industrial/manufacturing evolution rings loud and clear.

There is a clear and distinct path that is evolving. This evolution is occuring regardless of the cries of vendors that you must purchase their products or services to survive or stop the tide of change. It is contrary to suggest that industry or manufacturing will not survive. There is no suicidal rush towards destruction regardless of the news reports that this company or that

company is entering bankruptcy. In fact, if you watch closely, you will see that the businesses that do not survive, or are failing, are the very businesses that are working against change and that their failing has to do directly with management or cultures that are trying to hold on to the 20th Century concepts without a true forward look to the future or any true innovation.

Change invokes fear. Those companies, groups and individuals that fear this continuing evolution of the workforce and industry are doomed to suffer that which they fear the most. In the end, the innovative and aggressive companies and individuals will guide and have power over this evolution while others fail.

We, the authors of this study, see a new and exciting frontier in business, industry and R&M that needs exploring.

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Executive Summary

Since the turn of the century a growing number of organizations have been addressing the concept of the skilled workforce crisis. By and large, these studies have focused on the issue with the assumption that business practices, related to the workforce, should continue in the same fashion as through the 20th Century. Most of these organizations look to government and academia to resolve the issue by supporting and providing a ready-made workforce and a demand that parents and academia should educate the upcoming workforce in accepting skilled trades as a career choice.

The general conclusions of these studies, summarized, are:

- ☑ Students, parents and teachers should be recommending skilled trades careers as a choice to students;
- ☑ Government should require traditional and trade schools to generate curriculum to meet local business requirements in skills, experience and work ethic;
- ☑ Government should support industry and manufacturing in the cost of apprenticeships; and,
- ☑ Workers should strive to multi-skill and identify their training needs to become more employable.

Additional recommendations, from these studies, included tort reform, additional protections for companies as incentives to generate apprenticeship positions and similar recommendations.

These recommendations assume maintaining existing business practices and the status quo including as they relate to reliability and maintenance. However, the present business and skilled trade environment mirrors a similar period at the turn of the 20th Century which resulted in a major evolution in business and skilled trades. The result was the development and acceptance of 'scientific management' and the assembly line. For the remainder of the 20th Century there were only minor changes to business, other than leaps in these basic premises, due to government interaction, business, consumer demand, research, technology, war and unions.

Up through the 1900's, 20% of the workforce were between the age of ten and fifteen. There was also a significant volume of an immigrant workforce and unemployment in the range of 15%. As the second decade of the 20th Century progressed, there was a move towards isolationism in the USA, which generated a series of laws that drastically reduced the volume of immigrant workers. Prior to 1910, skilled and unskilled workers were put in the position of having to accept long working hours, low pay, unsafe working conditions and other work-related issues as there was a ready workforce prepared to take their positions. Following the changes, unemployment decreased to about 2%, coupled with the timely concepts of scientific management in 1911, the assembly line by Henry Ford in 1913 and manufacturing and productivity improvements that were funded by the government as part of the war effort in World War I. The result was a culture of

speeding up assembly lines, the implementation of the French invention of bureaucracy in order to control business and other productivity and profit improvements throughout the century.

As we enter the 21st Century, we are faced with a new change to the availability of the skilled workforce and global competition issues that preclude another evolution in business and manufacturing. In the new business environment, certain skilled workers and their contribution to business success are considered business assets.

The US Census Bureau's Bureau of Labor Statistics (BLS) has cited that there will be a workforce available to replace the existing workforce, in numbers, and that the skilled and experienced workforce will grow dramatically in the 55 and older category through 2014. However, there is also an expected decrease in worker demand across all industry and manufacturing sectors during the same period. Sixty percent of new job growth will be split between high paying, high education positions, such as engineering, medical services and computer science, and low paying, low education service industries. In effect, there will be a change to the USA middle class that had emerged at the beginning of the 20th Century, with a greater definition of upper and lower classes. This concept goes along with the increase of students entering higher education and the decrease of those same young adults, ages 16 through 24, entering industry. The BLS estimates that the number of 16 to 24 year olds entering the workforce will remain the same as 2004 levels. The period between 2015 and 2024 will see a gradual increase in available skilled workers as the 'baby boom echo' generation begins to enter the workforce.

With modern existing technologies and new advances in manufacturing technologies and philosophies, we can expect to see changes in 21st Century industry and manufacturing. Many of these changes will involve advanced technology in automation and other practices that will reduce the skill level requirements for manufacturing and, in some cases, remove the human element altogether. While this evolution may not be easily accepted by many, it is one of several inevitable changes, such as the movement of the manufacturing of a growing number of commodity industries outside of the USA. As these changes have been taking place since the 1980's, the American workforce has adapted to the knowledge that having to move jobs over their career is now a way of life.

With these changes, the type of skilled workforce required for Reliability and Maintenance (R&M) can also be expected to have to evolve. It is expected that the future R&M workforce will include three classifications:

1. The General Maintenance Worker: Will perform basic tasks in either a particular craft or general tasks. Often will require the direction of a skilled tradesperson or knowledge worker in the performance of tasks, or, for planned maintenance, written procedures. Training is mainly provided as On-the-Job Training (OJT). The general maintenance worker will have limited formal education and will perform as a maintenance laborer;
2. The skilled tradesman may be a journeyman or master of his/her particular craft and will have some level of skill and experience necessary to perform planned

maintenance, corrective maintenance and construction. May be internal workers or contracted, but will be task oriented. Skilled tradesmen will generally have OJT, formal training or an apprenticeship. Their skills will be transferable and in a reasonable level of demand;

3. The knowledge worker:
    a. Is the top tier R&M specialist for one or more skills within the company that are also transferable within one or more industries. The particular skill-set found in knowledge workers include, but are not limited to:
        i. Solution and value oriented;
        ii. Uses technology as a tool;
        iii. Continuous/life-long learning. Keeps up to date on new and upcoming advances;
        iv. Understands aspects of asset management;
        v. Strong work ethic and internal/external customer service;
        vi. Education and Experience; and,
        vii. Is a leader, coach (mentor) and supports efforts within the company.
    b. Knowledge workers:
        i. Are mobile and are in demand. They can leave as required;
        ii. Job satisfaction and training opportunities are usually required to retain. As they are in demand, they command a higher salary, but financial awards, alone, will not retain them;
        iii. They are partners and cannot be 'ordered.' They must usually be persuaded;
        iv. They tend to pay for themselves many times over;
        v. Self directed;
        vi. Process oriented; and,
        vii. May be internal, service or consultants.

Knowledge workers must be identified and nurtured by their management. In fact, management must approach the skilled workforce of the 21st Century with a new paradigm. A few concepts that must be considered by management include:

- ☑ Maintenance policies should be formulated by the people closest to the assets;
- ☑ A successful, lasting maintenance program can only be developed by the maintainers and users of the assets working together; and,
- ☑ Knowledge workers must be developed and nurtured.

The primary methods for developing and retaining knowledge workers are:

- ☑ Involve the knowledge worker, or developing knowledge worker, within management decisions related to reliability and maintenance. Make him/her a partner in decisions related to asset management;
- ☑ In addition to an appropriate salary and benefit package, the knowledge worker will expect access to training, seminars, conferences, involvement in trade-related standards and certification programs and having an impact on the industry;

- ☑ Ideas must be heard and considered. Quick decisions are important as the knowledge worker tends to be result oriented; and,
- ☑ Flexibility and freedom to do what must be done with little or no supervision. Most knowledge workers are entrepreneurial and take pride in success.

Organizations have already gone through drastic transformations in workforce and quality improvements like Six Sigma, Lean, Quality Revolutions and ISO 9000. Most resources have been deployed on manufacturing and process infrastructure improvements with little concern about maintenance and reliability. One of the last bastions that allows for dramatic improvement of the productivity of company assets is best practices in Maintenance and Reliability. Smart companies are quickly finding that the journey toward best practices in physical asset management pays big dividends. Unfortunately for many - this realization will happen too slowly as the available resources, primarily skilled experienced maintenance and reliability experts will be in shorter supply. The convergence of short supply and increased need will demand superior recruiting and more detailed planning than ever before.

The future holds great promise for knowledge workers in the field of maintenance and reliability. As the shortage of both high level and lower level skills becomes more pronounced, the competition to hire or contract with these knowledge workers will intensify. Companies that use cost to drive maintenance decisions rather than best practices will loose knowledge workers and see costs skyrocket. Companies that attract knowledge workers and implement best practices will see increased profits through higher availability and increased output, lower scrap rates, higher quality product, and finally lower maintenance labor and material cost.

Companies that hire and retain the right maintenance and reliability workforce, create an environment that empowers the knowledge worker, and leverage available technologies will reap the rewards. The companies that wait to read about the Reliability Revolution on the front pages of national and international news media will be far too late!

Section 1: Introduction

In the 1990's, an increasing number of industries including industrial services, engineering societies and others, started to warn that a skilled workforce shortage and loss of experience was on the horizon. Most of industry avoided addressing the issue, instead continuing to focus on the 1980's notions of eliminating skilled and experienced workers through attrition and early retirement, in an effort to reduce costs through a reduction in labor. Recently, industry and manufacturing leaders have started realizing the impact of a reduction in experience. When visiting factories, service centers, field service companies and other employers of skilled trades, the vast majority of skilled tradesmen tend to be in their late 40's, 50's and 60's with only a handful of workers in their 20's and 30's.

Within the works, surveys and papers associated with the skilled workforce issue, several common threads can be identified, whether the work dismisses an impending issue or is extremely alarmist. These common threads include:

1. The younger generation views skilled trades as a last choice, taking positions reluctantly;
2. Parents want their children to enter high tech and business industries, viewing the trades as 'lower class;'
3. Teachers and career counselors push students towards academic, high tech and business careers, in particular careers that involve higher education;
4. Schools are not training students in the needs of manufacturing and industry, nor in strong work ethic. The result is that students join the workforce without the ready-made skills to start work immediately;
5. Industrial and manufacturing businesses are not making apprenticeships available nor are they mentoring new workers;
6. Business executives do not understand the importance of the traditional skilled workforce and unions are preventing companies from investing in apprenticeships; and,
7. Technology and outsourcing will resolve any future workforce problems.

In this study, we will explore a number of these studies, works, surveys, articles and general opinions from the USA, Canada and Australia, in particular. From government census surveys and opinions to manufacturing studies, from military to internet surveys, many of the studies that we will discuss were developed by leaders in statistics and traditional industry.

When reviewing the information, one thing in particular struck us. They each assumed that the skilled workforce issue was of concern because industry needs to continue in its present direction. A direction that started with the change away from the position of craftsmen with Harpers Ferry Armory in 1824, to management taking charge of the workforce with scientific management (Taylorism) in 1911 and 'speed-up' with the

assembly line and Henry Ford in 1913. The workforce provided a counter-balance to 'speed-up' with the union, in particular the UAW strikes (lock-ins) of 1936.

The challenge to making a company more competitive, throughout the 20th century, was to do the same things faster with fewer people. As world-wide competitiveness increased and trade barriers have fallen along with the advance of the computer age, companies embraced any concept that improved profits. In the early 1980's Eliyahu Goldratt introduced the concept of the Theory of Constraints, which was a further improvement in speeding up processes with a focus on reducing inventories, operations costs and throughput from a macro level. This changed the micro-view of management focus on speeding up individual processes and time and motion studies to areas that would have a greater impact.

The next stages included such concepts as lean manufacturing, total quality management, reengineering and similar philosophies to increase worker output and process improvements. In the meantime, there have been parallel social messages showing excitement and a social life in the high technology and business environments and how depressing the industrial and manufacturing environment supposedly is.

