Voices of the Oklahoma Aerospace Industry Leaders

Improving Oklahoma's Workforce and Ultimately Our Economy

Skills Gap Analysis Report - 2010

Final Report

ANAUTICS

ANAUTICS, INC.

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AUTHORS AND CREDITS

ANAUTICS, INC.

Anautics is a woman-owned certified, HUBZone certified small aerospace business with 10 years experience providing innovative technology solutions, research and development efforts to industry and government organizations. Anautics has a proven track record of implementing programs and projects across the United States and throughout Department of Defense. Our project base consists of efforts at Tinker AFB, Engineering Division, Oklahoma Department of Commerce/Oklahoma Aeronautics Commission, and Ft. Benning, GA. Anautics was chosen in 2007 and 2008 to present as a Showcase Company at the National SBIR Conference, We won the Journal Record Innovator of the Year in 2008 and the 2010 Tinker and the Primes Small Business Award. Anautics employees are committed to provide for our customers the best solutions - effectively, efficiently and economically. Anautics has conducted three Skills Gap Analysis Research efforts in the Oklahoma City Area.

RESEARCHERS

SANDY SCAFFETTA JOHNSON, PH.D. conducted research with adult learners for the Oklahoma City Public Schools and a Skills Gap Analysis Report for the Oklahoma Business and Education Coalition. She served on the Advisory Committee for Performance Pay for Teachers for the Oklahoma Speaker of the House and also conducted research on and testified before the Joint Oklahoma Legislative Education Committee regarding First Year Teacher Programs for State Representative Ann Coody. She has nine publications and has presented 25 research and professional development activities locally, statewide, nationally and internationally. While teaching in Anadarko High School, she was honored as the District Teacher of the Year and nominated for the Presidential Award for Excellence in Mathematics and Science Teaching. In business, she was one of 50 nominations across the State of Oklahoma for the Woman of the Year. She currently serves on the Board and the Executive Committee for the Oklahoma Commission for Teacher Preparation and on the Board for the Oklahoma Professional Educators. She is a member of the State Chamber of Commerce, the Greater Oklahoma City Chamber of Commerce, the Midwest City Chamber of Commerce, the OKC Rotary Club 29, and is an Honorary Commander for the 552d Air Wing Command at Tinker AFB.

BILLY D. GASTON, PH.D. has extensive technical skills that cover a broad spectrum ranging from software architecture to implementation. He provides expertise in process modeling, data modeling, architecture design, data structures, text mining, and record linkage algorithm research and design. His formal background in Computer Science, Mathematics, and Education provide a breadth of knowledge and experience. Dr. Gaston has an extensive history in research including several publications and presentations locally, statewide and nationally. Dr. Gaston worked a number of years at Tinker AFB in association with Oklahoma State University conducting research on weapon system health data and designing and implementing algorithms and applications to enhance and maintain aircraft maintenance and sustainment systems. Dr. Gaston is the Chief Technology Officer and Vice President at Anautics, Inc. where he brings a high level of expertise that supports the company's mission, initiatives and innovations.

REVIEWS OF THE EXECUTIVE SUMMARY AND THE FULL REPORT

Victor Bird, Director, Oklahoma Aeronautics Commission
"The U.S. is and has been the global leader in Aerospace & Defense (A&D) since the end of WW II. A&D is one of Oklahoma's top three economic engines. An adequate pipeline of skilled workers is the foundation of the industry's vitality, yet the alarming fact is that the industry is not attracting enough skilled workers to replace the workforce it is losing. This report picks up from where the Governor's Workforce Council study on the industry's workforce left off, and provides us a flight plan to begin addressing this challenge."

Robert J. Conner, SES, President/CEO, Aerospace and Defense, LLC. Former Director of the Air Logistics Center, Tinker AFB.
"Workforce needs are a key focus for industry in Oklahoma. Jobs are vacant in Oklahoma aerospace companies today because of a shortage of qualified candidates. As a state, we need to do a better job of equipping students for the work place. The solid recommendations in this report must be acted on. The skills panels have provided a great deal of good information and can provide the foundation for action to come. But, without resources, that won't happen. The challenge for the leaders of industry; workforce and economic development activities; and our educational system is to focus the resources needed to make it happen."

Reed Downey, Small Business Owner and President of the Board for KIPPS Schools in Oklahoma City.
This report clearly lays out the challenges Oklahoma faces in meeting the demands of the Aerospace Industry. The state of our education system is not new; it was developing and went unheeded even though the signs were there for well over 30 years. During those years industry had a great supply of well educated baby boomers as well as those who are now called the Greatest Generation..To turn the entire education system will take a major effort, but the demands of the industry are NOW. To fill the gap until the system can be restructured and rebuild, look to those schools such as KIPP and Harding Charter Prep and others that are already producing the kind of graduates who can succeed in the areas needed by the industry. Partner with them and help them expand rapidly to meet the needs of the industry. These schools are already centers of excellence, use them!

Edward Laverdure, Lt Col USAF (Ret), MA, Principal, Velocity Ventures in Longmont CO.
"This ground-breaking study by Anautics led by Dr. Johnson examines the current challenges in maintaining and developing the Oklahoma aerospace industry workforce and serves as a clarion call for our state's business leaders, educators, parents and students to engage now by taking the necessary actions to close critical gaps between expectations and performance at all levels in the system and create an inspiring vision of America's technological leadership in 21st century aerospace, astronautics, propulsion, and supporting sciences. It is a new operational environment and we must chart a course for aerospace advancement independent of Federal requirements -- carpe diem."

Tom O'Neill - President, Crossbow Consulting Inc.
Formerly Deputy Director of the Oklahoma Aerospace Institute
"This report lays the foundation for a long-needed aerospace work force requirements and delivery system. That system brings industry, education and government together to deliver the work force the industry needs to ensure Oklahoma can compete in the global arena today and in the future."

Ben T. Robinson, Brig General, USAF, (Ret) - VP, Oklahoma School of Science and Mathematics
President/Owner, Sentry One LLC.

" In my over 8 years with the Oklahoma aerospace industry covering time as a consultant with a national company, the Executive Director of Boeing Aerospace Operations in Oklahoma, with the Oklahoma Aerospace Institute, with Oklahoma Career Technology Center and now as the President/Owner of an aerospace consulting LLC, I have never read a more comprehensive, data based, industry driven, actionable report. The amount of research and data supporting this report is eye opening. The fact that so much of this report was produced from interviews with industry leaders gives it unprecedented credibility. The findings and recommendations are spot on. Right now we have many new leadership positions in the state such as our Governor, our Lt Governor, our Secretaries of Commerce, Education and Science and Technology and our Superintendent of Public Education. Each are stakeholders in this report and the aerospace industry. We must get behind this effort to keep it going and to provide the leadership and organization to make it worthwhile and enduring. Oklahoma has an opportunity to be an innovative, pace setter in building significant relationships among industry, education and Government. We want all to see that Oklahoma is open for aerospace business."

Aerospace Skills Panel Participants

The following industry leaders, education provider leaders, government representatives and others participated at least once in our Skills Panel activities.

Central Regional Skills Panel

Aerospace Industry

AAR
Boeing
Chromalloy
Design Intelligence Inc
Defense Logistics Agency (DLA)
Frontier Electronic Systems Corp.
General Dynamics IT
Lear Siegler Services
LSI
Pratt & Whitney
Pro-Fab Inc
URS
Valco, Inc.

Education Providers

Autry Technology Center
Canadian Valley Technology Center
Francis Tuttle Technology Center
Gordon Cooper Technology Center
Metro Technology Center
Oklahoma Career Technology Systems
OSU - School of IE&M
Rose State College
SOSU
University of Oklahoma K-20 Center

Government

Central Oklahoma Workforce Investment Board
Federal Aviation Administration
Government Service (GS) Supervisors
North Central Workforce Investment Board
Oklahoma Bid Assistance Network
Oklahoma Center for the Advancement of Science and Technology
Oklahoma Department of Commerce
Oklahoma State Regents for Higher Education
OSU / Aging Sys Sustainment and Enabling Tech (ASSET)
OSU Center for Innovation and Economic Dev (CIED)
OSU Information Technology
Southwest Workforce Investment Board
Tinker AFB, OC – ALC
US Department of Labor/ETA/OA
Vance AFB

Other

CYR Consulting Inc
GDH Consulting
Greater OKC Chamber of Commerce

Eastern Regional Skills Panel

Aerospace Industry

American Airlines
Cherokee Nation Industries
Cinch Connectors
Da-Pro Rubber, Inc.
Diehl Aero-Nautical Co
Executive AirShare
First Wave
Flight Safety International
Hill Industries
L-3 Aeromet
Lucas Finishing
Lufthansa Technik
Malone's CNC Machining, Inc.
Mint Turbines
Nordam Group
Precision Machine
Raytheon
Spirit AeroSystems, Inc.
Tulsair Beechcraft

Government

Eastern Workforce Investment Board
Indian Nation COG
McAlester Army Ammunition Plant
OBAN
Oklahoma Aeronautics Commission
Oklahoma Center for the Advancement of Science and Technology
Oklahoma Department of Commerce
Oklahoma Manufacturing Alliance
Tulsa Workforce Investment Board

Education Providers

Central Technology
OK Dept Career and Tech Education
OSU Center for Innovation and Economic Dev
OSU Information Technology
Tulsa Technology Center

Other

Horizon Business Concepts
Liberty Partners
Managing Creativity
Tulsa Metro Chamber of Commerce
Workforce Solutions

Future Skills Panel

AAR
Acorn Growth Companies
American Airlines
Ardmore Development Authority
ARINC
BizJet International
Capital Aviation
Design Intelligence Incorporated, LLC
Enviro Systems
Flight Safety International
General Aviation Modifications (GAMI)
Lufthansa Technik
FAA/Mike Monroney Aeronautical Center
Oklahoma Aeronautics Commission
Oklahoma Aerospace Alliance
Oklahoma Aerospace Institute
Oklahoma Department of Commerce
Spirit AeroSystems, Inc.
The Boeing Company
Tinker AFB, OC – ALC
University Multispectral Lab

SECTION 1: AEROSPACE INDUSTRY WORKFORCE OVERVIEW

According to the U.S. House Committee on Science and Technology Press Release in late 2009, the aerospace workforce is defined as "NASA civil servants and its contractor space workforce; the broader aerospace workforce that support space, aviation, and defense programs; as well as a chain of suppliers, businesses and service organizations that also support the aerospace sector."[1] In this press release, growing challenges were discussed with regard to the U.S. aerospace workforce. Those challenges are:

- the aging of the aerospace workforce,
- the stability of space-related programs,
- the skills required for major programs, and
- the status of the pipeline for future workers.

Throughout this study, the workforce "pipeline" terminology is used. This "pipeline" is defined as the pathway in education that eventually leads to employment in the aerospace industry at any entry-level position. This includes but is not limited to touch labor, information technology, engineering, program and business managers, and other aerospace related occupations.

This Skills Gap Analysis Report is a documented instrument that represents the voices of the Oklahoma aerospace industry, providing insights into the aerospace industry in Oklahoma on three of the four challenges listed by the House Committee on Science and Technology. All are discussed in this report with the exception of the stability of space-related programs. The Subcommittee on Space and Aeronautics Chairwoman Gabrielle Giffords stated, "Aerospace jobs are high-paying, high-skilled jobs – jobs that will enable us to compete – and lead – in the 21st century, not just in space but back here on Earth too." These types of jobs are critical to our nation and to our state. Committee Chairman Bart Gordon stated, "This workforce is a lot like Humpty Dumpty – if it is taken apart, it won't be easy to put back together. They have the unique skills and the institutional knowledge crucial to the success of our aerospace industry and, therefore, to our overall national competitiveness."[1]

Since we live in a global economy, the overview provided in this report discusses the International, National, and State implications of the aerospace industry on the economic impact of the aerospace industry and what other countries are doing to establish and grow their aerospace programs. Oklahoma aerospace executives were asked a series of questions in personal interviews about the state of the aerospace industry in general. One of the executives commented that with all the outsourcing, military and space initiatives downsizing we are doing now, if we continue on the path we are currently taking, the aerospace industry in the United States will become a "maintenance service" rather than a "design and build" industry.

This is vitally important to our Oklahoma aerospace industry and our economy because we may be in for a fight to train and retain our highly-skilled workforce in the near future. The time to act is now to preserve and to enhance the aerospace potentials for the State of Oklahoma. For competitiveness and for national security, we need to maintain our high-quality aerospace workforce. If incorrect decisions are made now, it will certainly affect many generations to come. Because the aerospace industry has a

global footprint which includes Oklahoma companies, research in this section is provided for International, National and State aerospace applications.

1.1 INTERNATIONAL

The United States, burgeoned by its massive $100B+ defense procurement budget, has the largest overall aerospace industry in the world at $204B. The next largest countries, underpinned by European defense spending and world class Original Equipment Manufacturers (OEMs) and service companies, are France ($50.4B), the United Kingdom ($32.7B), and Germany ($32.1B). Turning to Asia, Japan ranks sixth ($14.1B), followed by China ($12B) and Russia ($10B). Furthermore, rounding out the top ten are Italy ($9.9B) and Brazil ($7.6B).[2] America has led the world in the modern aerospace era starting with the birth of the first modern aircraft developed by the Wright brothers in 1903. Echoes of the successes accomplished during the Cold War and the great Space race still linger. However, the international community has never been satisfied with taking a back seat to the United States. Global competitiveness in aerospace is a growing reality for several countries around the world once thought to be years behind in their potential to facilitate innovative advancements in any industry. Foreign governments and companies are aggressively positioning themselves to become more competitive in an effort to capture their place as global leaders in the aerospace industry.