With computer technology, middle and upper management has been able to communicate and view operations from a distance. As communications have increased with cell phones, email, satellite, GPS, WiFi, Bluetooth and more, management, consultants and other experts are no longer tied to the factory or their desks. Some of the issues were identified as early as 1970:

> *In the three short decades between now and the 21st century, millions of ordinary, psychologically normal people will face an abrupt collision with the future. Citizens of the world's richest nations, many of them will find it increasingly painful to keep up with the incessant demand for change that characterizes our time. For them, the future will have arrived too soon…*
>
> *It has become cliché to say that what we are now living through is a 'second industrial revolution.' This phrase is supposed to impress us with the speed and profundity of the change around us. But in addition to being platitudinous, it is misleading. For what is occurring now is, in all likelihood, bigger, deeper, and more important than the industrial revolution. Indeed, a growing body of reputable opinion asserts that the present movement represents nothing less than the second great divide in human history, comparable in magnitude only with the first great breaks in historic continuity, the shift from barbarism to civilization."*[1]

This concept of 'Future Shock' was a little extreme from what we have actually experienced. Instead, it seems that a vastly growing number of individuals have embraced the high speed 'business at the speed of light'[2] concepts that now drive industry. However, the result appears to be that there is a growing divide between

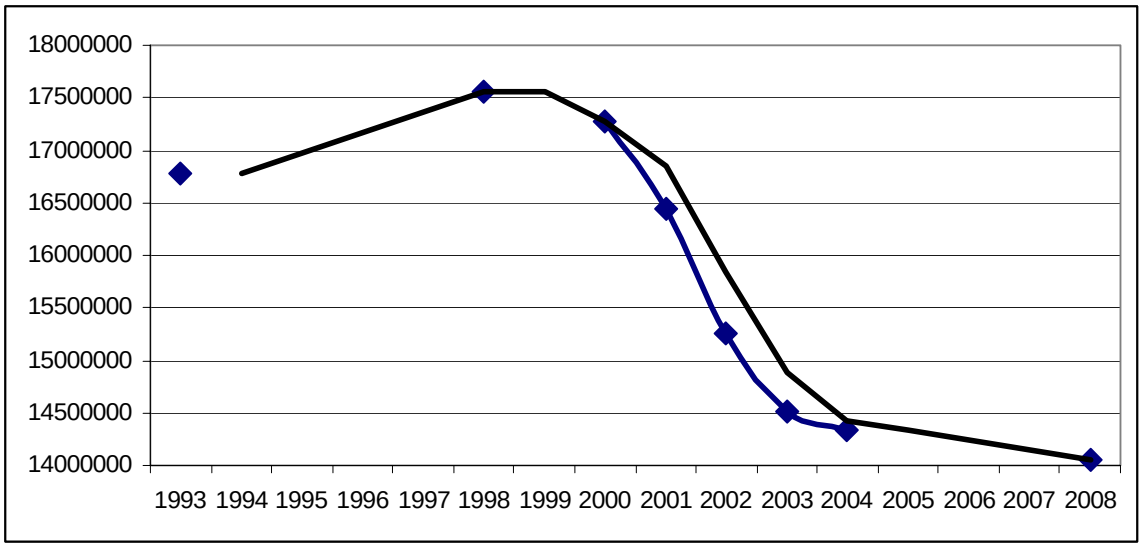
[1] Toffler, Alvin, Future Shock, Random House, 1970.
[2] Term coined by Bill Gates of Microsoft

management and the workforce as managers strive to sort through the high volume of information that is presented in order to identify the important from the mundane. Additionally, the workforce sees less of leadership and leadership only sees numbers in place of the workforce.

General Population Changes, Present and Future

While demand for manufactured product has remained constant, or grown, as a share of the US economy, the actual production has lagged by a widening margin since 2000. This wedge means that actual demand has not translated to expanded employment output. Additionally, as the baby-boom generation grows older and leaves the workforce, there is a lag in replacement workers to cover the replacement demand and demand for new employment.

Figure 1: Manufacturing Employment in the USA (All Labor)



"A continuing divergence between the increased average age and a decrease in population growth will continue to make it difficult to find and retain qualified workers."[3]

What Has Brought Us Here?

Baby boomers that were born from 1946 to 1964 will be between 50 and 68 years old in 2014. The annual growth rate of the 55 and older age group is projected to be 4.1%, four times the rate of growth of the overall labor force. The 25 to 54 age group will be around 0.3% and below 25 years will be essentially flat from 2004 through 2014. This means

[3] The MPI Group, The Wisconsin Manufacturing Study: An Analysis of Manufacturing Statewide and in Wisconsin's Seven Economic Regions, Wisconsin Manufacturing Extension Partnership, September 2005.

that our experienced and reliable workforce will be aging with a growing lag from a younger work force.

"Since the second decade of the 1900's, several population events have occurred in the United States with a long-lasting impact on future labor markets. The impact of these events appeared after a roughly 16 year lag, when the population cohorts involved entered the labor force."[4] The events in question are as follow:

1. 1920's and 1930's: A noticeable reduction in birthrates, a phenomenon referred to as the 'Birth Dearth.' This group presently makes up the 75 year and older generation, and is by and large, out of the workforce.
2. 1946 to 1964: The 'Baby-Boomer' era involved a significant increase in the US fertility rate and approximately 78 Million people were born. This segment was between the ages of 40 and 58 in 2004 and will be between the ages of 50 and 68 years in 2014.
3. 1965 to 1976: The 'Baby-Bust' era refers to the era where the number of births decreased once again. This segment of the population constitutes the prime-aged worker group aged 25 to 54 from 2004 through 2014. This group makes up a much smaller population and the difference in numbers will contribute to the decrease in the growth of the labor force through 2014.
4. 1976 to 2000: The 'Baby-Boom Echo' is comprised of the children of the baby-boomers after 1976. A part of this cohort entered the workforce in 2004 and will be in the prime-aged workforce by 2014.

As a result of this fluctuation in population, the baby-bust generation is entering the prime labor age. Because of the much smaller group, the numbers applied to replacing the aging workforce, as well as new job growth, will cause difficulty in the workforce by 2014.

The median age for the labor workforce peaked at 40.6 years in 1962. In 1982 this value was 35 years, 37.7 years in 1994, 40.3 in 2004 and is projected to be 41.6 in 2014. It is expected that labor growth will slow to 1% from 1.2% from 2004 to 2014. Additionally, the continued trend in 'early retirements' of the 55 and older workforce will signify additional challenges, especially as the early group of baby-boomers are already close to retiring in vast numbers.[5]

[4] Toossi, Mitra, "Labor Force Projections to 2014: Retiring Boomers," Monthly labor Review, US Census Bureau, November 2005.
[5] Toosi, Mitra

Figure 2: Change in Workforce (in 1,000's) by Age Group from 2004 – 2014[6]

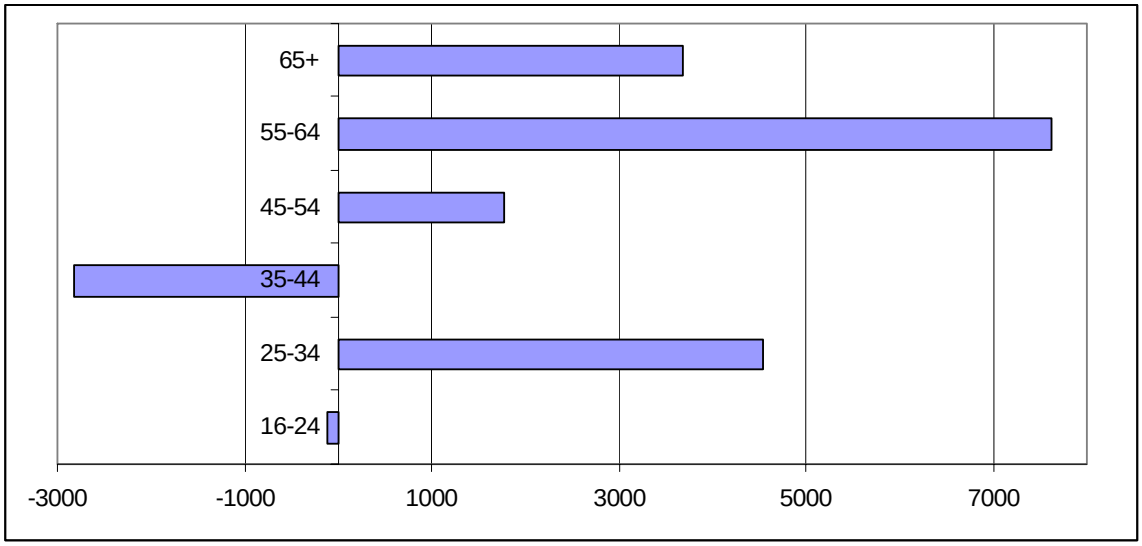
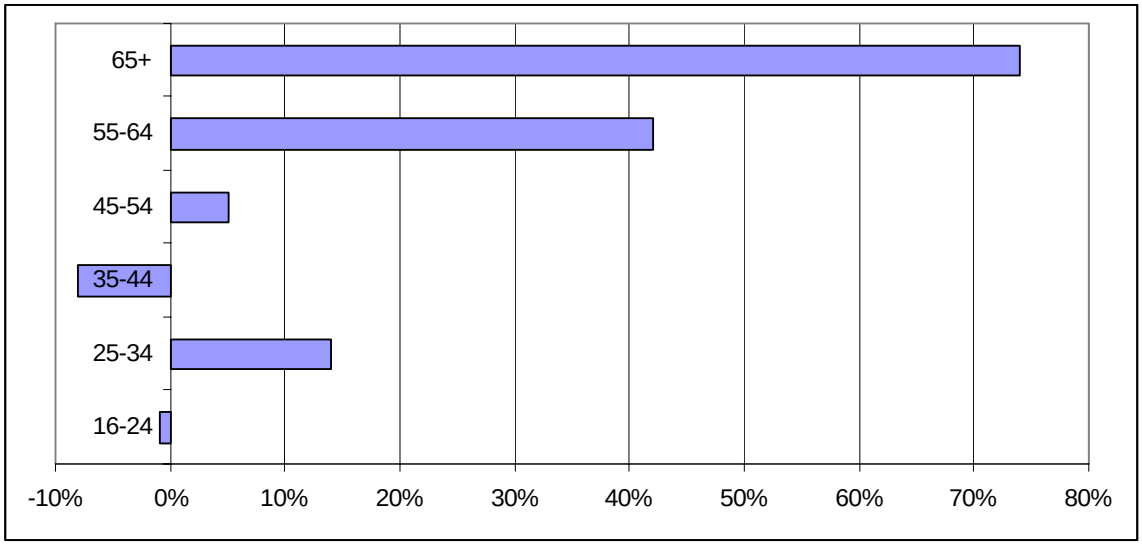


Figure 3: Percent Change in Workforce 2004 to 2014[7]



What is the Impact?

Defining the impact of this change is a challenge as it is meeting a range of responses from the Department of Labor Statistics, US Department of Defense, a variety of states' Departments of Commerce, and the National Association of Manufacturers, to name a few.

[6] US Bureau of Labor Statistics, "Labor Force Projections," Occupational Outlook Quarterly, Winter 2005-2006

[7] US Bureau of Labor Statistics, "Labor Force Projections," Occupational Outlook Quarterly, Winter 2005-2006

In a report presented by the US Department of Defense to Congress in February, 2005[8], it was reported that there is no industrial crisis and that feelings of crisis are 'misplaced.' The report then goes on to justify why the US Department of Defense needs to obtain military materials overseas.

The US Bureau of Labor Statistics states, within its November 2005 report that while there is a change in the makeup of the workforce to an older workforce, that there is sufficient manpower to maintain USA competitiveness. However, all of the reports take into account number of people and not skill, experience or work ethic.

The Wisconsin Manufacturing Study[9] identifies one of the key issues over the next decade will be the waning of a competent replacement workforce (Table 1).

Table 1: Most Prominent Concerns 2005 to 2015

Concerns	Percent
Availability of skilled, qualified workers	61.6
Healthcare coverage and costs	19.2
Training	5.5
Compensation to workers and compensation levels	5.5
General benefits and insurances	2.7
All other	5.5

In the Spring of 2005, the National Association of Manufacturers contracted Deloitte to study the workforce.[10] "The details behind the talent shortage reveal a stark reality. More than 80 percent of respondents indicated that they are experiencing a shortage of qualified workers overall – with 13 percent reporting severe shortages and 68 percent indicating moderate shortages. Also worrisome is the finding that 90 percent of respondents indicated a moderate to severe shortage of qualified skilled production employees, including front-line workers, such as machinists, operators, craft workers, distributors, and technicians. As expected, the research showed that engineers and scientists are in short supply, with 65 percent of manufacturers reporting deficiencies – 18 percent severe and 47 percent moderate."

What would cause this diverse view of the United States workforce over the next decade?

The Younger Generation

The four sets of information presented in this report are differentiated by their points of view: The US Bureau of Labor Statistics focuses on the forecast of significant increase

[8] US Department of Defense, Annual Industrial Capabilities Report to Congress, February, 2005
[9] The MPI Group, The Wisconsin Manufacturing Study: An Analysis of Manufacturing Statewide and in Wisconsin's Seven Economic Regions, Wisconsin Manufacturing Extension Partnership, September 2005.
[10] Deloitte, 2005 Skills Gap Report – A Survey of the American Manufacturing Workforce, NAM, Spring 2005.

(about 60% of growth) in the professional and service industries, with the most significant being in the computer industry.

"Advances in manufacturing technology, such as faster machines and more automated processes, and a shift of assembly and other production activities to countries with lower labor costs are expected to decrease employment for a number of production-related occupations."[11]

In particular, maintenance in the manufacturing industry is expected to decrease by 17,000 jobs with self-employment in this group increasing slightly. The total percentage of workforce in the maintenance and repair industry is expected to remain steady at 3.9%, although with a much aged workforce. The US Bureau of Labor Statistics lists maintenance skilled workers as requiring moderate on-the-job-training (OJT) (e.g., farming and agriculture is long OJT and food service is short OJT).

In general, over the 2004 to 2014 period, 54.7 million job openings are expected in the economy, approximately three times as much as from general employment growth (18.9 million). The slower increase in population and available workforce is expected to fill in these jobs.

However, statistics do not account for the attitude of the 16 to 24 year old range, which is decreasing its presence in the workforce. "During the past several decades, the number of students enrolled in high school, college and summer school has increased, resulting in a decline in the overall labor force participation rate of youths, especially those 16 to 19 years. According to research by the Bureau of Labor Statistics, more of the workforce in the 16 to 24 year old age group reported going to school as one of the main reasons for their nonparticipation in the labor force in 2001 than their counterparts had reported a decade earlier."[12]

"The most disturbing barrier, manufacturers report, to securing needed workers is the broken image of manufacturing within the state. High school students disdain this future, avoid even discussing it with their colleagues, and accept manufacturing jobs apparently with reluctance."[13]

The incoming workforce, depended upon by the Bureau of Labor Statistics and US Department of Defense reporting of a lack of industrial crisis, is viewed differently by manufacturers. "There is an emerging two-tiered workforce in Wisconsin.[14] Older, reliable, hard-working employees are retiring soon. Their potential replacements may not be as dedicated to the work ethics of their forerunners and they are increasingly difficult

[11] US Department of Labor Statistics, "Employment Outlook 2004-2014: Occupational Employment Projections to 2014," Monthly Labor Review, November, 2005.
[12] Toosi, Mitra
[13] The MPI Group
[14] Note: Similar comments in studies within other USA State-funded research.

to hire and retrain."[15] The report continues to point out that although declining and replacement workers are not yet in high demand, the warning signs are there.

The issue in the USA is almost unique, as it relates to the 16 to 24 year generation. "The problem for US manufacturers is that the challenge is not universal. Countries with rich educational heritages, e.g., India, China and Russia, are graduating millions more students each year from college than the United States. With such international talent readily available and significant shortages existing at home, it is clear that the future of American manufacturing may now be at stake."[16]

Additionally, the quality of education and worker will be, and may presently be, degrading. "In addition to shortages of various types of employees, manufacturers surveyed reported that they are also dissatisfied with the skills of their current employees. Among respondents to this national survey, nearly half indicated their current employees have inadequate basic employability skills, such as attendance, timeliness and work ethic, while 46% reported inadequate problem-solving skills, and 36% indicated insufficient reading, writing and communication skills."[17]

Connecting the Dots

The US Census Bureau, US Bureau of Labor Statistics and US Department of Defense each identify that the aging workforce is not an issue and no industrial crisis exists, even stating that such feelings of crisis are 'misplaced.' From a statistical point of view, this may appear realistic. However, the US Bureau of Labor Statistics did identify a dramatic change in the development of new jobs. Over 60% of new growth will be split between the higher income, higher education professional and management positions and the lower income, lower education servicing industry. Almost all other industries will be fairly stagnant.

Key industries, particularly in manufacturing, that make up the US middle class are moving, slowly, out of the USA. The US Department of Defense, which makes up less than 3.9% of the economy, is making purchasing decisions outside of the US manufacturing industry. Traditionally strong industries, such as automotive and steel, are quickly becoming commodities.

State Commerce departments and US manufacturers have identified a reluctance of the 14 to 24 year generation from entering industry, a reduced work ethic, challenges in retaining the younger workforce and difficulty obtaining skilled workers. "Clearly, this situation is untenable for America. Although our manufacturing sector has been able to remain vibrant and to compete successfully in a global economy, its ability to do so in the future is predicated on the availability of a highly skilled, innovative, 'high-performance workforce.' Without a sufficient supply of these types of employees, the manufacturing

[15] The MPI Group
[16] Deloitte
[17] Deloitte

sector will suffer – which in turn will have a detrimental impact to the nation's overall economic health."[18]

General Concepts

As we explored the associated works, studies and other information, we did our best to think 'outside the box.' With this in mind, there are a number of concepts that must be considered as we develop conclusions:

- ☑ We cannot blame the young, their parents, academia nor government for the skilled workforce crisis, if any. This appears to be more of a 'blame game' issue. It has never been academia's purpose to provide a worker-ready-to-work, but to provide graduates with the ability to gain experience quickly;
- ☑ We should consider that it may be time to break from concepts and philosophies that are close to 200 years old. After all, we have come to the point where we have to reach, often overextending ourselves, to make small, incremental improvements to work. In a great many cases, almost all that we have seen, companies have 'over-leaned' their workforces, in particular as it relates to reliability and maintenance, in their present context. The result has been increases in worker stress, physical and mental health issues, repetitive motion injuries, etc.;
- ☑ We have technology, knowledge, experience, communications and other advantages that our ancestors did not, when this exact same situation occurred in the 1800's and early 1900's, giving us a distinct advantage to implement new concepts never before considered. If so, why are we doing things exactly the same way, but much faster?;
- ☑ A number of novel and advanced concepts and philosophies have been presented over the past forty years. However, they have been implemented within the framework of past concepts and not the new thought and business processes necessary. We must consider these as ways to address changes to the changing workforce environment;
- ☑ Understand that attempting to hold back what appear to be evolutionary changes in values and concepts may actually do more harm than a workforce crisis would; and,
- ☑ The manufacturing and industrial environment, including that of the skilled trades, does not have to resemble its present form.

[18] Deloitte

Section 2: Overview of Studies and Comment

In this section of the Skilled Workforce study, we will provide a short summary of studies and articles in the USA, Canada, Australia and elsewhere. Each of the studies utilized are readily available via the internet. Following each summary, we will comment on the study in the context of the 'General Concepts' in the 'Introduction.'

US Census Bureau

The US Census Bureau, Bureau of Labor Statistics (BLS) Provides ten year projections based upon business and population census and projected business statistics. "The 10-year projections of economic growth, employment by industry and occupation, and labor force are widely used in career guidance, in planning education and training programs, and in studying long-range employment trends."[19]

> *A closer look at the 2004-14 labor force shows that certain demographic groups are projected to grow more rapidly than others. The labor force will continue to age, with a projected 4.1% annual growth of the 55 and older age group, more than four times the rate of growth of the overall labor force. Baby boomers entering the labor force market beginning in the late 1960's as a huge wave of workers who swelled the level and growth of the labor force. During the decade of the 1990's, baby boomers were the prime-age working group of 25- to 50-year-olds, still contributing to a relatively high annual growth of the workforce. They will be concentrated in the 50- to 68-year-old workforce in 2014. Because older workers tend to have significantly lower participation rates, the baby boomer exit from the workforce, as with their entrance, will have significant impacts on the growth of the labor force.*[20]

Information, such as this, tends to generate alarm and a 'knee-jerk' reaction that the economy and US business is in dire straights. However, it should be remembered that the information is based upon statistics and statistical projections based upon present and potential conditions. The headline of the BLS projection outlook, above, actually states: "The US economy is expected to expand at a moderately strong pace over the coming decade, with restrained inflation, continuing strong productivity growth, and a labor force growing at a steady rate with a favorable outlook for a wide array of job opportunities."[21]

In fact, the BLS warns about 'impending workforce shortages:'

[19] Bureau of Labor Statistics, BLS Releases 2002-12 Employment Projections, BLS News, 2004.
[20] Saunders, Norman C., A Summary of BLS Projections to 2014: Employment Outlook 2004-2014, BLS, 2005.
[21] Saunders, BLS, 2005

> *In summary, the labor force is projected to grow steadily into the future, albeit at a slower pace than in the past. BLS assumes that because labor markets clear, slower growth in labor supply will be reflected in slower growth in labor demand. Care should be taken not to compare household-based measures of employment with establishment-based versions discussed in the industry level of detail. Such comparisons could lead to a belief that BLS is predicting shortages when, by assumption, none exist in the projections.*[22]

One of the most significant implications, provided by BLS projections, is that professional, high education, high pay positions and service, lower education, lower pay positions will grow by about 60% of all growth, and at about the same pace. The traditional middle-class positions of maintenance, reliability, production, etc. will actually experience a 'decline in growth.' There is not expected to be a decline in population growth, just a slowing of growth, with the loss of total manufacturing jobs by about 17,000, well within any statistical accuracy.

What is particularly important about the BLS information, is that it is used to provide information for many of the other US-based studies. A careful review of much of the information provided by BLS, we have been able to determine that arguments on both sides (workforce concern, or not) can be developed based upon the specific agenda of the group performing the study.

The Wisconsin Manufacturing Study

The Wisconsin Manufacturing Study[23] was commissioned in order to identify methods for the twenty-four Wisconsin economic regions can compete within the USA and globally. The conclusions and recommendations provided by this study were similar to other studies performed by other state organizations.

> *Wisconsin manufacturing executives believe that they face four major barriers that could limit the state's readiness for competition with other states and countries. These are:*
>
> - ☑ *Manufacturing has a poor image professionally;*
> - ☑ *Taxes of all types are high;*
> - ☑ *Businesses are unable to contain manufacturing costs;*
> - ☑ *There is an emerging two-tiered workforce. Older, reliable workers are retiring soon. Their potential replacements are difficult to attract and retain.*
>
> *The consequence is that Wisconsin is beginning to approach critical difficulties as it attempts to transit from low-cost, high labor, low profit Old Economy*

[22] Saunders, BLS, 2005

[23] The MPI Group, The Wisconsin Manufacturing Study: An Analysis of Manufacturing Statewide and in Wisconsin's Seven Economic Regions, Wisconsin Manufacturing Extension Partnership, 2005

> *commodity products to the high-cost, low labor, high profit New Economy niche and specialty global markets. However, New Economy manufacturing might reverse the present status and offer the incentives to attract a highly motivated workforce.*
>
> *As commodity products yield to low-pay countries, Wisconsin's manufacturing executives predict a migration of corporate headquarters, research and development, and production from the state in the next five years. This may signal the loss of market share in commodity markets.*[24]

The report identifies seven requirements to improve their competitive position. These include:

1. Tax incentives to encourage the purchase of equipment and technology;
2. Automated technology support through subsidies and tax incentives;
3. Provide state-funded on-the-job training for new employees;
4. Tort reform to reduce product, workplace and environmental liability;
5. Planning and coordination of recruitment efforts of new businesses;
6. Export distribution channel assistance for manufacturers;
7. Overcome ethnic language blocks through English as a second language programs and pre-employment training.

> *It is notable that most Wisconsin manufacturers who participated in the panel discussion and online questionnaire still emphasize Old Economy concerns – taxes, work ethic, costs of doing business, poor image of manufacturing – even as they begin to recognize the need for long-term strategies that would move them into the New Economy.*[25]

The emphasis is on government, state, academia and other organization to address the issues of work-ethic, training the new skilled workforce and attracting the younger generation into traditional and high technology positions.

As will be identified, this appears to be a standard set of requirements. However, as noted above, the researchers of this study identified that the executives were looking at present, not future conditions. Therefore, the recommendations were based upon projecting the existing way of doing business into the future and a strong emphasis on work ethic.

It is also interesting to note, at this point, that younger generation work ethic has been noted in studies we have reviewed up to, and including, Frederick Taylor's 'Scientific Management' in 1911. It is our opinion that this particular issue is a cultural mindset that new groups do not have the same work ethic as the existing group in most working environments.

[24] The MPI Group, 2005
[25] The MPI Group, 2005

National Association of Manufacturers Skills Gap Report

The National Association of Manufacturers'[26] contracted Deloitte Consulting, LLC, to perform a study (The NAM Report) on how manufacturers plan their human capital strategies and the barriers that they encounter. In particular, this report focus' on skills shortages by manufacturing.

> *More than 80 percent of respondents indicated that they are experiencing a shortage of qualified workers overall – with 13 percent reporting severe shortage and 68 percent indicating moderate shortages. Also worrisome is the finding that 90 percent of respondents indicated a moderate to severe shortage of qualified skilled production employees, including front-line workers, such as machinists, operators, craft workers, distributors, and technicians. As expected, the research showed that engineers and scientists are in short supply, with 65 percent of manufacturers reporting deficiencies – 18 percent severe and 47 percent moderate.*
>
> *In addition to shortages of various types of employees, manufacturers surveyed reported they are also dissatisfied with the skills of their current employees. Among respondents to this national survey, nearly half indicated their current employees have inadequate basic employability skills, such as attendance, timeliness and work ethic, while 46 percent reported inadequate problem-solving skills, and 36 percent indicated insufficient reading, writing and communication skills.*
>
> *The talent shortage being reported is not a theoretical or distant problem. In fact, 83 percent of respondents indicate that these shortages are currently impacting their ability to serve customers. Specifically, the survey found that skill deficiencies are causing difficulties for manufacturers in terms of their ability to maintain production levels consistent with customer demand (56 percent), to achieve productivity targets (43 percent), and to achieve or maintain target levels of customer service and satisfaction (33 percent).*
>
> *Clearly, this situation is untenable for America. Although our manufacturing sector has been able to remain vibrant and to compete successfully in a global economy, its ability to do so in the future is predicated on the availability of a highly skilled, innovative, 'high performance workforce.' Without a sufficient supply of these types of employees, the manufacturing sector will suffer – which in turn will have a detrimental impact to the nation's overall economic health.*[27]

The premise of the report relates to the fears that US manufacturing competitiveness is in danger due to the loss of skilled workers and work ethic. Following are the issues that were identified:

[26] Deloitte, 2005 Skills Gap Report – A Survey of the American Manufacturing Workforce, The Manufacturing Institute, 2005
[27] Deloitte, 2005

- ☑ The exodus of baby boomers form the workforce with their skills will reduce the available talent pool;
- ☑ There is a changing attitude about careers and job satisfaction in the upcoming workforce;
- ☑ Technical skill requirements in all new job requirements, unskilled workers are a thing of the past in manufacturing;
- ☑ Manufacturers' dissatisfaction with K-12 education and inadequate career counseling;
- ☑ Declining percentage of students in USA studying science and engineering.