To maintain a competitive edge in today's global economy a talented, highly skilled workforce of Science, Technology, Engineering and Mathematics (STEM) workers such as scientists, technicians, engineers and researchers is required. "The worldwide competition of overall national strength is actually a competition for talents, especially for innovative talent."[18] This remark by China's President Hu Jintao sends a resounding message that a nation's stability hinges on a dominant presence of a workforce that is both skilled and talented. Many today would argue that the proverbial hinges securing our workforce have malfunctioned to the extent that the U.S. as a nation is in danger of losing its global presence as a superpower.

The Aerospace Industries Association (AIA), a national Aerospace Industry Association considered a leader by many, reported that in the US only 33% of bachelor's degrees awarded are in science or engineering, while Thailand had 69%, Japan 63% and China 56%.[6] As China races to become the leading provider for Asian MRO, China's aerospace market is already the fastest growing aerospace market in the world. China's civil aviation service providers achieved a 17.1% increase compared with last year (2009).[7] Singapore's aerospace industry has grown at an average rate of 13 percent since 1990 to become the most comprehensive Maintenance, Repair and Overhaul (MRO) hub in Asia.[8] More than 8,000 manufacturers are located in Singapore, and while the country feels the pressure from China's emergence every bit as much as Western nations do, Singapore expects to double its manufacturing output to $300 billion (US$192 billion) within the next dozen years.[9] To meet the demand for this

increased business opportunity the Singapore Workforce Development Agency (WDA)'s Aero/Aeroplus program began recruiting job seekers willing to re-skill into the aerospace industry. This effort was eventually enhanced and transitioned to the Aerospace Workforce Skills Qualification System (WSQ), a national qualification awarded by the Singapore WDA. Employers know that individuals who have this qualification are benchmarked to local and international best practices and standards. In addition, two countries in South America, Argentina and Brazil, are successfully utilizing the glamour of space and subsidized tuition to attract young students to the STEM classes and related fields, especially engineering.[10]

Brazilian based company TAP Maintenance & Engineering, with a staff of 2650 and an annual production capacity of 2.2M/year man-hours has become the leader in Latin America MRO market and is ranked among the 10 main aeronautical maintenance companies of the world.[11] The German MRO workforce places significant focus on training, introducing the industry to young school children, aligning cities with the industry, and ongoing incentives for continuing education while on the job. As of the third quarter of 2009, German-based company Lufthansa Technik AG employed 19,742 staff with an increase of +4.0% from last year, partly because of an increase in vocational trainees and a total of 307 young people beginning apprenticeships.[19] Lufthansa Technik hosts 500 practical work experience placements for school children; it also supports more than 450 industrial student internships and undergraduate engineer project leading to full professional qualifications.[19]

It has become more apparent that countries worldwide are developing at rates once thought unimaginable. These countries are investing in their workforce by engaging and grooming children at early ages. They are becoming more innovative in equipping their workforce to meet the intense demands that are required to be a leader in the aerospace global market. With the continuous proliferation of information, the innovative strides in technology coupled with a poor economy, the 'playing' field has become more level. By providing incentives and a skilled but inexpensive workforce, smaller countries have learned to leverage these assets even taking full advantage in a global economic meltdown that almost demands that companies become lean, outsource or relocate across the globe.

1.2 National

As of 2009, the U.S. Aerospace and Defense (A&D) industry employed over 815,000 workers with approximately 644,200 of those coming from the aerospace industry alone.[13] Although the A&D industry employs over 815,000 workers, it supports more than two million high-quality jobs and 30,000 suppliers across 50 states.[13, 15] "Aerospace contributed $97 billion in export sales to America's economy in 2007. U.S. aerospace sales alone account for 1.5 percent of our country's gross domestic product."[13] Within the U.S. Aerospace sector, the civilian aviation maintenance subsector is estimated to include a workforce consisting of close to 275,000 workers and provide a $39 billion impact to the U.S. economy.[16] Eighty-five percent of those jobs can be attributed to MRO which accounts for 233,237 workers. An estimated 200,000 of those workers are employed in FAA certified repair stations. It is noted, most repair stations are actually small businesses. MRO alone accounts for 60% of the $39 billion impact and parts manufacturing and distribution account for 38% of the market. "In 2007 more than 600 million

passengers relied on U.S. commercial air transportation, and more than 150 million people were transported on general aviation aircraft. More than 40 percent of the value of U.S. freight is transported by air. Aerospace capabilities have enabled e-commerce to flourish with overnight mail, parcel delivery and just-in-time manufacturing."[18]

There is no doubt that the aerospace industry has greatly impacted the American economy and national security. Leaders throughout the United States are strategizing to develop a skilled workforce of scientists, engineers and technicians to ensure that the nation's aerospace industry remains viable. However, the nation's intellectual capital continues to decrease while demands for innovation and usable technology increase. The jobs provided by the aerospace industry span multiple skill sets and levels. They consist primarily of engineers, business and program managers, and manual "touch labor." The once revered U.S. educational system continues to show signs of weakness and decline. Of 270,000 freshmen entering college in the U.S., only 7.5% are intended majors in engineering, lowest level since 1970.[6] As stated in a 2010 article entitled *Impact of Recession on California's Aerospace Industry* in SMT, a manufacturing publication of *i-Connect007*, "Between 2009 and 2014, the ten fastest-growing aerospace occupations are: machinists, aircraft mechanics/service technicians, computer-controlled machine tool operators, industrial engineers, computer software engineers, business operation specialists, aerospace engineers, and engineering and other managers. A bachelor's degree is required for six of the ten occupations, with the remaining four occupations requiring work experience, on-the-job training or a vocational training certificate."[14] The Bureau of Labor Statistics reported in 2007 that over 2.5 million STEM workers would be needed to fill aerospace-related job vacancies across the nation.[18] Unfortunately glaring challenges confront the U.S., making it difficult to meet the ensuing demands of our future nation's workforce. Three of the many prominent challenges are:

1. the aging workforce;
2. the lack of skilled workers to replace them; and
3. a fractured pipeline of ill-equipped workers coming in from the P-20 educational system.

The aging workforce challenge is further highlighted in reports that indicate that over 58 percent of the national workforce is over the age of 50 suggesting that a large majority will be eligible for retirement, while only 22 percent of the workforce is age 35 and younger.[15] The nation must aggressively explore different avenues to populate its workforce pipeline to meet the expected demands. These specific issues threaten to devastate U.S. competitiveness, health and economic strength nationally and globally. The current economic downturn has further aggravated these issues as well.

Aerospace industries must address the challenge that it is not the responsibility of the Government to keep the aerospace industry going. It is the responsibility of the industry. Innovation and research drive

this as expressed by Burt Rutan in a presentation titled *Rutan Sees the Future of Space*. Rutan stated, "You don't have innovation cycles if the government develops and the government uses it. You know, a good example, of course, is the DARPA net. Computers were used for artillery first, then IRS. But when we got it, now you have all the level of activity, all the benefit from it. Private sector has to do it." According to Rutan, "We're entering a second generation of no progress in terms of human flight in space. In fact, we've regressed. We stand a very big chance of losing our ability to inspire our youth to go out and continue this very important thing that we as a species have always done. We need to inspire them, because they need to lead us and help us survive in the future."41 While this illustration specifically addresses space-related programs, it also directly applies to the aerospace industry. The excitement and fulfillment of aviation and aerospace efforts should be marketed in our schools and across industries to encourage the brightest and best young people to consider careers in aerospace.

The time to take action is now. According to a new study published by the Atlantic in December 2010, Your Child Left Behind,[36] old excuses such as teachers' salaries and classroom sizes, and diversity of the population cannot be used any longer to account for the low achieving performances of young people educated in our schools. This study compared our best students, those who had at least one parent with a college degree, affluent and white to the accomplishments of foreign students who took the PISA (Programme for International Student Assessment). US young people used in this comparison are not generally subject to language barriers or racial discrimination. Because of the study findings, "these relatively privileged students do not compete favorably with average students in other well-off countries. On the percentage basis, New York state has fewer high performers among white kids than Poland has among kids overall. In Illinois, the percentage of kids with a college-educated parent who are highly skilled at math is lower than the percentage of such kids among all students in Iceland, France, Estonia, and Sweden." Oklahoma ranks well below both of these states. According to an Organization for Economic Co-operation and Development (OECD) 2010 *Strong Performers and Successful Reformers in Education, Lessons from PISA for the United States*, there is a significant cost to the international achievement gap. Researchers used an economic model to relate cognitive skills as measured in PISA and other international tests to economic growth. Even small improvements translate to large Gross Domestic Product (GDP) gains. For example, raising our average PISA scores by 25 points over the next 20 years could translate to a gain of USD [74] trillion for the US present value of future improvements in GDP. Bringing all US students to a baseline level of proficiency for the OECD, could imply GDP increases for the US of USD 72 trillion.[55] As the reader will find in this document and the full Skills Gap Analysis Report, aerospace employers need work-ready, college-ready entry year employees, and the industry leaders are ready to get involved in the education system for the advancement of the industry.

1.3 STATE

Over the past several years, Oklahoma's estimated $12.4 billion commercial aviation industry has continued to be a dominant economic catalyst for the state's economy. Research consistently gives the aerospace industry credit for providing Oklahomans with over 72,000 jobs, which have wages above the state average, and approximately 145,000 total jobs directly, indirectly and induced. The average wage is recorded at $55,000 which is almost double the state average. This is accredited primarily to the fact that Oklahoma is the home of two of the world's largest military and commercial maintenance, repair and overhaul (MRO) facilities - Tinker Air Force Base and American Airlines. These facilities are located in Oklahoma City and Tulsa, respectively. In addition to Tinker AFB, the Federal Aviation Agency (FAA) Mike Monroney Aeronautical Center is another major federal installation that contributes greatly to Oklahoma aerospace.[15] MRO, OEM, and air transportation are three primary sectors of aerospace impacting Oklahoma. Other subsectors are supply chain management, engineering and modifications, manufacturing, and emerging technologies such as unmanned aerial systems/vehicles, and Fixed Base Operators (FBO). As a result of its strong MRO presence, Oklahoma's aerospace workforce consists of a large number of jobs at the technician, trade, and engineering levels.

Oklahoma is plagued with issues that cripple its ability to sustain the momentum needed to recruit and enhance its aerospace workforce. Like many other states, the Oklahoma K-12 education system appears to be severely broken. "The most recent National Assessment of Education Progress (NAEP) fourth grade reading and math scores show that the scores of Oklahoma fourth graders, relative to the national average, have *declined* over the roughly ten-year period since the state became the leader in early childhood education."[17] A recent state report card revealed that in the Oklahoma City Public School District, 54% of fourth graders read below grade level[17] and this is representative of many other communities in Oklahoma. If aggressive, focused measures are not taken, these students and others like them will find it difficult to matriculate through high school or to effectively contribute to society, crippling the possibility of becoming skilled enough to obtain a job in the aerospace industry.

Many students who do manage to transition from high school to college must eventually take a number of remedial courses before pursuing their degree or certification.[20] This further subscribes to the existence of a fractured pipeline of highly skilled workers and if not addressed places Oklahoma in a position that further hinders the nation by not providing a workforce that can quickly and effectively contribute to its viability and quest to remain a global leader. However, with a newly elected State Superintendent, Oklahoma has an opportunity to act to develop better learning experiences for students that will aid in producing higher student achievement and graduation rates before it is too late.

Current industry focus remains on creating aerospace awareness, engaging the educational and training systems, and creating synergy among Oklahoma aerospace companies. The Oklahoma aerospace industry is presently identifying gaps within Oklahoma practices in relation to the rest of the nation and the global platform to determine the near- and long-term steps needed in order for the state to become a recognized pillar in the advancement of global aerospace innovation. This can happen if Oklahoma's industry and affiliates commit to establishing ongoing means to successfully educate Oklahoma students and inspire them to produce innovations that engage the world now and in the future to come.

SECTION 2: OVERVIEW OF THE SKILLS GAP ANALYSIS METHODOLOGY

2.1 MISSION OF THE PROJECT

This project was funded by a U. S. Department of Labor BRAC Implementation Grant and the Oklahoma Governor's Council for Workforce and Economic Development. In March 2010, Anautics was awarded a portion of the grant to conduct an aerospace Skills Gap Analysis study, to establish and facilitate three aerospace skills panels for the purpose of understanding the state of Oklahoma's aerospace industry workforce pipeline today, and to develop a process to collect, revise, and update data relative to the state's Aerospace industry and skills gap research information. To understand the workforce pipeline, it was necessary for the results of the study to reveal answers to the following questions: how well does the pipeline function, how can the pipeline be improved immediately, and what long-term innovations can be implemented to maintain and grow the industry in Oklahoma. Both the Skills Gap Analysis and the Skills Panels further the actions recommended in the *Strategic Plan for the Growth of Oklahoma's Aerospace Industry* completed in 2009.[29]

There were three major objectives of the Aerospace Workforce Project.