The study provides the following recommendations to fix the alarming trend that "The largest manufacturing country in the world can barely find the skilled employees it needs to remain competitive in a global economy. The 1990's and the recession of 2000-2003 were a proving ground for manufacturers – they were forced to adopt lean manufacturing processes, utilize new technologies, develop new products and new niches, and adapt to an extremely competitive global business environment."[28]:

- ☑ Employers must understand the importance of human capital as a business investment: "If employees are engaged through a strategy of career ladders, incentives, competitive wages and benefits, and supportive working conditions, they will stay – research bears this out. As a result, we recommend that employers invest at least 3 percent of payroll whenever possible in training support for their current employees."[29]
- ☑ Employers must implement new and non-traditional approaches to dealing with skills retention challenges.
- ☑ Employers must help the general public and public sector to understand what companies need.
- ☑ Educators must produce graduates familiar with the world of work and the skills needed to be effective in it.
- ☑ Education and workforce policies must reflect the need for lifelong learning.
- ☑ Individuals must take responsibility for their employability.

The definition of a skilled worker by the NAM report is:

> *A skilled production worker is the highest level production technician within the manufacturing environment. A skilled production worker is able to operate manufacturing equipment in more than one process and is capable of recognizing process improvement opportunities. His/her knowledge of manufacturing equipment and processes is sufficient to understand and resolve moderately complex production issues, provide preventive maintenance, and make routine repairs. The skilled production worker applies advanced problem solving and analytical thinking skills to troubleshoot non-routine production issues.*[30]

[28] Deloitte, 2005
[29] Deloitte, 2005
[30] Deloitte, 2005

At first glance, this report gives a definitive impression that "This human capital performance gap threatens our nation's ability to compete in today's fast-moving and increasingly demanding global economy. It is emerging as our nation's most critical business issue."[31] However, there are several troubling conclusions made within the report:

1. Skilled shortages are 'forcing' companies to adopt lean manufacturing processes, utilize new technologies, develop new products and new niches, and adapt to an extremely global business environment. With this being one of the primary premises of the report, we cannot provide an appropriate response to this irrational premise. As manufacturing and production businesses have been working towards methods to 'lean' business for profitability for almost 200 years, with this statement, it would give the impression that skilled shortages are actually a benefit to US business' ability to compete.
2. The NAM Report expects the younger generation, through academia and self-training to provide ready-made skilled workers, defined above, with little investment by business. The real purpose of academia is to provide employees with the ability to learn and allow them to make career choices. We do agree with the recommendation for manufacturers' to become more involved in the community and to provide a positive outlook on the skilled trades.
3. As noted in the BLS studies, there will be an exchange of the skilled workforce as the baby boomers begin to retire after 2010, newer skills will be required for new economy workforces and the numbers entering the skilled workforce will not fall, but will maintain or increase by approximately 1%.
4. The premise of the report is that in order for manufacturing to maintain the status quo, their recommendations must be implemented. However, it is the premise of the 'Skilled Workforce in the 21st Century' study that companies must adapt to competition in a global economy.

The US Chamber of Commerce Reports

Following are a series of excerpts from US Chamber of Commerce Reports as they relate to the skilled workforce:

> *The Bureau of Labor Statistics (BLS) estimates that the number of people in the labor force ages 25 to 34 is projected to increase by only 3 million between 2002 and 2012, while those ages 55 years and older will increase by 18 million. By 2012, those aged 45 and older will have the fastest growth rate and will be the largest age-group in the labor force by far. According to estimates released in February 2005 by the United Nations, the fertility rate in the United States is*

[31] Deloitte, 2005

> *projected to fall below 'replacement' level by 2015 to 2020, declining to 1.91 children per woman (lower than the 2.1 children per woman rate needed to replace the population). By 2010, 77 million baby boomers will retire and, by 2030, one in every five Americans is projected to be a senior citizen.*[32]

This statement is made to support the following position:

> *We support the expansion of temporary visa programs for essential workers, creating paths to permanent residence for these workers when appropriate, and providing a way to earn legal status for the millions of undocumented workers already in the United States. Immigration reform remains a top priority, and we'll continue to work with our coalition, the Essential Workers Immigration Coalition, to urge the new Congress to advance reforms and encourage President Bush to resume the migration negotiations with Mexico.*[33]

The population and skilled workforce statements above are the very type warned about in the BLS paper previously cited by Norman Saunders of BLS in "A Summary of BLS Projections to 2014: Employment Outlook 2004-2014." Also, the birth rate issue cited is the 'worst case scenario' of five scenarios given by the "Proceedings of the United Nations Expert Meetings on World Population in 2300,"[34] and relates to North America. The '0 growth' scenario (median scenario) actually shows an increase in population in North America all the way through 2300.

As related to education and the skilled workforce:

> *The Carl D. Perkins Vocational and Technical Education Act funds programs in high schools and community colleges to enhance skills necessary for participation in the workforce. These programs need to be restructured so that they integrate academic excellence with skill acquisition and enable students to successfully enter postsecondary education or the workforce without remediation. …*
>
> *The plan must be based on state and regional labor market needs, define appropriate outcomes including employability, and contain the following elements:*
>
> - ☑ *Student performance requirements that comply with state standards.*
> - ☑ *A core set of academic courses for all secondary students aligned with NCLB to reduce the need for remediation beyond high school.*
> - ☑ *Core sets of technical skills for postsecondary education programs based on employer needs in specific industry sectors.*

[32] US Chamber of Commerce, Essential Workers: Needed Workforce for the Future, http://www.chamber.com, 2005
[33] US Chamber of Commerce, 2005
[34] Department of Economic and Social Affairs, Population Division, Proceedings of the United Nations Expert Meeting on World Population in 2300, United Nations, 2004.

- ☑ *Description of a competitive grant process by which secondary and postsecondary education institutions secure funds to develop programs that lead to high-wage, high-skill jobs in high-demand occupations and industries, that reflect regional business needs. The process should encourage joint proposals between secondary and postsecondary education institutions.*
- ☑ *Incentives to design dual enrollment programs that allow students to complete high school and pursue technical skill training, associate degrees, apprenticeship experience, or certificate programs simultaneously as one means to reduce dropout rates and link to postsecondary education/career pathways.*
- ☑ *Alternative routes to teacher certification that do not jeopardize compliance with NCLB.*[35]

Of particular concern throughout the recommendations presented by the US Chamber of Commerce reports is the lack of responsibility by business to interact. In fact, their policy recommendations relate directly to providing ready-made-for-work employees by academia.

In general, the US Chamber of Commerce policy studies present the issue as a crisis in an effort to make policy recommendations on increasing the import of low cost skilled workforce and laws and incentives requiring academia to focus on providing a trained and experienced workforce to business.

US Department of Defense Capabilities Report

"The Department does not concur with concerns raised by some that the US defense industrial base is in crisis."[36]

> *US defense systems lead the world and the US industry that develops and builds them continues to be the most technologically innovative, capable, and responsive in the world. The Department expects that US industry leadership to continue into the foreseeable future. The four DIBCS reports published in 2004 identified a total of 1,773 warfighting capabilities where the US military should maintain at least one generation lead over potential adversaries and 255 priority critical technologies and components supporting those warfighting capabilities. Industrial Policy identified only 19 (7.5%) of these most important technologies where there was a potential US industrial base insufficiency.*[37]

[35] US Chamber of Commerce, Carl D Perkins Vocational and Technical Education Act of 1998 Reauthorization, 2005.
[36] US DoD, Annual Industrial Capabilities Report to Congress, US Department of Defense, 2005
[37] US DoD, 2005

The report does continue to discuss and justify additional purchases overseas in areas that will not impact Defense capabilities.

Apprenticeship Training in Canada

The "Accessing and Completing Apprenticeship Training in Canada"[38] is a study of the barriers affecting apprenticeship training for skilled trades in Canada. "CAF-FCA promotes apprenticeship as an effective training and education system that contributes to the development of a skilled labour force, and provides a mechanism for key stakeholders to support apprenticeship delivery systems across Canada."[39]

> *Skill shortages, declining birthrates, an aging workforce, and increasing global competitiveness in Canada are all combining to create an environment in which human resources are the country's number one comparative advantage – or weakness, if Canadians do not respond to this challenge. For this reason, skill shortages and the need to be innovative in how we develop and utilize human resources have become top public-policy and private-sector concerns in Canada.*
>
> *Increased investments in industry training and apprenticeship have been identified as part of the solution to the skills dilemma. Workers in the skilled trades, in particular, have been identified as essential to building and maintaining Canada's place in the knowledge-based economy…*
>
> *These generic barriers have been grouped into nine categories, each reflecting a particular aspect of supply or demand conditions for apprenticeship:*
>
> 1. *Negative attitudes to apprenticeship and a poor image of trades*
> 2. *A lack of information and awareness of apprenticeship*
> 3. *Difficulties with unwelcoming workplaces or training environments*
> 4. *Costs of apprenticeship to individuals, employers and unions*
> 5. *Concerns over the impacts of economic factors on work and apprenticeship continuation*
> 6. *Concerns about the lack of resources to support apprenticeship*
> 7. *Concerns about apprentices' basic and essential skills*
> 8. *Shortcomings of workplace-based and technical training*
> 9. *Issues regarding regulations governing apprenticeship*[40]

As relates to attitudes and information:

[38] Canadian Apprenticeship Forum, Accessing and Completing Apprenticeship Training in Canada: Perceptions of Barriers, Government of Canada, 2004
[39] Canadian Apprenticeship Forum, 2004
[40] Canadian Apprenticeship Forum, 2004

The negative attitudes of youth, students and parents towards apprenticeship have resulted in a negative image of trades. Trades are often perceived as second-class or dead-end careers with little potential for advancement…

Employer attitudes to apprenticeship are perceived to be a major and fundamental barrier. A perceived lack of training culture and poor human-resource planning on the part of many employers were seen to contribute to this barrier. These attitudes result in an absence of positions for apprentices and a relatively low level of support for apprenticeship training…

The lack of awareness about trades represents another important generic barrier. The poor image of trades may derive from this lack of awareness, but it also reflects a societal focus on university and the trades' failure to promote themselves…

A shortage of effective high school trades work experience and industrial arts programs, as well as the tendency of guidance counselors to promote university-based careers, represent significant educational barriers to apprenticeship...

Employers, individuals and unions perceive the cost of apprenticeship as another barrier. For some employers, particularly in small businesses, it is unclear whether the benefits of apprenticeship outweigh the costs, and the cost of apprentice supervision and wages is a particular concern…

During economic downturns, reduced demand in overall work can lead to fewer opportunities for apprentices or, worse, to an interruption in or termination of an apprenticeship…

Provincial education and training-system representatives pointed to the relative lack of funding for apprenticeship training as the most important barrier preventing these representatives from fulfilling their apprenticeship role…

Employers, as well as some labour and aboriginal spokespersons, expressed strong concerns about the personal attributes and characteristics of many apprenticeship candidates. Other respondents agreed that young people may lack the proper academic preparation at the high-school level and, consequently, these youths bring inadequate essential skills, including mathematics and literacy, to their apprenticeship training…

Representatives of both employers and unions mentioned that technical content of training curriculum, currency of equipment used in training and instructors' knowledge of current styles and practices often lag behind technical and other changes in trade-specific skills. In addition, reliance on traditional written tests, rather than practical demonstrations of skills, was criticized by some respondents…

> *The ratio of journeypersons to apprentices is perceived by some to be a barrier for individuals entering into apprenticeships. Current ratios may limit employers' ability to bring in as many apprentices as required.*[41]

The study suggests apprenticeship stakeholders consider the following measures:

1. Programs that change perceptions and attitudes about apprenticeship and trades
2. Increase within secondary school systems to support and promote the trades, through counseling, information, programs and enhanced teacher awareness
3. Address the costs that apprenticeship stakeholders encounter
4. Mitigate the impact of economic factors that can lead to a lack of work and an interruption or termination of apprenticeships
5. Reassess the adequacy of resources for apprenticeship
6. Understand and promote essential basic skills such as arithmetic, reading, computer use, that individuals must have to enhance their chances of success
7. Provide accessible technical training arrangements and up to date curricula and equipment

This was one of the more comprehensive studies that identified potential problems, barriers across all stakeholders and common-sense recommendations. Like the other studies, however, it still focuses on maintaining the status quo.

Victoria, Australia Skills Challenge Study

On of the primary concerns over the Victoria study[42] was the impact of Lean Manufacturing on skilled trades development.

> *We found very little awareness or concern by managers on either the potential for later skills shortages because of the low numbers being trained or planning time frame that took into account the true six to seven year period needed to develop future high level maintenance tradespersons. This is either an indicator of confidence in the future supply of skilled labor, either directly from the market or through labour hire and contracting out, or more likely it indicates that in the current constrained and lean environment, managers are unable or unwilling to commit to the time frames needed to ensure training supplies a significant proportion of their future skills needs.*
>
> *One key informant stated that the low numbers in training were part of a broader trend by the manufacturers to eventually downsize the scale of Australian manufacturing operations.*[43]

[41] Canadian Apprenticeship Forum, 2004
[42] Victorian Learning and Employment Skills Commission (VLESC), Renewing the Capacity of Skills Formation: The Challenge for Victorian Manufacturing, 2005
[43] VLESC, 2005

This is the first of the studies which identified an initiative, such as Lean Manufacturing, as a barrier for skilled trades.

> *The overall tone and subject of many of the comments was also a concern. Comments on the barriers to achieving further improvements outweighed comments outlining a positive plan of action for the next major steps in skills development strategy. With regard to skills issues, we saw managers surviving, coping and thinking through the next incremental improvement and employees suspicious of their company's commitment to training. We did not, however, see the energy and strategic thinking that would enable us to say that the industry on its own will deliver the skills base that Victoria will need to remain a strong manufacturing State.*[44]

> *With regard to production workers, we found that technical skills required by production workers has gone down with the introduction of new technology. The major skills needs for production workers are now in the areas of cognitive and behavioral skills. There was no evidence of skills shortages in production work other than in one enterprise for team leaders.*[45]

> *Increase in productivity and reduction in staff. This has been facilitated by lean manufacturing techniques including re-engineering of work organisation changes especially the introduction of teamwork. (Manager, Automotive Assembler)*

> *The major change was the introduction of teamwork approximately seven to eight years ago. The teamwork structure is only for production employees. Maintenance were originally incorporated into the teams but came out as there were too many problems. (Operations Manager Components Manufacturer)*[46]

Particularly interesting in the above statements is the general lack of attention to any reduction in skilled trades. Manufacturing, in this case, also focused on academia and the government to solve the issue, but unlike some of the other studies, did recognize that additional efforts by business and unions in apprenticeships would be necessary. However, the following comments appear to be underlying in all of the studies:

> *A view by some employer representatives that government should be doing more to promote manufacturing as a career and apprenticeships in particular, yet apprenticeships were not being offered by the companies in any significant numbers.*[47]

> *I feel that the company is now 'surviving' on the late 1980s reforms and structures. The time is right for a rethink/review of current directions. I am not*

[44] VLESC, 2005
[45] VLESC, 2005
[46] VLESC, 2005
[47] VLESC, 2005

> *sure of the extent that this view would be accepted by either management or employees but this is my view. (Human Resources Manager, Assembly Plant)*[48]

The common education and academia comments could also be found:

> *There was a real awareness amongst interviewees of the poor image the Automotive Industry and manufacturing in general has with young people. The now common complaints about schools not understanding manufacturing were made as well as the suspicion that teachers encourage students to think of manufacturing as the destination for people who were unable to make it into a 'more desirable' industry. The current efforts of both Governments and industry groups to promote the industry were acknowledged. Most companies stated that more needed to be done particularly by Governments as the problem was seen to be generic across manufacturing and not specific to any one enterprise.*[49]

Studies Comment

Both the Canadian and Australian studies appear to be the more neutral of the studies. However, they echo many of the same sentiments with little thought to changing how industry operates as related to the skilled trades. The above comment by the Human Resources Manager was the first and only comment that introduced the concept that we have accomplished almost all that we will with present efforts and that we should be viewing new concepts as they relate to the skilled trades.

We are not questioning the honesty of these studies. We are, however, questioning the premises.

The questions finally arise:

1. Is there a skilled trades crisis?
2. If so, what can be done?
3. Who is responsible? And,
4. Are there alternatives?

We will return to these questions in section four of the Skilled Trades in the 21st Century.

[48] VLESC, 2005
[49] VLESC, 2005

Section 3: Skilled Trades Survey by ReliabilityWeb.com

During 2005, ReliabilityWeb.com introduced a questionnaire on http://www.maintenancebenchmarking.com concerning the skilled workforce. It consisted of eleven basic questions. In this section of the skilled workforce study, we will review each of the responses, then contrast the responses against the studies reviewed in Section 2.

The questions included the following:

1. What is the average age of your maintenance workforce?
2. Does your company offer an incentive program to encourage early retirement among the maintenance workforce?
3. What job benefits are available to your maintenance workforce?
4. Does maintenance have top management support and leadership at your company?
5. Please indicate the best description related to procedure based maintenance within your maintenance workforce.
6. Please indicate the best description of knowledge capture within your maintenance workforce.
7. What percentage of maintenance work is currently outsourced?
8. Over the next 5 years will your use of outsourced maintenance contractors increase or decrease?
9. Over the next 5 years will your maintenance workforce staffing requirements increase or decrease?
10. Does your company have maintenance positions available that have been vacant for more than 90 days?
11. Please make any comments about the shortage of a skilled maintenance workforce.

There were 841 individual unique responses. The sample represented a cross section of all industry world-wide.

Responses

On the following pages, we will provide the raw responses to the survey. Based upon comments within the questions, responses were provided by both management, skilled tradesmen, consultants and field service (outsource) companies.

Figure 4: Average Age of Maintenance Workforce

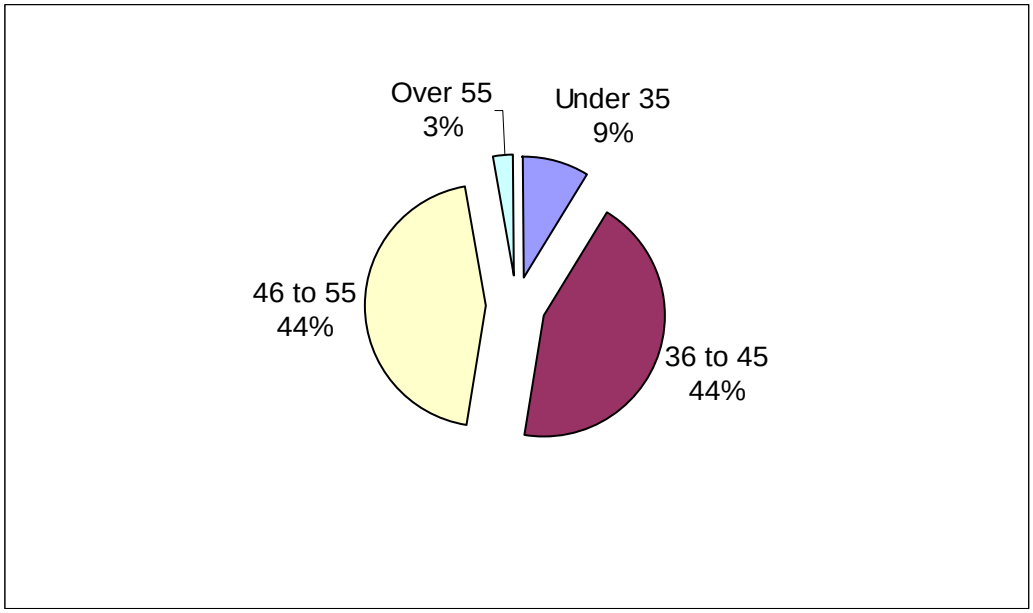
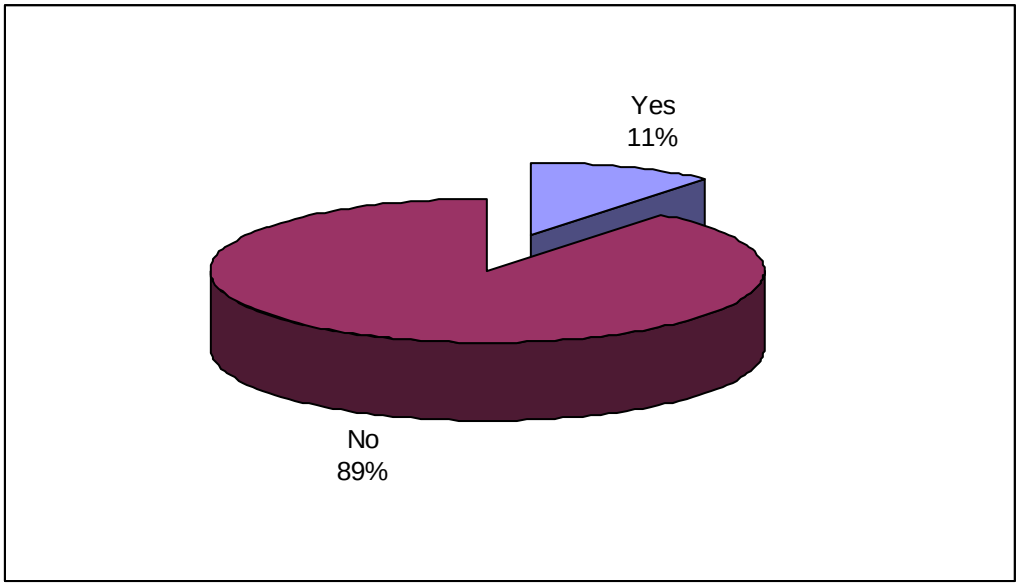


Figure 4 identifies that the responses echoed the present values represented by the US Census Bureau, Bureau of Labor Statistics. By 2014, the values will move up with the 'Over 55' category increasing dramatically.

Figure 5: Does Your Company Offer Early Retirement Incentive Programs in Maintenance?



With 89% of companies not providing incentives for early retirement, it can be assumed that a significant number of companies realize the value of their more experienced skilled tradesmen.

Table 2: What Job Benefits are Available to Your Maintenance Workforce?

Response	Percent	Ranking
Financial incentive tied to maintenance performance	14.0%	12
Wage scale above average	40.3%	4
Flexible work schedule	22.0%	9
Maintenance related training from 3rd parties offered	54.2%	1
Maintenance related training from in-house resources offered	53.9%	2
Support for Professional Association membership	22.9%	8
Support for Professional Certification	28.1%	7
Support for attending maintenance conferences	28.9%	6
Support for college courses	53.9%	2
Support for paid magazine subscriptions	17.7%	11
Profit sharing plan	29.0%	5
Stock option plan	19.4%	10
Clear maintenance career path defined	13.3%	13
Child care options	5.1%	14

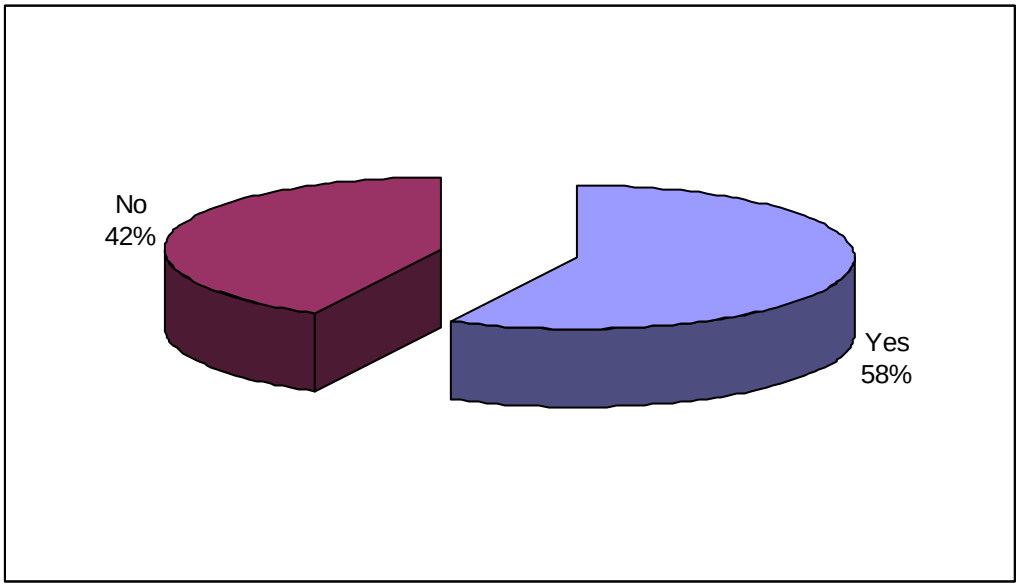
Of particular interest in Table 2 is that 'Clear maintenance career path defined' (13th out of 14) was rated as one of the primary recommended incentives, for employee retention, in several of the studies in Section 2. Other important items included training, which are cited as first and second in this table.