A. Provide staff support for facilitation and staff support for the three skills panels
   1. Processes used to build and maintain the Panels
   2. Statistics on Panel participation
   3. Continued support of the Panels
   4. Training for the WIB Directors
B. Delivery of a comprehensive aerospace Skills Gap Analysis Report
   1. Methods of collecting data
   2. Review of data collected thus far
   3. Review of activities for future panel meetings
C. Continuing Process to Update and Revise the Workforce Requirements Information within the Skills Gap Analysis Report

A Skills Gap Analysis is a process of identifying the skills that an employer's workforce needs but may not have in order to complete the assigned tasks efficiently and effectively. Information to expose gaps regarding the recruiting and hiring processes, training that is required for new hires, and job forecasting were researched and presented to our Skills Panels for discussion and application in order to investigate "gaps" that may exist between current job skills conditions and desired job skills conditions. The conditions this study will analyze are the gaps that exist between the aerospace workforce job skills that currently exist and the job skills desired by the employers in order for workers to perform tasks without supervision and without additional training. This study represents the voices of many of the aerospace company representatives in Oklahoma who discussed the following attributes of the workforce: General Education and Training, Core Job Skills, Education and Programs, Employment, Certifications and Licensures, Retiring Workforce, and Knowledge Capture with an output of Awareness and Recommendations for Improvement as shown in Figure 2.1. From these discussions and from several personal interviews, recommendations are submitted to empower the industry to become actively involved in the areas where narrowing the gap between current conditions and desired conditions could make a substantial difference in the productivity of the industry and its economic development in the

state of Oklahoma. In this section, a review of literature establishes a foundation for our needs assessment research.

Figure 2.1 – Aerospace Workforce Needs Assessment

2.2 Organization of the Project

The Oklahoma Aerospace Institute (OAI), a program of the Oklahoma Aeronautics Commission (OAC), managed the grant on behalf of the Oklahoma Department of Commerce. OAC subcontracted the OAI program management duties to Veritas Consulting, LLC. Anautics, Inc. was selected to provide staff support for facilitation and three skills panels, deliver a comprehensive report and establish an ongoing process to update and revise the Workforce Requirements Information within the Skills Gap Analysis Report. Southwest Research Institute assisted in some focus group research and facilitation. Figure 2.2 provides a Project Organization Chart.

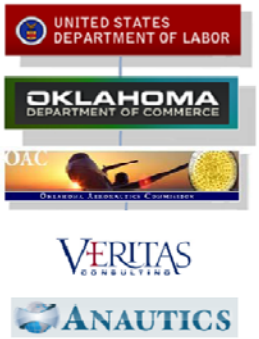


Figure 2.2 Aerospace Workforce Research Organization Chart

2.3 Methodology of Building the Aerospace Industry Database

In order to build and maintain the Skills Panels, databases hosted by the OAC and the Oklahoma Aerospace Alliance (OAA) consisting of Oklahoma aerospace companies were merged and updated. Initial research was conducted to identify the most current information on over 600 Oklahoma aerospace companies identified within the merged database.

2.4 Establishing and facilitating the Skills Panels

Anautics met with OAC and OAA to select approximately 150 potential companies who could provide valuable information in the areas of Maintenance, repair and overhaul (MRO), Manufacturing, Supply Chain Management, Emerging Technologies, and/or Engineering Modifications. Aerospace representatives from the government, military bases, education and training segments were also

selected. Invitations for Skills Panel participation were distributed to company representatives via emails, personal phone calls and a formal letter from OAC Director Victor Bird. By request, Regional panel participants were asked to be either human resource managers or an "operations/middle-managers" familiar with hiring processes, skill sets of entry-level employees, and skills requirements of job descriptions. Once company participants were identified and confirmed, skill panel meetings were scheduled. A total of three Skills Panels were established to discuss and analyze industry needs in training and skill development in the near, mid, and long-term and what the various institutions currently provide. Two of the three panels were regional: a Central Skills panel comprised primarily of the Enid and Oklahoma City MSAs, and an Eastern Skills Panel comprised primarily of the McAlester and Tulsa MSAs. The Central Skills panel was provided support by four Work Investment Boards (WIBs) as a valid means to assess the aerospace industry needs on an ongoing basis. Likewise, the Eastern Skills panel was provided support by four WIBs. The Central Skills panel met in Midwest City at the Tinker Business Industrial Park and the Eastern Skills panel meetings were held in Tulsa at the Tulsa Technology Training Center. Two joint meetings were held: one at the Aerospace Summit in June 2010 and one in January 2011 in Bristow, OK.

The third panel was statewide and was denoted as a Future Skills Panel. Participants in this panel were those individuals in executive level positions involved in strategic/long-term planning. Preference was given to executives who were not involved in the Regional Skills Panels. The Future Skills Panel took a long-term, more strategic view of aerospace industry skills focusing on requirements and future opportunities in aerospace. It also documented aerospace workforce issues and concerns, and from an administrative perspective, recommended strategies to address the identified issues and concerns.

There were 14 skills panel meetings: six for the Central Region, six for the Eastern Region, and two for the Future Skills Panel, and two joint Regional Skills Panel meetings. The selected skills panel topics are described in Figure 2.3.2. A data validation joint skills panel was held in January 2011 in order for the Regional Skills Panel participants to read and discuss drafts of all sections that contain their comments. The groups validated their discussions and anxiously anticipated the published report.

Figure 2.3.2 Skills Gap Analysis Report Structure

Skills panel agendas and facilitator guides and distributed utilizing email and the Oklahoma Aerospace Workforce Resource Center website. Company representatives were called and/or emailed a few days prior to the skills panel meetings to confirm their participation. Very focused questions were developed

from the Skills Program Statement of Work for the Grant. These questions were revised and refined by project team members from Veritas and Anautics. Southwest Research Institute also provided support in this area in the initial stages of the project.

Roundtable interviews using focused questions were also conducted with Government Service (GS) Supervisors who are experienced in working with entry year personnel at our military installations.

Within this report the following terminologies are used to denote each of these groups:
Regional Skills Panel (RSP) participants in this document are denoted as **RSP participants**. For specificity, occasionally groups may be described as **Industry RSP participants** or **Education RSP Participants**. These would denote the subset of Industry participants or the subset of Education participants, respectively, within the whole RSP. **Future Skills Panel** participants are denoted as **Industry Leaders. Government Service Supervisors** are designated as such. The **Government Service Supervisors** worked in maintenance support, engineering and technicians, and software maintenance support. All participants are listed on Page vi and Page vii of this document.

2.5 METHODS OF COLLECTING DATA

Several methods were used for collecting data throughout the study. Primary research was collected and analyzed from responses gleaned from:

- Regional Skills Panels Focus Group Questions
- Future Skills Panel Personal Interviews
- Future Skills Panel Focus Group Questions
- Online Supplemental Surveys for Panel Participants
- Online Questionnaires for non-Panel Aerospace Companies
- Focus Questions for Government Service Supervisors of Engineers and Touch Labor
- Other personal interviews

Secondary research was gathered from a summary of relevant existing research and literature. Current skills, knowledge, and abilities of the aerospace workforce were also identified throughout the study.

This study is intended to represent voices of the Oklahoma aerospace industry.

It is also intended to help increase worker productivity, increase the number of entry-level workers who eventually will need minimal on-the-job training, provide access to adequate numbers of qualified workers, increase the number of workers who have the necessary basic skills, increase worker morale, and increase workers loyalty to their employers. This study should provide a decision-making instrument for the stakeholders in the Oklahoma Aerospace Industry.

SECTION 3: AEROSPACE WORKFORCE NEEDS ASSESSMENT

3.1 INTRODUCTION

The aerospace workforce encompasses all aspects of the government and commercial industries which include manufacturing, MRO, parts suppliers, research and education providers. To facilitate the large number of aerospace activities performed across Oklahoma, the industry strives to continue to build a credentialed workforce with specific licensures and certifications. The aerospace workforce needs assessment involves an industry-lead systematic examination of recruitment, employment, and retention within the aerospace workforce with emphasis on its present and future state. Direct observations, questionnaires, key aerospace industry leader interviews, relevant literature reviews, and focus group data were collected and analyzed by researchers. Current skills, knowledge, and abilities of the aerospace workforce were identified throughout the study. The data collected and analyzed in this portion of the Skills Gap Analysis will reveal problems within areas central to aerospace development and provide implications for the future of the aerospace industry. In the segments to follow, we will introduce the research objectives, provide a relevant literature review, present research findings and conclude with a summary of implication for the future of the Oklahoma aerospace industry workforce.

3.2 SUMMARY OF RESEARCH OBJECTIVES

In order to assess the present aerospace workforce needs and project what they may be in the future, it was important to understand the challenges surrounding how businesses are currently recruiting, employing, and retaining their workforce. Investigations into what type of applicants are applying for the aerospace positions were conducted. Other questions that helped guide the needs assessment were: Are businesses finding well-qualified, work-ready applicants? If not, what type of training is necessary and what length of time is required before the employee is considered a "qualified worker." Applicant workforce skills, employer recruiting practices, and employer expectations of potential employees led to many lively discussions in the focus groups. Finding capable applicants is critical to the aerospace business functions. The amount of in-house training or on-the-job training that must be conducted can be critical to effectively execute the mission of the industry, adhere to delivery deadlines without delays or additional costs and manage quality requirements within the allotted contract period. Also investigated were the forecasting processes companies employ to predict what their employment needs may be in the near term. The accuracy of these forecasts would help describe the types of education programs needed to ensure a smooth transition of trained workers to the workforce to better establish a growing, thriving industry.

The workforce needs assessment research section focused on four main objectives for the Focus Group discussions of assembled Regional Skills Panels. The following objectives guided the questions.

- To provide an overview of the project and project goals;
- To provide an overview of the research in the aerospace industry needs regarding recruiting, hiring, training, and forecasting;
- To gather information from HR/Managers who are currently dealing with these issues in the aerospace workforce; and
- To allow each group to share their findings.

With detailed focus questions, deliberate attention was applied to primary workforce needs within specific subsectors of the aerospace industry; namely touch labor, information management, program and business management, engineering and others. The panels discussed many types of skills and qualifications required in the workforce but may not be widely held by applicants. Investigations into interview processes and types of exams either given to potential hires or used by the interviewing companies were also conducted. Panel members also discussed difficulties they encountered when seeking specific technical skills or certifications at certain educational levels. Other areas discussed were soft skills, education provider support for industry needs, basic skills requirement for entry-level jobs, and work readiness. Recruiting and retention practices and challenges were also discussed.

3.3 Literature Review

In our research, "education reform" and "complete overhaul" are two phrases RSP participants used when describing necessary changes to both the U.S. and Oklahoma K-12 education system. In particular, Oklahoma still faces a shortage of content certified middle school and high school teachers. This directly affects what courses school districts can offer and forces some schools to try to initiate programs to use videoconferencing or enter educational agreements with neighboring districts, technical colleges or universities, but direct student-teacher contact and hands on experience cannot be underestimated.[25]

In a 2006 Oklahoma's Workforce Employer Survey[21] conducted by the Oklahoma Department of Commerce, 2804 employers within the State of Oklahoma responded to several questions concerning workforce education, basic skills and soft skills, hiring issues, and employment forecasting. According to this report, the percentage of workforce between the ages of 18-65 will need to rise from 73% in 2010 to 91% by 2030 to replenish a projected retiring workforce for the same period. This makes it critical that our education providers and our training facilities adequately prepare for job growth and economic success.

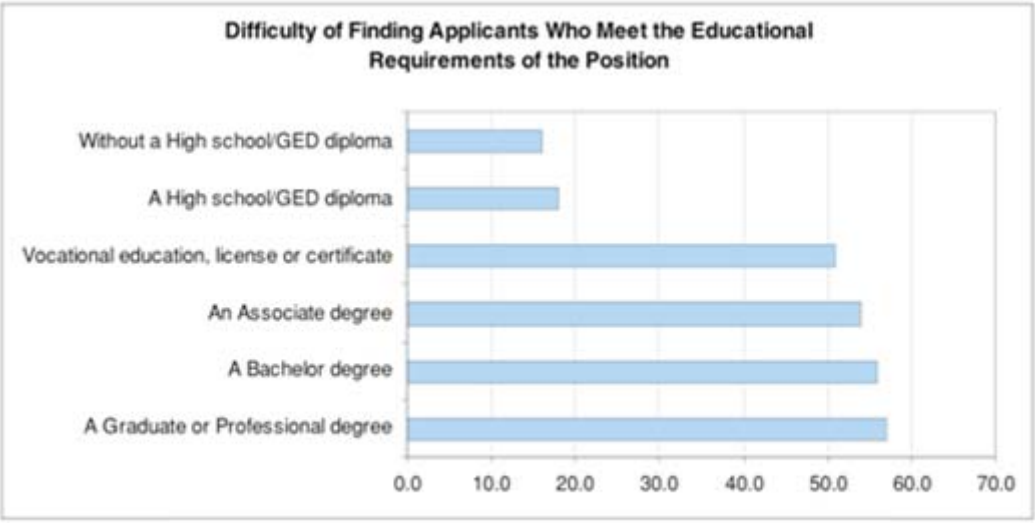


Figure 3.2 - Oklahoma's Workforce Employer Survey - 2006

Employers in this survey indicated that they have difficulty finding employees with basic skills as well. Over 50% of the participants responded that they have difficulty finding employees with adequate

communication skills, job-specific skills, and problem-solving skills. Moreover, 40% - 60% of participants reported that they found it difficult to find employees with soft skills such as the ability to adapt to change, staying on task, timeliness, good work habits/ethic, and not letting personal business interfere with work.[21] Participants also reported difficulty in hiring employees whose technical job skills adequately fit the skills requirements. When faced with the dilemma of inadequate applicant skills many of the participants did not fill the positions, increased the wages in order to attract more skilled applicants, or increased overtime for employees. Almost 30% of the participants who responded to the survey indicated that they also hired a less qualified applicant for the position advertised. Almost 60% of the participants noted that they found it difficult to find an applicant who had a vocational education, associate, bachelor or graduate degree citation. In addition, 10%-20% of RSP participants admit that it was even difficult finding someone with a GED or high school diploma. Out of 24 managers, 17 indicated they were presently experiencing staff shortages in their touch labor positions and 16 indicated a current shortage of engineers.