Other responses included such comments as (most are individual responses):

- ☑ 401k plan
- ☑ First class insurance and retirement package;
- ☑ Comprehensive benefits package;
- ☑ Individual tool budget;
- ☑ Paid vacations and holidays
- ☑ In-house apprentice and craft training programs;
- ☑ Paid lunch and breaks;
- ☑ Promotion of diversity in skills;
- ☑ Production bonus; and,
- ☑ Pay scales based upon tested performance skill

There were, of course, a number of candid responses including: 'You get to keep your job.'

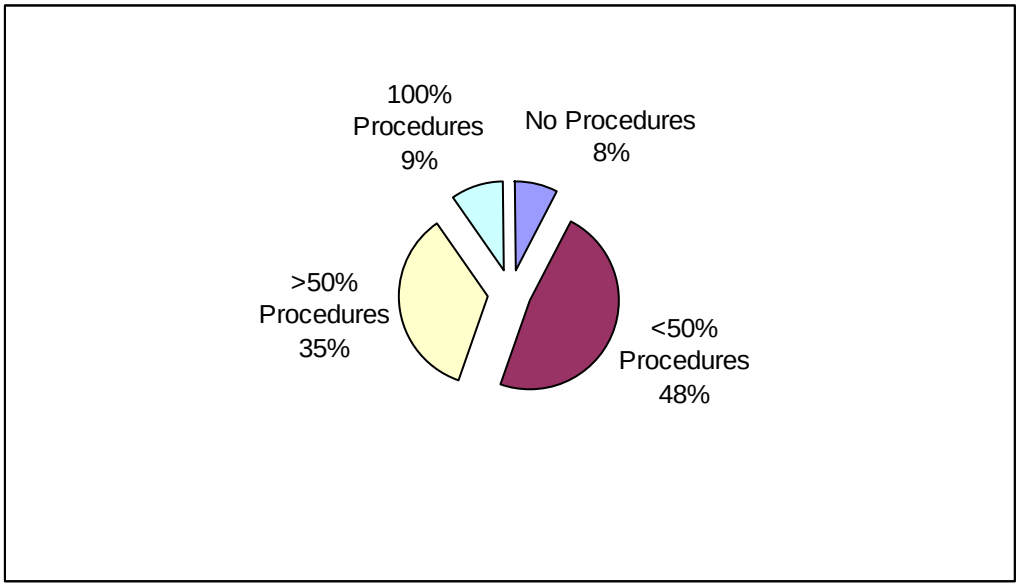
Figure 6: Does Maintenance Have Top Management Support and Leadership at Your Company?



Following are a few of the additional comments (summary):

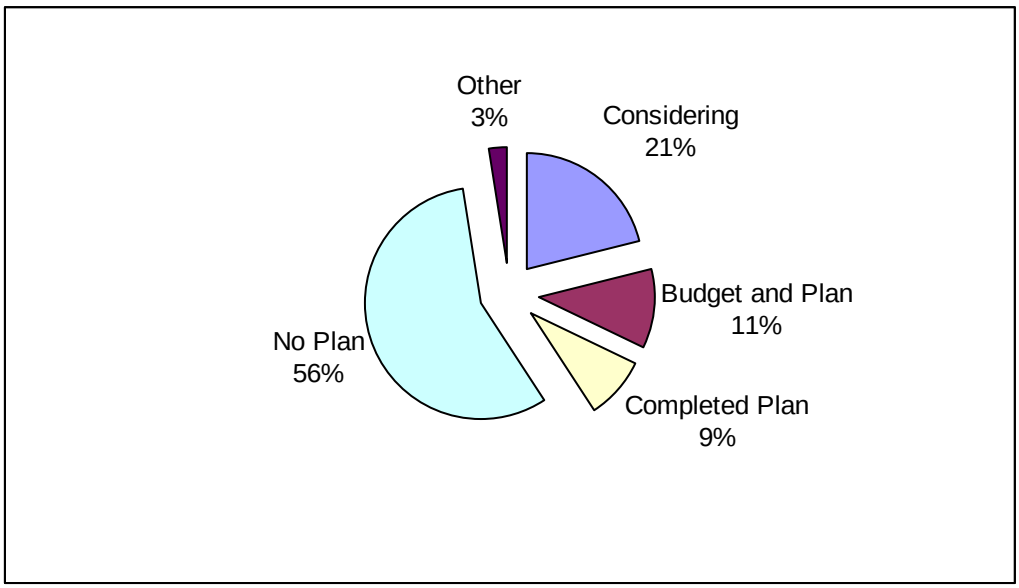
- ☑ Maintenance is viewed as a 'necessary evil.' This was the number one comment.
- ☑ Management constantly looking for ways to outsource maintenance, even at higher costs. This was the number two comment.
- ☑ Lack of understanding of maintenance at the executive level. This is the number three comment.
- ☑ Maintenance understaffed to the point where all maintenance is reactive. This is the number four comment.
- ☑ First jobs to be cut when cut back required.
- ☑ Facilities aging and maintenance budget decreasing.
- ☑ **"Due to cost cutting measures, management has decimated the maintenance staff of all junior people with no junior trades program in effect."**
- ☑ Maintenance and engineering management positions used to train new managers on the way up.
- ☑ Corporate restructuring placed maintenance under production and reactive maintenance now prevails.
- ☑ Maintenance is viewed as an expense/expenditure.
- ☑ Supported for regulatory reasons.
- ☑ "Our company supports predictive/preventive maintenance…" Achieve 96%+ availability in production.
- ☑ "Our Vice President is the most supportive manager that I have ever worked for."
- ☑ Coordinated, centralized maintenance leadership eliminated.
- ☑ Increased expectations, reduced funding, no assistance or leadership to achieve goals.
- ☑ Maintenance input not sought in areas where they can have an impact. "Management/Engineering doesn't listen."

Figure 7: Indicated Best Description Related to Procedure Based Maintenance



While only 9% of companies claim to have fully developed procedure based maintenance programs, 83% have some level of completion and 8% have no procedure based program.

Figure 8: Indicate Best Description of Knowledge Capture Within Your Maintenance Workforce

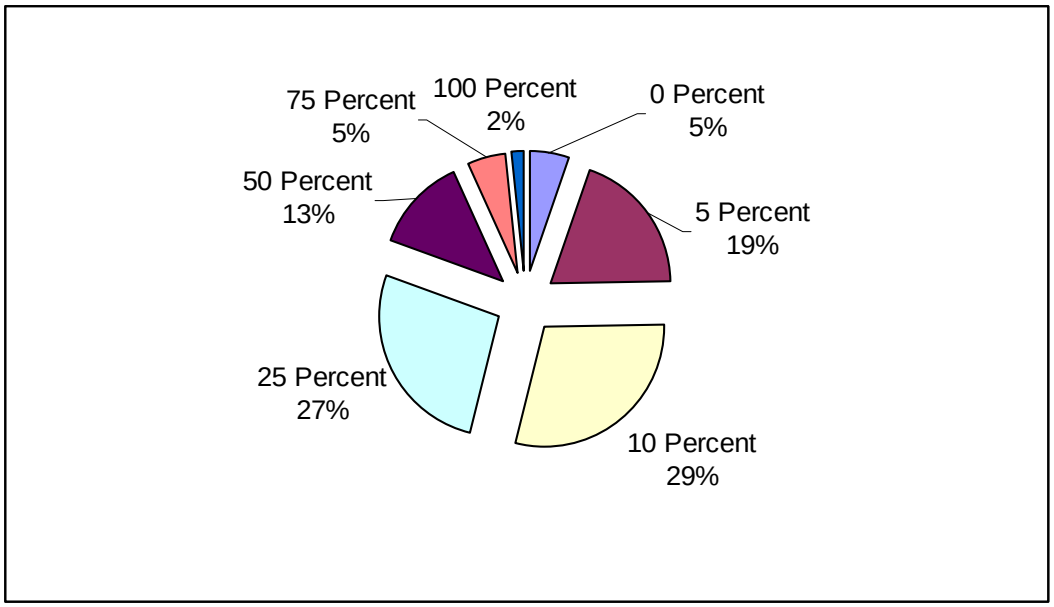


While procedure-based programs provide some level of reduction in the requirement for skilled work by walking a worker step by step through a process, the development of these programs should include information gathered from experienced tradesmen. However, as shown in Figure 8, 56% of companies have not made an effort to capture the knowledge of their skilled workforce.

Other comments include:

- ☑ Cross Training;
- ☑ Use of CMMS/EAM system considered a solution;
- ☑ Use of Condition-Based Maintenance such as RCM
- ☑ 5S, Lean, 6-Sigma
- ☑ On-The-Job-Training (OJT)

Figure 9: Percentage of Maintenance of Work That is Currently Outsourced



Outsourcing work has been considered a good strategy to fill in the holes left by the reduction of experienced skilled workers and to improve the productivity of maintenance tasks. Over 56% of companies surveyed outsourced 10 to 25% of reliability and maintenance. 2% outsource all maintenance and only 5% do not outsource maintenance and reliability.

As identified in Figure 10, 44% of the companies identified that there would be an increase in outsourced maintenance during the next 5 years and only 8% identified a potential decrease. With 48% maintaining the same level of outsource and 44% identifying an increase, it can be assumed that the demand for reliability and maintenance service companies will increase over the next five years.

Figure 10: Use of Outsourced Maintenance Contractors to Increase Over Next 5 Years

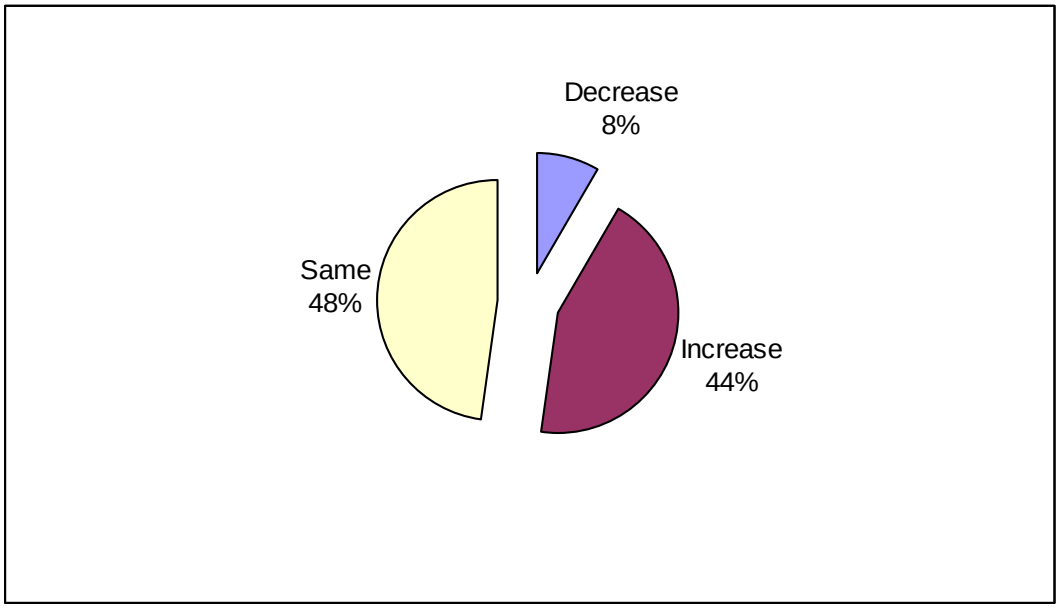
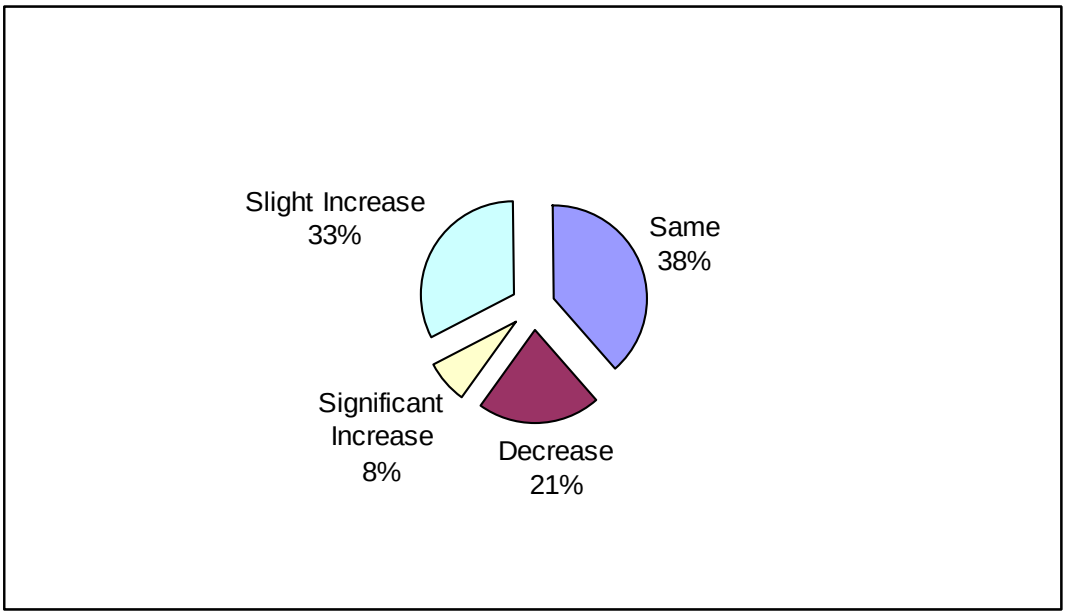
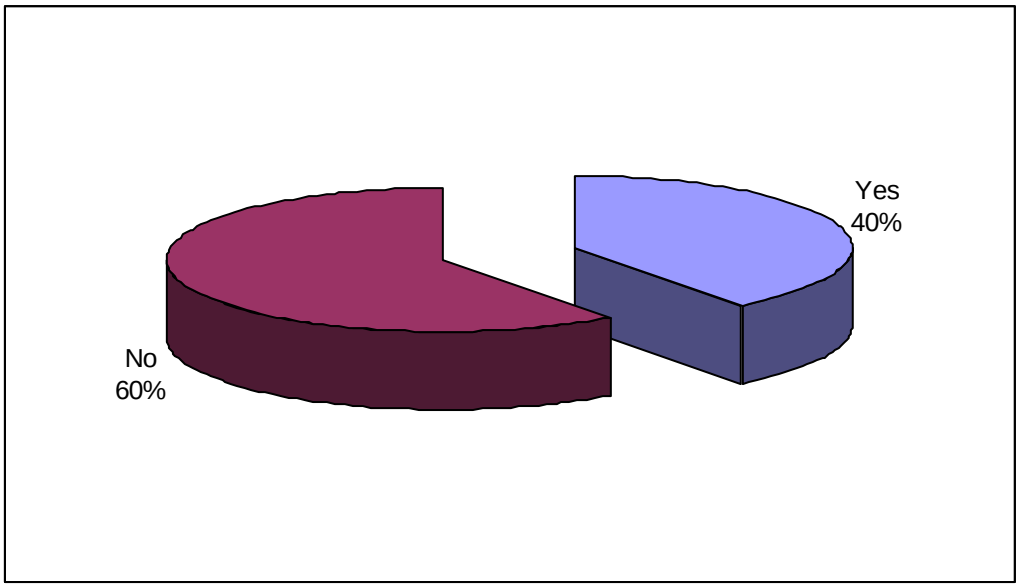