Employers in this survey indicated that they have difficulty finding employees with basic skills as well as shown in Figure 3.3. Over 50% of the employers responded that they have difficulty finding employees with adequate communication skills, job-specific skills, and problem-solving skills.

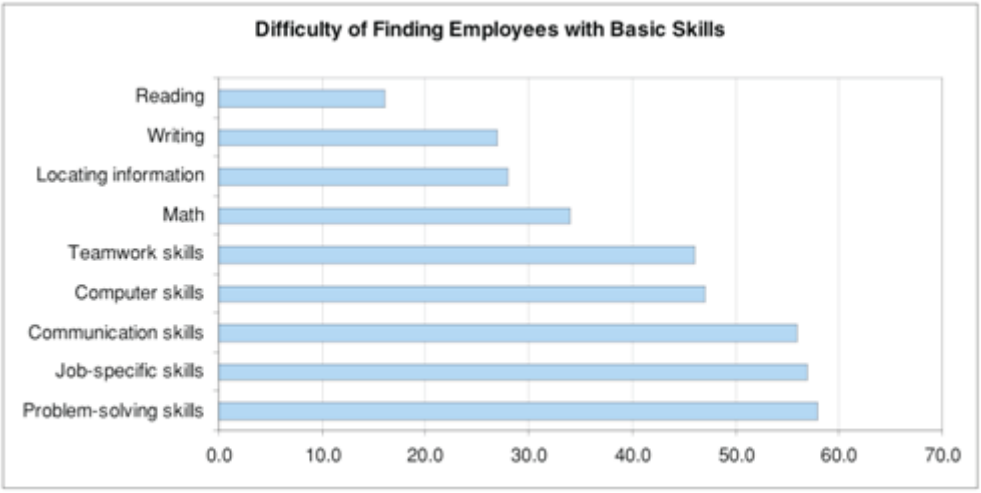


Figure 3.3 - Difficulty of Finding Employees with Basic Skills

Moreover, 40% - 60% of employers reported that they found it difficult to find employees with soft skills such as the ability to adapt to change, staying on task, timeliness, good work habits/ethic, and not letting personal business interfere with work.[21]

The term K-12 (Kindergarten to Twelfth grade) is gradually being phased out as it relates to aerospace awareness. Officials are now targeting Pre-Kindergarten (PK or P) students and preparing them through college years. P-20 denotes this range of education years. Research has shown that today's youth have begun to gradually avoid STEM fields to the detriment of the nation's security. The US scores considerably lower in the STEM fields in comparison to other nations. The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year-olds' performance in reading literacy, mathematics literacy, and science literacy every three years. PISA is

sponsored by the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of 30 member countries, consisting of 30 OECD jurisdictions and 27 non-OECD jurisdictions. The available pools of STEM students are rapidly diminishing and from the latest available PISA scores, it appears that the students who do chose to pursue a career in a STEM field will be less competitive than their foreign counterparts.[22] In science literacy, U.S. students scored lower than 16 of the other 29 OECD jurisdictions. In math literacy, 23 OECD jurisdictions scored higher on average than U.S. students.[23]

The amount of available talent is limited due to graduation rates as stated earlier in this report. Available talent is further limited due to other industries that compete for the same talent. Two of those competing industries are information technology and financial institutions. Research indicates there are a number of reasons would-be aerospace professionals select a career other than aerospace. One such reason is the perceived instability of the industry due to the large cutbacks experienced by the aerospace and defense industry in the early 1990's. This perception of the aerospace industry directly affects defense spending and national security. The deficiency of a skilled and innovative talent pool within the US threatens national security and the United States' abilities to remain a global leader. More and more of our scientific content areas are dominated by foreign nationals in our Institutions of Higher Education.[24] Graduates are choosing alternative career fields.

Over 50% of the engineering doctoral degrees produced in the U.S. are awarded to foreign nationals who in turn are not eligible for U.S. security clearances.[24] The number of graduate students with temporary visas in engineering fields almost tripled from 1980 to 2007, increasing from 568 to 1366.[110] Postdoctoral appointees in engineering in degree-granting institutions are also dominated by foreign nationals. In 2007, there were 1592 postdoctoral appointees in engineering who were US citizens and permanent residents as compared to 3345 temporary visa holders in the same field.[110] Additionally, of those students who are eligible and attempt to obtain a security clearance, a number of them have jeopardized their likelihood of being cleared as a result of negative behaviors and events engaged in during their youth such as arrest, drug usage, drug abuse or content presented on social networking websites. A number of individuals exploit themselves by displaying content on social networking sites that weigh heavily against their chances of obtaining employment in national security-related occupations.[27]

Low achievement in science and mathematics influences the Science, Technology, Engineering, and Mathematics Programs in the secondary school curriculum. The lack of young people preparing for the science and engineering fields through the STEM programs, the lack of engineers who are US citizens in our workforce talent pool, and the inevitability of a retiring workforce causes a great deal of concern as to the future of the aerospace industry in the United States and more importantly in Oklahoma. More than 50% of the aerospace workforce are 45 years and older which makes it vital to recruit young professionals.[105] In 2008 alone, 27% of the engineering workforce became eligible for retirement. Many aerospace companies report that within 10 years almost half of their workforce will be eligible for retirement.

Despite forecasts of an increased need for skilled professionals, an Aviation Week 2010 Workforce Study indicated that approximately 19% of the entire aerospace workforce is currently qualified for retirement.[105] Even more critical to the retiring workforce dilemma, studies also indicate that the aerospace industry is losing its young professionals as well. Additionally, the attrition rate among those in aerospace with experience between zero and five years rose to 21.85% for 2009. This was a 6.15% increase from the previous year.[3] This compares to a 5% attrition rate in other age categories. Millennials, in the broadest sense, are denoted as those born between 1977 and 1995. They are often denoted as Generation Y, Echo Boomers or Trophy Kids because of their unique and wide range of characteristics. They are born, raised and developed in a world where information and technology is pervasive and at their fingertips. They are characterized as ambitious, self-absorbed, demanding job and career hoppers whose work must often take a back seat to their life pursuits.[113, 114] "Work, for this young cohort of professionals, need to fit within their lives, and they are not willing to shape their lives around the demands of work. They want a quality of life that includes family, friends, and community, and the most common request these employees make of their employers is for an increased recognition of their life outside of work – of the obligations, responsibilities and demands that they face beyond the office."[112] This is characterized as placing a higher value on instant self-fulfillment. However characterized, studies including this one, suggest that if not studied, managed and leveraged as a filter to enhance business practices, these multi-generational differences will only frustrate both older and younger professionals and lead to undesirable outcomes. "Understanding the needs of Generation Y professionals will be crucial to the success of any organization wishing to avoid the costs of rapid employee turnover, and interested in attracting and retaining a workforce that will be dedicated and productive."[112]

Aerospace workforce requirements in education and technical training, expectations of the employer, and the realities of the workplace environment must be shared among applicants, education providers, and RSP participants in order to narrow the gap between skills needed and skills supplied to the workforce industry. This is where the communications began in this study. The first focus group topics of recruiting, training, hiring, and job forecasting were directly related to the education preparation and retention of our workforce. Unfortunately, the present numbers of qualified aerospace professionals are being produced at a rate that will not sustain the industry.

In Section 3.4, our findings depict the outcomes of the discussions of the Regional Skills Panels with regard to these issues. Many of the findings parallel the research. However, several gems were also revealed that are specific to this research and will help quantify the gap that exists between the skills of the worker that are required by the industry and the skills of the worker that exist upon entry level employment specific to Oklahoma.

3.4 FINDINGS

In this section, the following terminologies are used to denote each of these groups: RSP participants as listed on pages vi and vii of this document are denoted as **RSP participants**. For specificity, occasionally groups may be described as Industry RSP participants or Education RSP Participants. These would denote the subset of Industry participants or the subset of Education participants, respectively. **Future Skills Panel participants** as those listed on page vii of this document are denoted as Industry Leaders. Supervisors of government employees are designated as **Government Service Supervisors**.

The findings published in this section discuss the processes and challenges the aerospace industry in Oklahoma faces with regard to recruiting, hiring, training, and job forecasting as voiced by participants of the Regional Skills Panels and the Future Skills Panel. Our focus group participants were presented with in-depth research spotlighting workforce issues, concerns as expressed by RSP participants in general, and the aerospace industry in particular. Activities included brainstorming primary needs in various workforce requirement areas, methods of recruiting, processes of hiring and training, and accuracy in forecasting workforce needs. Our discussions included skills required in touch labor, information managers, program and business managers, engineers, and other program support areas.

3.4.1 RECRUITING

WORKFORCE READINESS

The study found that RSP participants had difficulty finding applicants who met the educational requirements of the advertised position as shown in Figure 3.2. Over 50% of the RSP participants responded that they have difficulty finding applicants who meet their educational requirements for positions where skills require licensure, certification, or a degree equal to or higher than an Associate's degree.

Although the aerospace industry as a whole needs more skilled workers with industry-specific certifications and/or STEM degrees, Oklahoma RSP participants expressed that many of those they hire look better on paper than they actually perform on the job. When asked to compare the applicant skills they advertise for and the applicant skills they actually hire, some RSP participants indicated that entry-level employees might meet the minimum education and skill requirements, but many times, they have no relevant experience. As a result, substantial training is required to adequately prepare them at substantial cost to the company in both lost man-hours and additional training cost. Typically, more training must now be provided for less qualified applicants. One of the most interesting data points in this section is the correlation between the percent of applicants who are qualified for entry-level aerospace jobs and the American College Test (ACT) Profile Report for Oklahoma. Aerospace industry RSP participants indicated that between 40%-67% of applicants are technically qualified for aerospace jobs. According to the 2009 Oklahoma Act Profile Report, 67% of our Oklahoma 2009 graduates are ready for college work in English, 42% are ready for college work in College Algebra, 53% are ready for college work in Social Studies, and 28% are ready for college work in Biology.[83]

Additionally, once hired, some workers met the necessary certification or education requirement, but their learned skill sets were either not specific to aerospace or not in depth enough to perform the tasks unsupervised. For example, some RSP participants expressed the frustration they face when an applicant may have experience as a Sheet Metal Technician but they have not worked on curved sheet metal surfaces. For the aerospace employer, time and money must be expended for specific training even though the applicant, in this case, may already be trained in sheet metal work. Although some applicants have the required education, many do not have the hands-on experience in the aerospace industry necessary for them to be effective in the work place. Many of the young engineers who have degrees are not proficient enough in specific areas to be productive immediately. Many RSP participants expressed that engineers may have all the right answers in the interview, but they lack skills in teamwork and communication. One employer expressed better success with engineers who had training in Toastmasters because of the communication skills taught by this organization. The Government Service Supervisors also expressed the need for good communication skills. One supervisor stated, "In the cost analysis subset, you can run regressions in your sleep or on your fingers, but you must be able to articulate that or explain it to a lay person or decision maker, what good does it do to be able to do all the whiz bang rocket science stuff…if you cannot communicate it in a meaningful way." In general, many people believe that engineers do not possess the people skills needed to communicate effectively with the lay persons. . Another stated, "It amazes me that we have people with sometimes quite advanced degrees that cannot write a grammatical sentence to save their lives. And so I would say that's a failure across the board. Technical skills are great, but I don't know of anybody, or very few that are so technical that they don't require something in the way they communicate."

RSP participants reported that too many applicants are not workforce ready. RSP participants reported that although decent grades are indicative of being able to learn, grades alone shed little light on what their personal job behavior is in various situations. One manager described teamwork qualities as wanting to know "how they play in the sandbox." Another manager of a large corporation noted he looked at the transcript to see how the applicant treated the basic classes, over the whole course of enrollment, not just the interesting ones. As a whole, RSP participants stated they needed employees who could multi-task, obtain security clearance, complete a high school education (for touch labor) or a four-year degree for salary job, acquire the required certificate and/or license where applicable, and/or possess relevant experience. These were also requirements of the Government Service Supervisors' employees. Many RSP participants discussed strange situations that arise during job interviews. Several RSP participants discussed the problems they have with applicants who cannot pass required drug testing. Some RSP participants are beginning to use WorkKeys®, PassPort™, or other established standardized tests because diplomas and degrees are no longer reliable measures of work readiness.

When asked what positions they advertise the most, our industry RSP participants reported Sheet Metal Mechanics and Electronics/Electrical Technicians. Aerospace industry leaders suggested 70% of the employment needs are directed toward positions requiring specialty skills, while some form of systems engineering experience was about 30%. RSP participants reported a need for applicants to be motivated, self-directed and mechanically inclined. Participants who faced difficulty in finding qualified applicants

reported that they sometimes resorted to using an outside contracting agency to fill the position, hired contract labor, hired less qualified people or were forced to stop taking on more work. Some did not fill the position which meant current employees took on more work or more overtime. RSP participants noted that between 40%-67% of applicants are qualified for positions that are advertised. However, because of the current economic downturn, our RSP participants expressed a positive sense that applicants are now "hungry for work," and that the most current applicants appear to be overqualified for some positions because they cannot find work in their specialty areas. These applicants tend to be more committed to performing the tasks assigned. Our Skills Panels discussed the fact that the economy has created more of an alert applicant pool where workers, in general, are more sensitive to the requirements of their job. This appears to be true especially for the older worker. Government Service Supervisors also commented on the attitude of new hires as well. "Government has schedulized and regionalized a lot of the lower skill level, entry level positions and so here at Tinker, those jobs I came up the ranks in, when I started was GS-3. They don't exist. I started out as a clerk/typist, was a trial technician, accounts maintenance clerk, I was chief of civilian pay for many years, I was a management program assistant, and those jobs that started at a GS-3 they don't exist anymore and so we are hiring people, instead of having day to day opportunities to cut their teeth and learn their way through the world, we're substituting their education for that, which is ok to a point but at some point in the and we do promote people too fast. ….We have people sitting at 12's that haven't built the groundwork. As a GS-3 you're picking up the way the Air Force (AF) does business, acronyms, how to work with each other, take directives, who to call a sir, you are building your foundation and now you're straight out of college you're probably going to be a 7, an engineer two years out of college you're a 12 and expected to know everything. Foundation building is painful but educational."

When asked what they expected from job applicants, RSP participants reported that they expect some form of training and the ability to have respect for company and positions, good attitude, well-groomed, shows up, willingness to work, and a good worth ethic. Some RSP participants even had specific expectations during the interview process that involved evaluating listening skills and the ability to follow directions. RSP participants asked for specific items to be brought to the interview and then paid special attention to see if the applicant satisfied the request. Other RSP participants reported that just answering questions in the interview was not very impressionable; however, when applicants posed questions back to the interviewer, this was favorable as it indicated creative thinking. Possessing interpersonal skills, being prompt and respectable were other expectations. Surprisingly, several of the groups reported utilizing social media such as FaceBook to investigate applicants as part of the interview process and prior to the first face-to-face meeting.

During personal interviews, Industry Leaders also voiced concerns about the quality of the current aerospace workforce. Several expressed the need for expert science, engineering, and technology skills. Many of them stated concerns with the low numbers of American engineers our universities are

graduating. In their view, engineers in today's workforce need to be "multi-interdisciplinary" meaning that they should be familiar with more than one area in engineering, and they understand basic business principles such as accounting, management and finance. One executive stated that the aerospace industry needs to communicate better with the universities to specify exactly what skills are needed in the industry from our entry-level engineers. Another stated that the industry leaders need to "reach out to fix education, galvanize kids into the sciences" and make a concerted effort to recruit young people into the engineering field. In order to offer a competitive edge in the marketplace, companies must develop a skilled and flexible workforce that is capable of innovative thinking and able to think using a global view. Low numbers in engineering were also a concern of our Government Service Supervisors. There is a shortage of software engineers, that is, engineers who can also write computer programs. These engineers actually write the programming to control aircraft, and there is a very critical need for this specialty in computer engineering. They also expressed a critical need for metallurgical engineers.

The Oklahoma aerospace industry is in need of enhanced programs and practices specifically designed for their workforce in order to produce a more fluid pipeline of skilled workers that are certified as "workforce ready." The aerospace industry must examine how to train all levels of the aerospace workforce for emerging fields such as material composites and unmanned systems. Our workforce preparation will determine how much work stays in Oklahoma, as well as how much work we can import from national and international customers.

3.4.2 Recruitment and Retention

Recruitment and Retention In-State/Out of State

Retention of the workforce is also a major concern. Some reports indicate that the cost to train a new employee for a vacated position is as much as 1.5 times the salary of the employee replaced. This can be very expensive and causes time lost on productivity. Retention for some Oklahoma companies becomes an issue because many companies are located in rural areas and younger employees complain of limited activities and resources outside of work. When asked about current recruiting processes, RSP participants reported using outside contract agencies, staffing agencies, education providers, career fairs and career services. One company reported paying as much as $8000 to a staffing agency for each new employee retained. Some government RSP participants indicated their recruiting process consisted of the USAJobs.gov website, ex-military personnel or laid-off personnel such as individuals from NASA. Some companies reported having existing internship programs to recruit and hire students upon college graduation, while others attempted to recruit in areas hit with a number of layoffs like Wichita, KS and Tulsa, OK.

When attempting to recruit workers from out of state, companies in Oklahoma must battle the negative perceptions people have of this state. In this study, some RSP participants report that individuals actively avoid Oklahoma because many claim to have little knowledge of Oklahoma including its geographical location within the United States. As a result, applicant pools consist primarily of Oklahomans. To address the hiring issue, some companies resort to temporary staffing agencies to "try before you buy." This enables them to hire an employee on a temporary basis for a pre-defined period to determine if he or she is a good fit for the company and vice versa. Some RSP participants report they

hired employees from surrounding states like Texas, but they will not stay because of the inability or unwillingness to adjust to a job located in a rural environment.

Some of the Industry Leaders also expressed a perceived shortage of skilled workers because of the "image" of Oklahoma. Several expressed concerns that it is difficult to get young people to move to Oklahoma or to stay in Oklahoma when they are ready to go to work. Tax differentiations among regional states were given as one reason young people are lured out of state for work. One executive stated "there is not enough talent here (in Oklahoma) to expand my business." Another executive who transferred here from another state said, "Oklahoma is such an interesting place and I love it. Oklahoma offers a better lifestyle here than most other places I've been. It has affordability and good family values." Awareness of aerospace opportunities in the state and awareness of what our state has to offer young people and their families are both critical to building and retaining the aerospace workforce.

Workforce retention for the commercial aerospace companies is not only affected by poor perceptions of Oklahoma, but also by government hiring surges caused by government in-sourcing. Commercial companies reported that they found it difficult to keep employees because of the high wage and benefits offered by government facilities. One company in the survey reported a recent loss of over 80 touch labor employees to government positions within a four-month period. These same companies admit that government RSP participants offered security, salaries and benefits they simply were not equipped to counter. Within the employment area of our Central Skills Panel companies, two significant government facilities exist: Tinker AFB and the Federal Aviation Administration (FAA). The need for better recruitment and retention methods is especially vital due to the large number of workers approaching retirement eligibility. Such methods could be enhanced when tax incentives are available for the aerospace industry workforce. Better coordination and communication between commercial and government shared training opportunities would also help commercial companies replace their drained workforce. While the commercial companies attempt to fill their vacated positions, the Government Service Supervisors also expressed concern at filling positions because they cannot compete with the salaries provided by the Energy Industry. According to our interviews, the Government Service positions are as much as $17,000 per year below salary averages for engineers hired by the Energy Industry including companies such as OG&E.

3.4.3 Hiring

Basic Skills and Soft Skills

In this study, basic skills refer to the basic high school skills in language, communications, mathematics and science. Soft skills refer to a cluster of personal qualities, habits, attitudes and social graces such as but not limited to work ethic, attitude, communication skills, time management skills, self-confidence,

the ability to learn from mistakes, flexibility and adaptability. RSP participants were asked to analyze both basic skills and soft skills of the entry-level employees they have hired. These discussions about work-ready, entry-level employees were passionate and filled with concern.

RSP participants were asked about the difficulty they have in finding employees with adequate basic skills. Many RSP participants expressed concerns about entry-level employees' abilities to accurately read a ruler, work with fractions and proportions, read basic blueprints, sufficiently comprehend technical content specific to manuals, and adequately apply mathematics concepts to everyday problem solving situations. Discussions continued about the importance of precision measurement. The summation was articulated that when you are measuring a room, precision is not that important, but when you are working with intricate machinery, precision and accuracy are critical, and mistakes can be dangerous and costly. Additionally, in many situations, entry-level employees are not familiar with basic shop and hand tools, nor are they familiar with safety skills when operating basic shop tools.

During the conversations on soft skills, many passionate discussions ensued and this was a common thread and reoccurring topic throughout many of the skills panel meetings. RSP participants discussed frustrations with employees who do not report to work on time, who do not report to work every day, who do not take pride in their work, and who do not come to work in the proper dress even when the company has established a dress code. The dress code issue was a strong discussion specific to the way women are now dressing in the workplace.

Likewise, issues and concerns generated by generational gaps in the workplace were discussed at almost every skills panel meeting. RSP participants reported that older workers have a strong work ethic and were more apt to take pride in their job but admittedly were less flexible. In contrast, RSP participants perceived that younger workers had a strong sense of entitlement, needed recognition, possessed little desire to multi-task on items they did not believe was their responsibility or a part of their job description. If requested, multi-tasking is actually done, but then some recognition or reward is then expected. Participants felt that younger workers possessed a self-centered attitude yet were more adaptable, flexible and technology literate than their older counterparts. Younger generation workers were also perceived as being less loyal to the company. They seem to move from one job to another based on improved compensation, job location and flex hours.

The young professionals in this study wanted industry leaders to recognize two of the primary concerns of this younger generation: employees leave immediate supervisors and/or programs…not companies, and mentoring relationships should exist for company processes as well as for technical expertise. The willingness and sometimes overwhelming need of the younger generation to be heard highlights an important aspect of this skills gap analysis. Whether the primary issue is education, job skills, employment, or recruiting, there is an underlying issue that seems to thread itself throughout the entire tapestry of problems experienced within the aerospace industry. This underlying issue is multi-generational differences. It penetrates the walls of entire industries in all global nations. Individuals born in certain time spans have historically held different views and expectations from those generations

born before or after them, leaving the new and old generations with the sometimes unenviable challenge of adjusting to one another. To remain competitive and operate at a high level of efficiency these adjustments are often necessary in various areas within the government, commercial and academia arenas. As the imminent retirement of millions of Baby Boomers approaches and the growing nature of innovative businesses increase around the world, millions of millennials are flooding the workplace with technical savvy and a mindset that is very much different from those of previous generations.

When discussing the younger generation of workers, one of the Government Service Supervisors commented, "What I'm seeing [in young employees] is…what's in it for me now versus the long term investment. So, it's all about what's for today, or what can I get today. They are not willing to wait for a promotion." Additionally, another commented that it is not unusual for an employee of the younger generation to view their accumulated sick leave as days off during the year rather than trying to build a leave account to use in the case of an emergency. Another Supervisor stated " it would be beneficial to the schools, not just career services but the professors from different disciplines from different areas to say hey guys that entitlement your whole generation is real big on is not going to go over real well in the professional world. You come in as an entry level, whatever entry level is defined as, you need to show respect for it and understand it takes time to build the skills you need."

The Industry Leaders also expressed concern over the differences in the Millennial generation and the Baby Boomer generation. Several of these executives were confident that the Millennial generation will figure out how to work with other generations, how to solve problems in the workplace. One executive commented that this millennial generation solves problems differently than most workers, they are very comfortable with technology, and they will figure out the issues in the workplace. It just may be different than the older generation is expecting.

BASIC SKILLS	SOFT SKILLS
Math	Participate in a professional interview
Use of a ruler	Adapt to change
Use of fractions and proportions	Report to work the first day
Mathematics application	Keeping personal business private
Problem solving skills	Appropriate dress (especially women)
Critical thinking	Shows respect to others
Reading comprehension	Interpersonal Skills
Communication skills	Reliable
Read blue prints	Report to work on time
Ability to understand instructions	Staying on task
Ability to understand technical manuals	Strong work ethic
Computer skills	Willingness to work
Basic aerospace knowledge	Time management
Team work	Pass a required drug test

Table 3.1- Basic Skills and Soft Skills

Table 3.1 gives a summary of the areas RSP participants listed as inadequate preparation areas for many of their entry-level employees. While most of the conversation on basic skills and soft skills were focused on the touch labor type entry-level employee in the Regional Skills Panels, discussions also centered on the professional attributes of entry-level employee. One manager indicated that some applicants hired for

engineering positions knew how to answer the behavioral questions which indicates they were team players. However, once they were actually on the job, RSP participants found that the engineers did not really like to interact with people. RSP participants described these types of engineers as "turn the crank engineers." There currently exists the need for new hires and existing employees to possess the basic skills and soft skills necessary to effectively function in a professional working environment.

Our Government Service Supervisors also discussed mentoring programs that now exist to assist entry level employees with what they need to be doing and what career development they need to have. There are also informal mentoring activities in progress.

The Industry Leaders also discussed work ethics and basic skills when asked, "Is there a particular workforce concern or issue specific to Oklahoma?" A major concern discussed by one of the Industry Leaders was the inability of many of the applicants, including engineers, to pass mandatory drug testing. From the discussions there appears to be some problems with young people taking prescription drugs like pain killers, sleep aids, etc. This issue surfaced several times in the discussions of applicant interviews, and the problem was not specific to touch labor applicants. The thread ran through many of the professional positions as well. As shown in the literature review, this is an issue that is not specific to the Oklahoma workforce.