Figure 11: Maintenance Workforce Requirements to Increase or Decrease Over Next 5 Years



With 38% of companies maintaining the same level, 33% identifying a slight increase and 8% identifying a significant increase, it is expected that the demand for skilled and experienced R&M workers will increase within the next five years. Coupled with the expected increase in outsourced maintenance, it appears that many companies will look to outsourcing maintenance as a strategy to reduce the impact of the loss of these workers in the near future.

Figure 12: Has Your Company Had Maintenance Positions Available That Have Been Open for More Than 90 Days?



Following is a summary of comments made about the shortage of a skilled maintenance workforce:

- ☑ What is available is adequate for the level of jobs at hand;
- ☑ People coming off the street don't even know how to sharpen a drill bit;
- ☑ The skilled workers we have hired in the past two years do not have the higher skills required (numerous similar responses);
- ☑ The plant staff knows we need maintenance personnel but corporate does not want to increase the workforce (similar responses);
- ☑ In the next five years more than half of our maintenance workforce will be eligible to retire (similar responses);
- ☑ When we hire it's usually from another plant or site never from someone out of work;
- ☑ There has been a company-wide decision not to hire any new mechanics and as they leave the manpower requirements are outsourced;
- ☑ We used to have forty mechanics now have 15 with the same amount of work;
- ☑ As the existing workforce ages, I am seeing more time off for health reasons;
- ☑ I think the shortage is real but the source of the shortage is misanalyzed. There is a combination of problems from skills needed not being taught to the people not wanting to learn the skills;
- ☑ I don't see this problem getting anything other than worse until companies focus on recruiting people who are just entering the workforce. It must be done now before all of the so-called 'old timers' are retired;
- ☑ Our older workforce is staying, but the younger ones come and go quickly. Some don't like the overtime hours we require them to work. Others are just looking for training then on to what they believe are bigger and better paying jobs;
- ☑ We have been able to keep our apprentice classes filled but the entry level skills seem to be eroding;

- ☑ They are not hiring replacements, but there are more contractors than there used to be;
- ☑ I feel that industry needs to be more proactive in the recruitment of apprentices, as well as high schools need to encourage their students to look into the trades as a career;
- ☑ Young people do not seem interested in trade related maintenance work. The young people coming into the work force have very poor work ethics, don't take pride in the job that they do. Expect to have everything handed to them by the company;
- ☑ Within the next five years 80% of our senior personnel will retire. At the present time there is no knowledge base to replace these key personnel;
- ☑ Very little interest in long-term maintenance employees trying to upgrade their skills voluntarily;
- ☑ There isn't necessarily a shortage, but morale, training, expectations and setting clear and defined goals and job descriptions make a huge difference in skill. Workers cannot be the blame for the incompetence of the manager;
- ☑ There is a small percentage of people that have the ability to understand complex equipment and only a small subset of these who want to do it for a career;
- ☑ Very difficult finding qualified mechanics and electricians to work in a fully computerized manufacturing facility;
- ☑ Maintenance has no representation in upper management. Result: No input into planning;
- ☑ I oversee six manufacturing plants and we have not encountered issues to fulfill our needs. I have to admit that our skill set has changed from mechanical needs to electro-mechanical employees but it has not been an issue to find the proper skill set;
- ☑ The lack of company support while employed as the only engineer I decided to resign my position and start my own company doing exactly what I have learned over the last 18 years. I am now offering facility services;
- ☑ Resistance to changes in work requirements by older workers;
- ☑ It is difficult to hire folks to begin with, but what exasperates the issue is our inability to keep young folks from getting laid off because they are least senior. We need help from our union leadership as well as management;
- ☑ Some companies that I see do not want to pay for skilled maintenance staff, yet expect skilled and/or trained staff when hiring;
- ☑ Definite shortage of skilled workers in the contractor area;
- ☑ The corporate approach is to do more with less, identify critical systems and focus on operational essential equipment. Take risks with other equipment;
- ☑ As the skilled employees retire, outsource becomes more prevalent for land and building maintenance. Specialty machine maintenance requires in-house expertise;
- ☑ Lack of top management support for training;
- ☑ The plant manager eliminated the plant engineer, maintenance supervisor and two mechanics. He kept one mechanic and plans to outsource the rest of maintenance. This is lean manufacturing gone too far;

- ☑ Maintenance workers are seen as a dime a dozen. Upper management wants vast amounts of qualifications for certain jobs but are unwilling to pay 'skilled' wages. Some of the more talented maintenance workers leave without passing on any of their knowledge;
- ☑ What I see in our petro-chem industry in maintenance is that we are seeing unqualified contractors being hired in more and more to replace company workers and also at the same time training is not being used to train workers in their craft on the jobsite;
- ☑ Very difficult to find time to train when running a lean crew; and,
- ☑ By going to procedure-based work instructions we are removing the ability of our work force to think on their own. It has caused some problems when the unexpected arises and there is not any direction in the procedure to follow.

Summary

The ReliabilityWeb.com survey provides some supportive insights into the studies evaluated in Section 2. Following are several points gleaned from the responses:

- ☑ The majority average age of workers in 2005 were 46 to 55 years old. This finding is similar to the BLS findings identified in Section 2 of this study;
- ☑ Only 11% of the companies surveyed actively worked towards reducing maintenance staff through early retirement. This supports the concept that a majority of companies are working towards retaining skilled tradesmen. Supported within the comments from Question 11, many companies are hiring skilled workers away from other companies;
- ☑ One of the key items identified for attracting and maintaining skilled trades, identified by several of the studies reviewed in Section 2, was a clearly defined career path. However, it ranked 13th of 14 responses with a total of 13.3% of companies providing a defined career path. On the other hand, the availability of in-house and third party training, another important factor, ranked first and second;
- ☑ 58% of respondents identified supportive leadership in their companies. Both positive and negative respondents stated that management views maintenance as a 'necessary evil.' It was also presented that companies viewed outsourced maintenance as a solution to maintenance costs and lost in-house skills;
- ☑ 83% of respondents identified that maintenance procedures are in some stage of development. However, 56% of respondents identified that there are no plans to capture the knowledge of the older workforce;
- ☑ 88% of companies outsource between 5% and 50% of maintenance work. Only 8% saw a potential decrease in outsourced maintenance in the next five years. 44% identified an increase and 48% identified that the level will remain the same;
- ☑ Only 8% estimate an increase in workforce with 21% stating there will be a decrease, 33% a slight increase and 38% saying that demand will remain the same over the next five years;

- ☑ Over 60% have been able to find workers within 90 days. However, comments continue as to the age, lack of work ethic and inexperience. Also, it is apparent from the comments that industry expects these younger workers to arrive already trained to work in their environment;
- ☑ Throughout the responses and comments, all either identified personnel for existing practices or high-performance workforce. Few identified any opportunities from the skilled trades transition, nor solutions. As with the studies in Section 2, there seems to be a trend to maintain the status quo;
- ☑ There is a defined trend towards outsourced maintenance increasing over the next five years. This identifies an opportunity for R&M outsourced services and the potential growth in this area.

Section 4: Recommendations for the Skilled Workforce of the 21st Century

Is There a Skilled Trades Crisis?

So far as maintaining the status quo, there is a skilled trades crisis, but not a lack of manpower, as supported by all of the studies and reports reviewed in this study. The present methods of doing business, including reliability and maintenance (R&M) tasks and procedures are similar to those concepts developed since 1824 at Harpers Ferry Armory and reinforced in 1911 by Frederick Taylor and his concepts of Scientific Management.

Since the development of the assembly line by Henry Ford in 1913, the effort has been to speed up production. Initially, the impact was the reduction of time in assembling a car from over 20 hours to less than 90 minutes. Through to the present day, time and motion studies, incentives, lean programs, reengineering, Theory of Constraints (TOC) and more, have been used to shave seconds off of manufacturing times.

Training, time limits, scheduling and technology have been applied to reduce R&M times. The attempted addition of Condition-Based Maintenance (CBM), EAM/CMMS software, budget cuts and more, have been used to reduce maintenance costs. However, studies have shown that over 90% of maintenance programs to not deliver as promised, over 57% of EAM/CMMS programs do not meet expectations and a European study reports that 92% of ERP systems do not meet expectations. A majority of maintenance programs return to chaotic reactive maintenance programs following attempts to apply planned maintenance and CBM programs.

In 1983, Elayahu Goldratt introduced the Theory of Constraints. The purpose was to improve throughput and to reduce costs and inventories by reducing and removing constraints in the system. The concept of reduced costs being shown as reduced manpower was re-enforced. The application of Reengineering and Lean programs pushed this concept further, again. One of the key areas that management observed as a cost opportunity has been maintenance, which is an average of 40% of the operations budget of most facilities. In general, R&M was seen as an opportunity to reduce personnel that did not have immediate impacts.

With the entrance of the baby boom era into the workforce, there was an influx of readily available workers and an understanding that apprenticeships were required to bring R&M trades up to speed. This large number of readily available workers and trades, coupled with the application of automation and further reductions in time and motion, skilled wages increased slowly with management continuing to take further control of the workplace, a process initiated in 1824.

In the 1990's, some businesses, trade associations and professional societies begin to realize potential changes to the workforce as it becomes harder to find experienced workers in engineering and maintenance. Following 2000, the availability of an experienced and skilled workforce appears to have stagnated as the existing workforce advanced in age and the baby bust workforce just started into the workforce.

While it is also expected that there will be a slowdown in workforce growth, with the projected change to industry and manufacturing, it is expected that there will be enough replacement workers to manage existing and growth requirements. In fact, it is expected that through 2014, there will be a reduction for industrial and manufacturing skilled trades requirements by about 17,000.

The critical issue put forth by industry and manufacturing, per all of the studies, including the ReliabilityWeb.com survey, is the lack of a ready-to-work skilled workforce. The industrial and manufacturing studies primarily put the demand on academia and government to change training requirements to meet their needs. The lack of excitement, per many of the studies, by the 16-25 year-old generation, with the majority of new workers taking R&M positions as a last choice, is also an issue. Industry and manufacturing places the blame squarely on the younger generation, their parents, teachers and guidance counselors while not opening up the apprenticeships necessary to train the new workers. Finally, industry and manufacturers identify a lack of work ethic by younger workers and challenges hiring and retaining them.

What Can Be Done if the Present Direction is Maintained?

If we are to treat the change to the existing workforce as a crisis, the recommendations of the reviewed studies, both commented on in Section 2 and others, can be considered good, with some compiling. These recommendations are as follow:

- ☑ Students, parents and teachers should be recommending skilled trades careers as a choice to students;
- ☑ Government should require traditional and trade schools to generate curriculum to meet local business requirements in skills, experience and work ethic;
- ☑ Government should support industry and manufacturing in the cost of apprenticeships; and,
- ☑ Workers should strive to multi-skill and identify their training needs to become more employable.