One of the interesting inputs from the Government Service Supervisors was a discussion where the perception was that new young employees disconnect themselves from the industry workforce. One described the following scenario in the discussions of soft skills. "Another thing, a lot of the new hires out of college would walk around the halls with their earbuds and as someone who has been in the organization for a long time, if I see a new face I like to say 'hi, welcome aboard, if you have any questions….' These individuals with their headphones on, I didn't feel comfortable engaging and so for their future networking, establishing interpersonal relationships, or this person has this expertise I need to tell him about this other guy who has a problem and hook them up. But, from the get-go, it seemed these new hires were disengaged." Another responded, "It is a barrier because it slows their growth. People don't want to approach them."

Security Clearance

Many aerospace and defense jobs require their employees to obtain security clearances in order to perform certain tasks on classified materials. Often times, despite an applicant's ability to meet the education and experience requirement, poor choices in their past prevent them from obtaining the required security clearance. This has been impaired even further with the poor economy and the mounting credit debit, which affects credit ratings. Credit issues and personal finance problems among entry-level employees, in particular, pose problems with the potential need of employees obtaining security clearances. Additionally, non-citizens who graduate from our certification programs, colleges and universities are ineligible for security clearances since they are not citizens of the United States. As a result, the pool of eligible professionals is further limited. This presented major concerns for some of our RSP participants because of the sensitive work that needs to be conducted in the aerospace industry, especially on the military bases.

3.4.4 Training

Aerospace Workforce Training

As stated by one of the Industry Leaders, "As the aerospace industry evolves and more competitors enter the scene, companies must develop a skilled and flexible workforce, capable of innovative thinking to offer a competitive edge in the market." To describe a skilled and flexible workforce, four primary groups or types of trainable skills were identified in this study: basic, technical, soft, and other where other includes specialized skills needed to perform some occupation. RSP Participants were asked what length of time and what type of training their entry-level employees must have before they are ready to work without a supervisor. It is understandable and acceptable that a certain amount of training must be provided to the new hires to thoroughly equip them for their work duties. For touch labor jobs, most RSP Participants indicated that new employees needed one to three months of training in basic skills and technical skills. Only few indicated that they provided training for soft skills but many expressed the need for this. It appears that training dollars are generally spent on basic skills, technical skills and specialized training. Because of this expense, very little is spent to provide training for soft skills, at least in touch labor job categories. These workers must be able to read manuals and blueprints, solve basic math problems and be mechanically inclined. The required training ranged from $1000 to $5000 per employee. Generally, many touch labor workers do not require specialized training because in order to be hired they must have the appropriate certification and/or general experience. In contrast, for Information Managers, most RSP Participants indicated at least one to six months of technical training, and soft skill training are needed. The average value for this training ranged from $3000 to $5000 per employee.

While most of the conversations on basic skills and soft skills were focused on the touch labor type entry-level employee, discussions also centered on the professional level entry-level employee. Our Government Service Supervisors discussed training and supervision of the entry-level engineer. In general, it takes about 2.5 to 3 years for an entry level engineer to mature to a "journeyman" level. Virtually all advances are performance-based and well-documented. An employee can remain in one position indefinitely, if advancements are not accomplished in skills necessary to complete the mission.
Training employees over an extended period can be extremely costly for any organization. RSP Participants were asked what could be done to decrease the time between when an employee is hired and the time he can accomplish the overall task hired to do. One solution suggested by participants was to develop a job profile with a career readiness certification that would allow employers to better place employees in positions where initial training would be minimal. Such job profile and career readiness certification could also be used to filter applicants who may not actually be qualified thus requiring an employer to expend excess funding on job training and preparation. As in the case with some aerospace manufacturing workers laid-off in Wichita, KS, some of those workers were able to find jobs in Oklahoma but, RSP Participants indicated that some of the skill sets required for manufacturing and assembly were different from those required for MRO processes. Thus, large amounts of training were still required which would result in increased cost. Having a better picture of a new hire's job profile would help to decrease and/or eliminate such cost.

Another solution provided was placing new hires in environments to shadow an existing employee having sufficient job knowledge and skills. One Industry Leader stated, "We need experienced technicians manning up with new hires." Providing mentoring training for the experienced employee and then incorporating the mentoring success into the annual evaluation were also actions that some companies are doing. Some noted this would provide new hires with real-time solutions to real-world scenarios that classroom training could not provide, denoted as On-the-Job-Training (OJT). Other RSP Participants suggested that knowledge of basic terms and concepts associated with Lean, AS 9100 and SAP would assist new hires in understanding and performing their job.

Clarity and Stability of Industry Needs

Representatives from many of Oklahoma's major education providers participated in this study. These representatives in particular expressed a need for companies to confirm what training and education they really need as it relates to a given job category, as well as to recommend a standard for teaching the various technologies for the position. Standards are valuable in education because they help to ensure the specific curricula, as needed directly from the aerospace industry customers. There is also a need by education providers to have better stability and clarity of the needs of industry. As an example, many times the curriculum needed today by RSP participants may take two years to actually come to fruition in the education realm because of the processes in place to establish new coursework. Unfortunately, two years from the time the need is expressed, the RSP participants may no longer need that curriculum or have found the training in some other capacity. Participants described the stability of the needs "like chasing a rabbit." This paints a vivid picture of the changes industry undertakes. One manager suggested, "I need 60 people this week, and next week I need 10 or 15. Such stability is probably not attainable."

Education providers indicated they also understood the need for flexibility in order to adapt to various changes that are sometimes required to aid in stabilizing the industry. This is extremely important, especially to the technology centers because they play a vital role in providing additional training for applicants that are hired. Discussions among the education providers and the industry leaders were very productive but also very pointed as to the needs of both entities. Education providers need standards and better direction as far as the desired training. They also expressed the need for industry to help provide the technical equipment needed to properly train their aerospace students. Industry leaders expressed the need for more focused training with more up-to-date equipment and curricula. They also expressed the need for students to work on more applicable maintenance, repair, and overhaul structures in order to be better prepared when they enter the aerospace workforce. This need was expressed by both touch labor experts and engineering experts.

Specialized Education and Up-to-Date Training

For skill sets such as Metallurgical, Optical engineers, and Computer Engineers (i.e. Electrical Engineers who can also write computer programs), Oklahoma schools do not provide degree or training

programs. As a result, personnel to fill these specialized positions are recruited from out of state or the work itself goes out of state. Up-to-date education curriculum would offer a competitive edge for our Oklahoma aerospace industries and keep work within our borders. Additionally, as technology advances, up-to-date training for older employees is needed to ensure business competitiveness. This was a concern of every group, Regional Skills Panel Participants, Future Skills Panel Executives, and Government Service Supervisors. These supervisors also expressed concern for certain areas such as Financial Management where there is "no specific degree for what we do. It is not just accounting, they need some higher math, they need some analytical skills and accounting is not necessarily terribly analytical." Additionally, one Government Service Supervisor stated, "One of our big problems in recruiting is metallurgical engineers. We have to go far, far away, and it is difficult [to hire] because we have to compete with salary because this is one of the extra high salaries within engineering, and they are getting huge job offers from industry. We're trying to find someone to take a much lower salary and come to Oklahoma which is not generally their home state. So, it's a hard sell, it's a constant struggle. We need to hire 15 to 20 metallurgical engineers a year" and yet our universities are not supplying our need.

Industry Leaders determined that the aerospace companies need to work more closely with education providers to ensure that we have a capable workforce for the future. Industry Leaders also expressed the need to make the sciences more interesting to young people. Executives expressed the need to ensure that education programs are up-to-date and easily identified by the industries for use in training their entry-level employees. One executive stated that the Information Age has changed business so much that it is "difficult to keep the innovative juices going when using older methods of training."

3.5 Oklahoma Aerospace Workforce Needs Implications

The current needs of the industry are critical to the growth of the industry in Oklahoma and the state's economy. The needs expressed by our industry leaders and our education providers must be considered and addressed. The implications of the workforce needs assessment are summarized below.

- High school graduates who apply for jobs in the aerospace industry, in general, are not workforce ready. Many have not mastered basic mathematics and reading skills.
- Although some aerospace entry-level employees possess documentation for necessary aerospace certification or educational requirements, in reality many do not have depth of knowledge needed to perform an aerospace job unsupervised.
- Correlations exist between the percent of high school graduates who apply for entry-level aerospace jobs and the ACT Profile Report for Oklahoma.
- Higher academic expectations and more rigorous coursework in the STEM courses are needed for all students. Workforce ready and college ready should require the same curricula.
- Many applicants may pass the technical requirements for a position, but they cannot pass readiness exams such as drug tests.
- Many entry-level aerospace employees lack soft skills such as good work ethic, punctual attendance to work, reliability, time management, and appropriate dress.
- Some aerospace employees will not be able to qualify for a security clearance because of poor choices in the past.

- Recruiting and retaining the aerospace workforce presents challenges for the commercial industries because of the upsurge in Government in-sourcing.
- It is difficult to recruit potential aerospace employees to Oklahoma because of a lack of knowledge and appreciation for the state's qualities.
- Retention and recruitment are critical in order to prepare for a potential retiring workforce.
- It is critical to market Oklahoma better as a great place to live and raise a family.
- There is a distinct need to promote aerospace as an important economic industry in Oklahoma.
- Individual companies find it difficult to accurately predict number of employees and skills needed.
- Education systems are normally not agile enough to respond to training programs as quickly as employers need them.

It is important to note that the responsibility for gaps between what the skills of applicants are and what the industry needs were not placed totally on the education providers. The discussions centered on cultural issues and how the industry could get involved to help better prepare our youth for a career in aerospace in Oklahoma. However, it does indicate that workforce ready and college ready should be equivalent in academic preparation.

The aerospace industry is the third largest industry in Oklahoma. In order to supply the industries with a competent workforce to grow Oklahoma's economy, efforts must be made to address the skills gaps discussed in this research. This is a national security issue, and it is critical to the economic growth and development of the state of Oklahoma.

SECTION 4: AEROSPACE WORKFORCE CORE JOB SKILLS

4.1 INTRODUCTION

According to a 2010 Infogroup research report, three aerospace industries rank in the top 25 largest employers in Oklahoma. Tinker AFB ranks number one as the largest, American Airlines is 5th, and The Nordam Group is 23rd.[15] Additionally, according to the Bedford Report in 2010, the Pentagon expects that defense spending will increase by 1% through 2011. A plan outlined by Defense Secretary Robert Gates, increases spending directly on U.S. Forces by 2 to 3 percent over the next four years by reducing $100 billion in overhead expenses.[24] In order to build the foundation of the aerospace workforce in Oklahoma, the right core job skills must be provided for the industry. In this section, we will provide research objectives, research literature reviews, research findings, and implications associated with the core job skills for entry-level employees as discussed by our industry RSP participants and our Industry Leaders.

4.2 SUMMARY OF RESEARCH OBJECTIVES

The research objectives for this portion of the Skills Gap Analysis involved determining core job skills as they apply to the aerospace industry. The core job skills appear to be very broad and not very well-defined especially at the touch labor level. Identification of core job skills terminology, standards, and credentials that are accepted by the industry were also investigated. Of particular interest were areas where standards or credentials were not available or not generally recognized by the industry and how certifications could possibly enhance the workforce to provide better, faster and more economical services for the aerospace industry. Areas where certifications would help the industry the most were also discussed. See Appendix D for a sample list of Skill Levels, Standards, Certifications and Licensures.

HIGH IMPACT / LOW NUMBERS

In almost all industries, there are job skills that can be identified as “high impact/low numbers” positions. These positions are few in number of actual employees relative to the employment base but critical to operations of the company. To identify those positions in the aerospace industry and what the forecast predictions are for those high impact/low number positions will help inform the industry and the education providers about job skills that are critically needed and that may be scarce.

In today’s downturn of the economy, it is important to understand how aerospace industry skill sets may bridge across various industries such as energy, health care, logistics, business services and others. In order to provide employment transitions between industries during the cyclic economic activity during expansion and contraction, it is important to understand how curricula could be developed in order to prepare the workforce of today and tomorrow for a more versatile, flexible capability. In particular, in the event of business cycle expansions, it was important to identify what other industry skill sets would enable the aerospace companies to fill their workforce quickly and with the least amount of training. Conversely, when the aerospace industry is in a contraction, what other industry skills sets would enable our employees to transition to other job opportunities with the least amount of training. To understand and plan for these types of scenarios would enable our workforce to remain in Oklahoma and our industry to withstand the waves of economic fluctuation. Movements among the

industries by workforce with similar job skills are common during economic uncertainties. This research will provide answers as to how education providers can better prepare our workforce so that transitions are smooth and fairly uncomplicated, limiting the need of excessive training for new hires.

Core job skills, standards, high impact/low number job skills, and cross industry skill sets comprise the topics discussed by the Skills Panel participants in order to determine how the industry requirements for the workforce could be better generalized and utilized among the companies.

4.3 Literature Review

Today, entry-level jobs require higher levels of academic skills. Some of the entry-level skills required in the workforce are not only more rigorous but also different from the postsecondary requirements.[95] Additionally, based on an analysis conducted by the Governor's Council for Workforce and Economic Development, Oklahoma's Aerospace Industry Workforce: 2007 Report, it is estimated that the Oklahoma aerospace industry will face shortages of aerospace engineers, electrical engineers, and engineering specialists by the year 2014. Basic skills requirements may dramatically change within the industry making it difficult to find competent workers without providing a sufficient amount of in-house training.[25] This gap in what skills are needed and projected by the industry and what skills are readily available from recent graduates could prove critical to the economic development of the Oklahoma aerospace industry and other industries as well.