Additional requirements would include tort reform, additional protections for companies as incentives to generate apprenticeship positions, keep the economy strong and similar recommendations.

Who Is Responsible for Tackling the Skilled Workforce Issue?

Within the workforce studies reviewed in Section 2 and the ReliabilityWeb.com survey in Section 3, the general trend is for the responsibility to rest on government, academia and parents to promote and train the skilled workforce. This comes after decades of a lack of apprenticeships, R&M budget cuts, personnel cuts, long hours, lack of recognition and a lack of defined career paths by industry and manufacturing, in general.

Academia is also a business. In order to be successful, it must show a high job placement success rate upon graduation. If the jobs are not readily available, it is not in academia's interest to provide instruction that will not be attended or does not result in job placement.

Should government intervene and attempt to maintain the status quo? In the case of some industries, such as the airline industry, government history in bailing out companies has led to a lack of solution and innovation by the companies in question, and, normally, failure.

Are There Alternatives?

One of the primary findings during the review of the studies in both Sections 2 and 3 is that the studies and resulting recommendations work under the premise that things should remain the same. However, another view would be to embrace the evolution of the new skilled workforce and come up with solutions that provide a new level of productivity in business. Instead of focusing on task-times, the reduction of budgets while maintaining the same requirements, implementation of new R&M concepts and software while maintaining the old philosophies and traditional maintenance: Eliminate the old model and implement a new model.

The old R&M model is not working. Therefore, radical change is required in order to realize improvements and stronger returns-on-investment than continuing in the present direction.

Following are a number of recommendations that can provide a guideline for change and embracing present and near-future changes:

- ☑ If the decision is made to continue apprenticeships and the need for ready-made skills, industry must work directly with academia. There are existing programs with trade schools and community colleges and manufacturers. The manufacturer offers to provide financial assistance to students who meet specific criteria for the company's skilled trade apprentice requirements while working with academia to develop specific curriculum that meets their requirements. The students are then guaranteed a position with the company upon graduation. If they remained employed with the company for a specific length of time (ie: 6 to 24 months),

then their school loan is forgiven as a bonus. This solution ensures a workforce that meets company needs, provides a basic workforce need for training, and reduces the company's apprenticeship and retention costs.

- ☑ Embrace the changes required to apply EAM/CMMS and ERP within the organization. Applying these technologies to defective systems will only make the weaknesses and problems within the organization appear that much quicker. Instead, select software technologies that meet the corporate needs and apply the reengineering requirements that go with the technology. From the EAM/CMMS perspective, changes such as the application of CBM should be performed concurrent with the implementation of the software. Recordkeeping, scheduling and work orders should be performed in relation to the software requirements.
- ☑ Condition-Based Maintenance programs, such as Reliability-Centered Maintenance (RCM), which meet recognized standards (ie: SAE JA1011) must be applied. Once applied, the old program, if any, should be eliminated. This avoids the duplication of maintenance tasks and instills a maintenance process. Along with the RCM process, should be a periodic Maintenance Effectiveness Review (MER), which is a continuous improvement process for RCM. The proven impact of properly applied RCM processes will have a significant impact on maintenance costs and overall system reliability and safety.
- ☑ Condition Monitoring Systems, both route-based and permanently installed, should be investigated for application. Imagine a system that detects an impending problem, alerts the operator and maintenance anywhere, schedules its own corrective maintenance and parts while, in redundant systems, routes around the failed, or failing, part. A dream for the future? No. Such concepts and technologies have been developed and some are ready for commercial application, others are in development and should be available in the near future. Many of these systems utilize WiFi and Bluetooth technology.
- ☑ Capture the knowledge of veteran skilled workers. Select the best practices and develop both company best practices and procedures. When possible, compare them to industry best practices and procedures to ensure that work has been performed correctly.
- ☑ Software and Web-Enabled systems for skills and training assessments for the skilled trades exist. Some of these systems include both question and answer as well as practical tests. They can be set up to identify both third party and internal training available. This type of approach will dramatically save in training costs and will be more effective by applying the right training to the right person at the right time and for the right reasons.
- ☑ Include an R&M representative in executive decisions and budgeting efforts. This will ensure that appropriate measures and decisions are made concerning R&M budgeting so that such decisions do not have a negative short or long term impact on reliability.
- ☑ Establish clear lines of communication between R&M and management, especially where condition-based decisions must be made.
- ☑ Develop new and corrective maintenance specifications and procedures with R&M in mind. New equipment should include test points for CBM technologies and inspections as well as technical information to be used for analysis (ie: rotor

bars, stator slots, bearings, etc). Corrective maintenance specifications must include the gathering of technical information in reports (as with new equipment) and outline expectations. In both cases, ensure that such processes as commissioning for acceptance will be performed, with what technologies and what the pass/fail criteria will be to eliminate surprises and warranty-related arguments.

- ☑ Develop Commissioning Processes for new and used equipment. In order to ensure that equipment meets your requirements, set commissioning processes to verify that equipment meets specifications.
- ☑ Develop a 'crash team' of specialists who will make up the core of subject matter experts in order to act as an immediate response and triage team.
- ☑ Develop an outsourcing process for both specialized and flexible work force. Where it does not make economic sense to maintain technicians for highly specialized diagnosis, maintenance and repair, set up support contracts with vendors tied to response related to criticality of equipment. Additionally, other skills requirements for infrequent or flexible work conditions (ie: variable markets that involve frequent layoffs) should have this portion of the workforce outsourced with contracts that allow flexibility. How this is set up and the makeup of the contracted workforce is dependent upon the requirements of the company and the requirements of the contractor. These concepts will allow for flexibility and the ability to lean the workforce based upon the needs of the company without laying off key internal personnel. In some cases, it may be effective to outsource complete basic maintenance, such as the type of programs performed by commercial building services. Qualifications of the workers provided by the contractor must be outlined and the focus should be on best value, not lowest cost.
- ☑ Embrace technology. There is a significant technology gap between many of the baby boom skilled workforce, in some cases there is significant resistance. This type of situation should be addressed as the company sees appropriate. We understand that this is not a popular concept. However, a workforce that resists technologies that will make the company more effective, equipment available and the workforce more efficient is actually harming the success and, possibly, the survival of the company.
- ☑ Retain critical employees with value-based incentives.
- ☑ Utilize vendors as resource partners.
- ☑ Eliminate task-based maintenance and focus on process-based maintenance.
- ☑ An understanding by management that a program based upon these, and additional innovative concepts, will result in some portion of the skilled workforce 'waiting' for equipment to fail. One of the key failures in any maintenance program is 'maintenance entropy.' This occurs when a maintenance program becomes successful and the rate of failures and new return on investment opportunities are virtually eliminated. Presently, it is the habit of executives to cut the maintenance budget of a successful program. It is documented that the gap to a reduction in reliability, following the return to a traditional or reactive maintenance program, is 12 to 18 months.

There are other opportunities available perhaps more innovative than those outlined above. These should be considered based upon the environment. Understand that your future maintenance department does NOT have to look like the present.

Conclusion: Skilled Workforce of the 21st Century

Distinct changes in the global economy and competition requires a fundamental change to the reliability and maintenance skilled workforce. Until the 1980's it was expected that a skilled worker would join a company and be employed for life. With changes to competition, the implementation of 'downsizing,' lean, Theory of Constraints and other business practices, this can no longer be an assumption.

The studies reviewed in the Skilled Workforce in the 21st Century project identified that, should business and R&M practices continue in their present direction, we will experience a skilled workforce crisis by 2015. This does not mean that there will be a lack of people. It does mean that there will be a lack of properly trained and experienced workforce for R&M in its present form.

There is little choice but that the R&M industry must change from both the skilled workforce (skilled trades) and management standpoint. There will also be a distinct classification of skilled tradespeople and their value to the corporation. We will first address the skilled trades and classification then the required management changes.

Skilled Workforce of the 21st Century

There are three basic types of workers for reliability and maintenance in the 21st Century. Within each type, there will be variations.

Knowledge Worker

The knowledge worker is the top tier reliability and maintenance specialist for one or more skills within the company that are also transferable within one or more industries. The particular skill-set found in knowledge workers include, but are not limited to:

- ☑ Solution and value oriented;
- ☑ Uses technology as a tool;
- ☑ Continuous/life-long learning. Keeps up to date on new and upcoming advances;
- ☑ Understands aspects of asset management;
- ☑ Strong work ethic and customer (internal/external oriented) service;
- ☑ Education and experience;
- ☑ Is a leader, coach (mentor) and supports efforts within the company.

Knowledge Workers:

- ☑ Are mobile and are in demand. They can leave as required.

- ☑ Job satisfaction and training opportunities are usually required to retain. As they are in demand, they command a higher salary, but financial rewards, alone, will not retain them.
- ☑ They are partners and cannot be 'ordered.' They must usually be persuaded.
- ☑ They tend to pay for themselves many times over.
- ☑ Self directed.
- ☑ Process oriented.
- ☑ May be internal, service or consultants.

There are presently a number of knowledge workers within industry. They tend to be the person that immediately comes to mind when a problem arises. Many companies have at least one knowledge worker with only a few having multiple knowledge workers.

The future task will be to develop more within industry.

Skilled Tradesperson

The skilled tradesman may be a journeyman or master of his/her particular craft. Will have some level of skill and experience necessary to perform planned maintenance, corrective maintenance and construction. May be internal workers or service and tend to be task oriented.

Skilled tradesmen will generally have on-the-job training, formal training or an apprenticeship. Their skills will be transferable and in a reasonable level of demand.

General Maintenance Worker

The general maintenance worker performs basic tasks in either a particular craft or general tasks. Often will require the direction of a knowledge worker or skilled tradesperson in the performance of tasks, or, for planned maintenance, written procedures. Training is mainly provided as on-the-job training. The general maintenance worker will have limited formal education and will perform as a maintenance laborer.

Management Approach to the Skilled Workforce of the 21st Century

Management must approach the skilled workforce of the 21st Century with a new paradigm. A few concepts that must be considered by management, for success, include:

- ☑ Maintenance policies should be formulated by the people closest to the assets;
- ☑ A successful, lasting maintenance program can only be developed by maintainers and users of the assets working together;
- ☑ Knowledge workers must be developed and nurtured.

No, Jack Welch is saying something else: You simply have to treat your employees as an integral part of your business. Do that, and you will find employees responding by becoming more engaged and conscientious. And an engaged, conscientious worker is a more motivated, productive worker. It's really no more complicated than that.

Every employee wants to feel important to the company. And getting workers involved and empowered will make them feel important. Workers want to feel needed and important, a simple fact that business leaders can exploit, but it will require some sacrifice. Managing less is managing more, is how Welch would put it. And although managing less is not always easy to swallow, it has some tremendous advantages.[50]

The primary methods for developing and retaining knowledge workers are:

- ☑ Involve the knowledge worker, or developing knowledge worker, within management decisions related to reliability and maintenance. Make him/her a partner in decisions related to asset management;
- ☑ In addition to an appropriate salary and benefit package, the knowledge worker will expect access to training, seminars, conferences, involvement in trade-related standards and certification programs and having an impact on the industry;
- ☑ Ideas must be heard and considered. Quick decisions are important as the knowledge worker tends to be result-oriented;
- ☑ Flexibility and freedom to do what must be done with little or no supervision. Most knowledge workers are entrepreneurial and take pride in success.

Summary

Organizations have already gone through drastic transformations in workforce and quality improvements like Six Sigma, Lean, Quality Revolutions and ISO 9000. Most resources have been deployed on manufacturing and process infrastructure improvements with little concern about maintenance and reliability. One of the last bastions that allows for dramatic improvement of the productivity of company assets is best practices in Maintenance and Reliability. Smart companies are quickly finding that the journey toward best practices in physical asset management pays big dividends. Unfortunately for many - this realization will happen too slowly as the available resources, primarily skilled experienced maintenance and reliability experts will be in shorter supply. The convergence of short supply and increased need will demand superior recruiting and more detailed planning than ever before.

The future holds great promise for knowledge workers in the field of maintenance and reliability. As the shortage of both high level and lower level skills becomes more

[50] Slater, Robert, Jack Welch and the GE Way, McGraw-Hill, 1999.

pronounced, the competition to hire or contract with these knowledge workers will intensify. Companies that use cost to drive maintenance decisions rather than best practices will loose knowledge workers and see costs skyrocket. Companies to attract knowledge workers and implement best practices will see increased profits through higher availability and increased output, lower scrap rates, higher quality product, and finally lower maintenance labor and material cost.

Companies that hire and retain the right maintenance and reliability workforce, create an environment that empowers the knowledge worker, and leverage available technologies will reap the rewards. The companies that wait to read about the Reliability Revolution on the front pages of national and international news media will be far too late!

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