An industry standard is an established norm or requirement. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices. Generally, it is a basis for comparison and/or a reference point against which other knowledge, skills and abilities can be evaluated. Industry certifications refer to the confirmation of certain characteristics of an object, person, or organization to assure qualification to perform a job or task. This confirmation is often, but not always, provided by some form of external review, education, or assessment. An industry license is a legal document giving official permission to do a job or task; the right to perform a service. An example is the FAA Certified Airframe and Powerplant (A&P) license.

It appears from the research that many of the facilities conduct in-house training for those who have earned Bachelor's degrees. Therefore, our emphasis on standards, certifications and licensure is further focused on the touch labor workforce of the aerospace industry. Standards that appear in the research almost totally involve the work completed prior to high school graduation, namely the K-12 school years. The Aerospace Industries Association (AIA) recommends that the technical workforce standards should match or exceed the highest standards required in any international education system.[26] Likewise, the Governor's Council for Workforce and Economic Development (2007) report also recommends improved curriculum standards for the aerospace workforce.[21] Recommendation E: Enhance the pipeline and capabilities of Oklahoma's Workforce in the Strategic Plan for the Growth of Oklahoma's Aerospace Industry concurs with this as well.[29] Once a worker has entered the aerospace industry, there are other standards such as safety standards and material handling standards which are provided usually with in-house training by the industry.

With workforce certifications and licensures, it is possible to somewhat predict the output of internal operations and forecast the ability to meet industry requirements. Most companies work according to a quality management system and that helps aerospace industries improve safety, reliability and quality in manufacturing, MRO, and business management. While most of these are company certifications, certifications for the individual aerospace worker do exist particularly in the touch labor skills group.

The need for a credentialed workforce has been determined in many of the aerospace research efforts. While licensure is available in most states for engineers, the A & P licensure is the most popular in the touch labor skills category. Certifications and licensures which exist through the Community College of the Air Force (CCAF) are: Aviation Mechanic – Airframe, Aviation Mechanic – Airframe and Powerplant, Aviation Mechanic – Powerplant, Commercial Pilot, Flight Engineer, Parachute Rigger – Master, Parachute Rigger – Senior, Private Pilot – Airplane, and the General Radiotelephone Operator (GROL), Flight. The credential-issuing agency is the FAA.[30] These standards must be followed when maintenance and repair are conducted on military and commercial aircraft. There are also international standards that must be followed when maintenance and repair are conducted on foreign aircraft. While there are no inclusive directives regarding international certification, those companies such as Boeing and United Technologies (UTC) have issued guidelines to their suppliers regarding international certification requirements.[31]

In this analysis, this group of workforce skills is called "high impact/low numbers skills." The industry research is weak in providing which areas within the workforce have a high impact on production, manufacturing, or MRO operations and at the same time have a low percentage of the workforce in these positions. This will be discussed further in Section 4.4 Findings.

Cross industry skills sets are those skills sets that could be utilized in a transition from one industry to another throughout the cyclic business cycles experienced because of economic changes and challenges. The closest cross industry to aerospace is possibly manufacturing. According to the Aerospace Workforce Transition Program[16] developed by the Brevard Workforce due to the transitioning of many Space Shuttle/Constellation workers out of aerospace and into other careers, several career opportunities may exist in the following fields:

- Aviation
- Automotive
- Biotechnology
- Computers/IT
- Construction
- Electronics
- Environmental
- Healthcare
- Biomedical/Life Science
- Geospatial Systems
- Modeling & Simulation
- Telecommunications

According to Careers in Transition, the average worker in America will change jobs 10 to 12 times in a lifetime. Careers will change three to five times. For this reason, it is important to understand career transition and what industries provide similar positions so the worker can easily transition through various business cycles.

4.4 Findings

4.4.1 Core Job Skills Attributes

In this study a valid list of core jobs and associated knowledge requirements were identified. The core jobs were arranged in four categories: touch labor, program and business managers, engineering and a category denoted as other, which was comprised of jobs like purchasing, contracting, accounting, finance and program support. See Appendix D for a list of job titles and associated skill levels, Standards, Certifications and Licensures. Our RSP participants discussed key occupations currently pursued in Oklahoma aerospace. The list found in Appendix D is not presumed to be inclusive of all occupations in aerospace, but rather those occupations denoted as most critical to our aerospace workforce. It is obvious from this exercise with our participants that there is a need for better-defined standards for the aerospace workforce industry. For MRO, Manufacturing and production, the most often used standards are FAA, Federal Aviation Regulations (FAR), Manufacturers standards, and Customer standards. For workforce skills, the most often used licensure is the FAA A&P License. Both the industry RSP participants and the education providers desire more specific standards for the workforce skills requirements. This would enable the industry to better define job skills requirements for recruiting and hiring. Better-defined standards would also guide a more focused curriculum for the education providers.

4.4.2 Standards, Certifications, and Licensures

In surveys conducted, RSP participants reported that for most touch labor jobs the A&P license was the most commonly accepted credential. RSP participants agreed the A&P certification provides an overall broad based knowledge level, but does not provide the depth of information and skills necessary for many positions. As a whole, RSP participants indicated that this license was used for such jobs as Avionics Technicians, Aircraft Mechanics, Powerplant (engine) Mechanics, Inspectors, Testers, Sorters, Electro-Mechanical Equipment Assemblers, Painters, Transportation Equipment Specialists, Composite and Bonder Technicians, Sheet metal mechanics and others. For touch labor positions like Aircraft Mechanics, Composite and Bonder Technicians, it was reported that in actuality workers only required either the Airframe or the Powerplant portion of the A&P license. Although there has long been talk of adding other industry certifications that might be subsets or otherwise augment the FAA's A&P, as yet there is nothing. Currently there is no license or national certification that has a specific component of the A&P for licensure.

RSP participants were asked what job qualifications were sought but not found in applicants. They reported that engineers need design and drawing experience and touch laborers with experience in the following areas: machining, tool and die, contracting (*government projects*), 5-axis machining, CATIA, wire and fabrication and quality assurance. RSP participants did report that out of all the aforementioned areas, engineers were the easiest to find because they could be hired immediately out

of college; however, participants also admitted complications are arising because of the gradual decrease in available engineering graduates. Additionally, RSP participants reported that out of four major Oklahoma schools only 30% of engineering graduates of the 2009 class met their performance requirements. At least 50% of the 2009 class from those four schools were foreign nationals, which almost immediately eliminates them from Department of Defense positions as well as some private industry positions because of the inability to obtain security clearances.

Although RSP participants seem to agree on the required license for a number of the touch labor positions, they could not reach a consensus on the knowledge requirements and needed experience for several job positions. RSP participants were more apt to agree on a job title, but as discussions progressed, many listed different experience and knowledge requirements for a given job. For example, when asked to describe requirements for an Avionics Technician, responses concerning experience were anywhere from zero to one to two to three to five to twenty-five years. In discussing required knowledge, these were four of the responses for the Avionics Technician from different RSP participants:

- Someone who possessed Electrical Engineering Associates degree;
- Someone who had two to three years of engineering;
- Someone right out of high school with personality and technical knowledge; or
- Someone with a high school education who has attended a technical college.

Additionally all agreed that a four-year degree was not needed, but that an A&P License was generally expected. One manager insisted that he would accept military experience in place of an A&P License. Although the different RSP participants responded to the question according to their immediate need or past hiring experiences, their responses shed some light on the challenges the employers encounter when communicating their business needs to education and training providers as well as other industry partners. One of the difficulties in discussing workforce needs and job skills within the Oklahoma aerospace industry, particularly with small and mid-size companies, is a lack of an accepted vernacular and/or skill expectation when discussing both standard job positions and job skills, respectively. For example, "a machinist" at one company may have an entirely different skill-set than a "machinist" at another company.

The lack of standardization makes it increasingly difficult for companies to advertise appropriately and then hire the right personnel for the job. Moreover, it makes it difficult for education providers to educate and train personnel for a position, especially when industry may have several different ideas of the type of work a person in that position should be able to perform. For a job such as an Electrician or Radio & Electrical Technician, RSP participants' expectations ranged from having some harness, wire and tracing skills; high school education; military technical school education or technical college. RSP participants indicated that presently no certification exists for electricians. Jobs such as a Laminator, General Mechanic and minimal labor positions were also identified as having no associated licenses or certifications. For engineering positions, most all RSP participants expected a person to hold a college degree ranging from a bachelor to a doctoral degree. Aerospace and Mechanical engineers were

expected to have at least five years of experience, while other types of engineers were expected to have only zero to one year of experience.

Our Skills Panel responses and supporting research also documented that it would be extremely beneficial to employers and education providers if a set of core job skills could be mapped to a set of industry standards, certifications and/or licenses. One education provider stated, "Standards are valuable for education so we can teach the correct information needed by industry. Currently we are doing training in triage or sniper mode." Standards, certifications and licenses make it possible to create a ready pool of workforce skilled to fill vacant positions immediately. These credentials are also a means of providing competencies for occupations. Credentials can be leveraged to provide career and skill progression paths for aerospace workforce and enable employees' performances to be evaluated and certified. Credentials enhance recruiting capabilities based on standardized qualifications while at the same time assisting in the identification of competency gaps and training needs.

It is important to have standards defined for basic skill sets because they serve to prepare employees for entry-level positions. With regard to standards and certifications, some of our industry RSP participants expressed the desire to align the civilian sector with the military sector. This alignment was directly associated with EGRESS training. EGRESS training from the military application is the action of going out of or leaving a place by the most direct and safest means. The training involves survival of soldiers during combat. In aerospace, this is applicable to systems on manned aircraft where escape mechanisms are in place for safe escape, if necessary. From the employment perspective, aerospace companies who need personnel trained in EGRESS systems currently must recruit and hire ex-military personnel since this training is not provided for industry in Oklahoma.

RSP participants expressed the need for general awareness of the FAR, European Aviation Safety Agency (EASA), Civil Aviation Administration of China (CAAC), International Traffic in Arms Regulation (ITAR), and Export Administration Regulations (EAR). The need to teach standards on copyright, intellectual property and data transmission is also critical. Employees should realize the importance of such regulations and specifications and the role they play in assisting them to perform their jobs at a high level of excellence. This is especially important on ITAR requirements since employees handling equipment must be careful who sees and works with it. These intellectual property and data transmission regulations issues were discussed because it appears that many employees do not understand the critical nature of handling proprietary materials. Concerns for compliance with the regulations and intellectual property management listed in this section were also expressed by the Industry Leaders. Government contracting and compliance with Defense Contract Audit Agency (DCAA) financial regulations were also a concern of this group.

RSP participants in charge of touch laborers report a need for employees to have the proper license and certifications such as the FAA's A&P license. Those who do not have their license require someone with the license to sign off on work performed. This process can sometimes create delays in the work process because much of the work requires an authorizing agent to verify that the work has been performed correctly. For the most part, the A&P training licensure process is an 18-month program. Discussions

entertained the possibility of developing some certifications that would be separate from but complimentary to the A&P license in order to speed up the training process and pinpoint more specifically the skills needed for the tasks. Expanding the certifications could also meet some of the requirements to standardize coursework offered by education providers and at the same time assist the industry in developing standards for job categories.

Our government participants expressed 2.5 to 3-year timeframes to train journeymen and at least a 5-year timeframe to train engineers on specific skills required. Training for Computer Numerical Controlled (CNC) machines was also discussed as well as Computer Aided Three-Dimensional Interactive Application (CATIA). Few of these are offered at this time in the state in their current modern configurations. Some industry RSP participants indicated that they had to send employees out of state and sometimes out of the country for this training. This results in lost production and expensive investments in human resources for our aerospace industries.

4.4.3 High Impact/Low Numbers Job Skills

RSP participants identified skill positions that were considered 'high impact/low number" positions. In Information Technology, an example of this type of position is a network administrator. Although the number of network administrators in a given company may be limited, the impact that such a skilled position has on a company is tremendous. Participants in our skills panels provided job titles and

Job Category	Comments regarding High Impact/Low Numbers
Metallurgical Engineering	Oklahoma schools do not provide a degree for this. They have to find all the applicants from out of state.
Designated Engineering Representative(DER)	signs off on repairs, import from FL or GB
Accounting	Government Compliance
Programmers	Special design and creative programmers, FBO, A&Ps, Accounting knowledge. High salary requirements eliminates hiring in high numbers.
Optical Engineer	Oklahoma does not have any courses in this area; have to find employees from out of state (University of Arizona). Hard to recruit *to* Oklahoma; once here they leave after a few months because they can demand a high salary because highly specialized.
Machinist	High end
Technical Writer	The pool of technical writers comes from the telephone support. Once all the manuals are updated, the employee has to move back to the telephone support which the do not like to do.
Telephone support for software product	Burn rate of approximately 203 years. Retaining the employee is often times based on providing advancement in their career path.
Receptionist	They are paid lower, but they are the first person with whom the customer makes contact.
High Grade A&P Mechanic	Someone who can take an aircraft and manage the maintenance of the aircraft. They can take to aircraft worldwide.
Tool & Die	This employee deals with legacy machinery. Machinist tend to be territorial about what they do.
Quoting & Contract Review	time consuming (company new to aerospace)

Table 4.1 Aerospace Occupations identified as "High Impact/Low Numbers"

descriptions of those high impact/low numbers positions they encounter within their companies. Some high impact/low number skill positions reported consisted of Metallurgical Engineers, Avionics Technicians, Electricians, Life Support Technician, Non Destructive Inspection (NDI), EGRESS Technicians,

Optical Engineers, and Quality Assurance/Control personnel. See Table 4.1 for a list of positions with comments provided by RSP participants.

4.4.4 Cross Industry Skills Sets

Oklahoma's other dominant industries, includes energy, agriculture, education, manufacturing (non-aerospace), health care, logistics, and business services. Considering cross-industry occupations, RSP participants were given a scenario that if a surge occurred in the aerospace industry job requirements, which industry would fulfill the core job skills with the least amount of training necessary. Taking the top three identified industries, RSP participants ranked them in order from highest to least starting with manufacturing, logistics, and energy in that order. The RSP participants also listed the respective job skills attributes that best suited the aerospace industry job skills demands. Their responses are listed in the Table 4.2.

Industry	Reason for Selecting Employee from this Cross Industry	
Manufacturing (non-aerospace)	Lean; ability to decipher blueprints; Touch labor Basic measuring, quality, mentality Related technical skills	Lean; ability to decipher blueprints; Reading/writing, Math, precision measurement assembly Familiarity with the environment
	Troubleshooting skills, basic manufacturing, knowledge Comfortable with tools, tolerances, deadlines, teamwork Quality Assurance (QA), logistics, engineering and technical skills	
Logistics	Planning Strong process skills Material management	Procurement – 5 yrs Warehouse system mgmt Supply Chain Department
	Program managers, knowledge of project controls Basic computer skills/communication/ organization	
Energy	Technical skills Turbine engines/repair & troubleshooting Aircraft/CEO training	Program manager Wind energy/design Some engineering & technician specialties
	Similar to mfg although not as much emphasis on tight tolerances	
Education	Trainers Training aircraft mechanics	Program management Engineers, hard sciences
Agriculture	Engineering, technician Aircraft, spraying	Mechanics, engineers, electricians Farm equipment maintenance
	Work ethic, problem solving, common sense Farm machinery troubleshooting, equipment repair	
Business Services	Training and development Aircraft business Program/ project management	Only in business office functions Common communications skills Support positions
	Computer skills, communication skills Contract management, logistics, procurement Commonality of requirements to run and maintain business structure Office systems/ computer training – programmer	
Health Care	Management, IT In assembly positions, this conversion has worked well for us because of patience, attention to detail, flexibility	

Table 4.2 Cross Industries Job Skills Match to Aerospace Job Skills

Aerospace RSP participants were also given a second scenario to prioritize the industries they believed their workers were most qualified to transition to should a downturn in aerospace workforce needs arise. Again, manufacturing, energy and logistics were the top three areas identified; however, energy ranked second and logistics third.

In this study, worker agility is defined as the ability to transition in or across industries with minimal training. Our Regional Skills Panel participants were asked to describe how transitions might occur between industries as business cycles experience surges and downturns. Table 4.3 illustrates their responses to worker agility and their concepts of what training would be necessary in the transition.

As shown in the responses, manufacturing is the easiest transition from the aerospace industry with Logistics next. The most difficult transition appears to be between aerospace and the health industry. See Appendix C for a Job Category Cross Industry Table provided by O*NET Online/Crosswalks - http://online.onetcenter.org/find/career?c=15&g=Go .

[Intentionally left blank]

Transitions	How Transitions Occur	What Training is Needed
Aerospace →Energy	Technology structural More engineering or technical knowledge of energy A & P - turbines Jet engines to turbine engines ABET Engineering Electrical training Maybe some energy specific need	Training for extraction is not long – safety key Energy management/ general design WIND – waste to energy High School awareness More info on what skills are needed in energy Regulations awareness and knowledge
Energy → Aerospace	Regulations, aircraft manuals Knowledge of government aerospace A & P turbines Turbines to jets ABET Engineering A & P (or maybe a cross train program that covers differences	Specific to MRO is A & P Structural engineering Lean manufacturing; Quality Assurance; blueprinting & measurements More precision Regulations awareness & knowledge Aircraft parts training
MRO→ Manufacturing	None if it is in aerospace manufacturing Tactile skills – easy transition Easy transition – more tech skills A & P Quality Assurance, Program Management Information Technology	Design/Developers Company specific or basic computer aided processes On-the-job-training for specific product or process
Manufacturing→ MRO	Depends on position; but most of our sheet metal techs lack aerospace training Close tolerance needs Greater component understanding QA, Program Mgmt, IT	Procedural Technical orders A&P or difference training A & P License On-the-job-training for specific systems Good basic skills, MRO requires more flexibility
Aerospace →Logistics	Understanding of terminology Program Mgmt, IT Knowledge of moving products Time and materials management	Warehouse Management Systems and manufacturing management An expeditors or supply chain person would do well in
Logistics → Aerospace	logistics Supply chain management Knowledge of government processes/methods A & P Program Mgmt, IT	Aircraft parts training Safely moving items to another location Systems design Lean manufacturing; Quality Assurance; More regulations Blueprinting & measurements
Aerospace→ Business Services	More basic business management Program Management and Information Technology Financial training	Human relations; communications Support dept/contracts/regulations Business mgmt skills, accounting, computer Variety of management involving budgets
Business Services → Aerospace	Knowledge of government processes/methods depends on job classification more technical skills A & P, Program management	Aircraft parts training Lean manufacturing; Quality Assurance; blueprinting & measurements Training and administration specific to government, accounting
Aerospace → Health Care	Health related variances Information Technology Program Management	Communications; privacy Knowledge of Regulations Most would require licensure
Health Care → Aerospace	Knowledge of government processes/ methods and regulations A & P, Information Technology,	Program Management Lean manufacturing; Quality Assurance; blueprinting & measurements

Table 4.3 Aerospace Transitions from One Career to Another

4.5 Oklahoma Aerospace Workforce Core Job Skills Implications

The Oklahoma aerospace workforce encompasses both military and commercial industries. In order to maintain and advance the industry, core job skills must be identified and training must be readily available. Industry standards and certifications play a critical role in connecting the workforce and the education providers. In this study, both entities discussed the need for better-defined core job skills and standards for the industry workforce core job skills requirements. The implications as expressed by our aerospace experts are summarized below.

- A need exists for the aerospace industry to establish core job skills standards and certifications so there is consistency in job descriptions and job requirements;
- Subsets of the licensure for Airframe and Powerplant may be acceptable licensures that would promote more precise skill sets and less training time;
- A need exists for creating new industry recognized and awarded certifications that illustrate a greater depth of knowledge and allow for levels of experience within the natural demarcations of the A&P spectrum;
- A need exists to enhance networking capabilities among aerospace companies, which may alleviate the need for high impact/low number type of employees in medium to small size companies;
- There is a gap between the aerospace industry marketing and the cross-industry workforce skills applications to the aerospace industry;
- A need exists for better training in FAR, EASA, CAAC, ITAR, and EAR;
- A need exists for Metallurgical and Optical Engineer training;
- Develop standards and licenses, which would supplement and augment the A&P; requested by Both industry and education providers; and
- Understand how one can traverse from one industry occupation to another. This needs to be better publicized than it is now.

Possibly the most critical issue articulated among our industry experts and our education providers in the core job skills discussions was the need for industry experts to better define their core job skills standards so the education providers could better plan their program curricula to fit those standards. Both entities expressed a strong desire to work together to build a seamless interface between the industry and the education programs. This collaboration promises to supply a more qualified workforce with less on-the-job training.

SECTION 5: AEROSPACE WORKFORCE EMPLOYMENT OPPORTUNITIES

5.1 INTRODUCTION

The economy of the United States demands that we continue to develop and expand our aerospace industry engine. Our national security and competitiveness depend on the advancement of our aerospace industry. According to the aerospace experts, the aerospace and defense industry:

- directly employs over 815,000 Americans;
- supports more than 2 million jobs in related fields;
- contributed more than $81.2 Billion in export sales; and
- generates more than $11 Billion annually.

The Oklahoma aerospace industry:

- accounts for the largest military MRO facility in the world and the largest Air Force Air Logistics Center in the US;
- accounts for the largest commercial MRO facility in the world– American Airlines; and
- accounts for about 10% of the Oklahoma industrial output.

Because the aerospace industry is so vital to US and Oklahoma economies, it is important to develop a highly skilled, technical workforce. Most of the jobs in the aerospace industry are unique and require skills that take time to develop. Applying stealth coatings, programming satellite-controlled algorithms, and designing high-temperature jet engines are but a few of the unique, industry-specific employment opportunities. Exportation of US aerospace products, modernizing our military, and combating cyberspace are some of the cutting-edge requirements of our aerospace workforce.

The aerospace industry contributes to high-skilled jobs in the US, product manufacturing for exportation, the security of the nation, and the economic benefits of a country experiencing the most critical economic woes in its short history. Because of the importance of this workforce, it is vital that employment processes such as recruiting, hiring, training and retaining the workforce are better understood by both the industry employer and the potential employee.

5.2 SUMMARY OF RESEARCH OBJECTIVES

The Regional Skills Panels gathered at the Aerospace Summit 2010 in Oklahoma City, with a focus on Human Resources and Managers delving deeper into current employment issues and gaps, and industry's definition for "fully qualified employee." Our participants were tasked to identify gaps that may exist between the aerospace workforce skills needed and those skills that are actually present in entry-level employees. The need for training after employment, both in-house and offsite were discussed describing typical training time durations and cost. Forecasting and attrition within the industry based on age, business cycles, and the aerospace workforce opportunities in the near-, mid-, and long-term employment were discussed.

5.3 LITERATURE REVIEW

In a June 2010 publication, the Aerospace Industries Association reported that civil aviation is directly and indirectly responsible for contributing $1.2 trillion to the U.S. economy, supplying nearly 11 million jobs with a payroll of $379 billion. As of 2009, over 815,000 workers are employed by the Aerospace and Defense (A&D) industry with approximately 644,200 of those coming from the aerospace industry alone.

Although the A&D industry employs over 815,000 workers, it supports more than two million middle-class jobs and 30,000 suppliers across 50 states.[13] While these numbers are impressive, the economic downturn has dealt the aerospace industry several setbacks. Many companies are still scrambling to recover and salvage what remains of their business wreckage. Others have been forced to close their doors leaving unemployed workers contemplating relocation or even career changes.

The General Aviation Manufacturers Association (GAMA) compared deliveries in the first quarter of 2009 and the first quarter 2008 and discovered a 41.1% decline.[33] Air-tax service DayJet closed its door and filed for Chapter 7 liquidation in September 2008 while Eclipse Aircraft announced a Chapter 11 bankruptcy followed by Chapter 7 liquidation on February 2009.[34, 35] HondaJet delayed its first delivery scheduled for late 2010 to possibly the fourth quarter of 2011.[109] Hawker Beechcraft announced two rounds of lay-offs one in November 2008 and the other in February 2009. The total estimated number of job losses per lay-off round was 490 and 2,300 workers, respectively.[37] Approximately one-third or 300 of Piper Aircraft employees were laid-off in February 2009.[38] Considered the largest employer in Savannah, Georgia, Gulfstream announced a 2,700 worker lay-off in March 2009.[39] In Wichita, Kansas Cessna Aircraft reported cuts of 4,000 jobs between November 2008 and April 2009.[40] June 2009 introduced another round of Cessna lay-offs that included more than 2,300 employees. It is estimated that Cessna has laid-off half of its employees since November 2008.[40, 106]

Aerospace companies in Kansas have laid-off or are in the process of cutting more than 12,000 people, which is estimated to inevitably affect 25,000 more jobs because aerospace indirectly touches so many other areas of the nation's economy.[42] Although, some states were hit harder than others, clearly aerospace employment has experienced a decrease since 2008.[13] Furthermore, with the decline of human capital within the STEM areas, shortages within the industry are sure to increase if aggressive actions to attract new talent to careers in aerospace are not taken. This coupled with Boeing's 20 year forecasts of a market for over 28,000 new commercial airplanes worth $2.1 trillion[43] could mean that the U.S. will not have enough qualified people to meet such demands thus sending work elsewhere or worse, losing work all together. This would be crippling to the U.S. economy and would diminish its global competitiveness and technological superiority. Chief Economist Mark Zandi stated, "Aviation is the glue that keeps the global economy together. Without widely accessible and well-priced air travel, the global economy will quickly become less global."[43]

Although the total aerospace employment in Product and Parts Manufacturing seems to fluctuate, as a whole it has been in a steady decline since the year 1992, and shown in Figure 5.1. Although the graph depicts the typical business cycles, the trend is toward decline in the aerospace total employment; it appears that the trend in Production workers is likewise on a trend of decline as well. This graphic only accounts for the North American Industry Classification System (NAICS) 33641.[107]

In response to the gradual decline of the economy and the now economic downturn, some states were able to create and/or leverage several forms of incentives to try to help stimulate growth and awareness in the aerospace industry. In Oklahoma 348 engineers were hired in 2009 making an average salary of $76,000 as a result of the Aerospace engineer tax credit.[45, 46] Approximately $3.55 million in income tax credit was provided to engineers. The Aerospace engineer tax credit consisted of the following benefits:

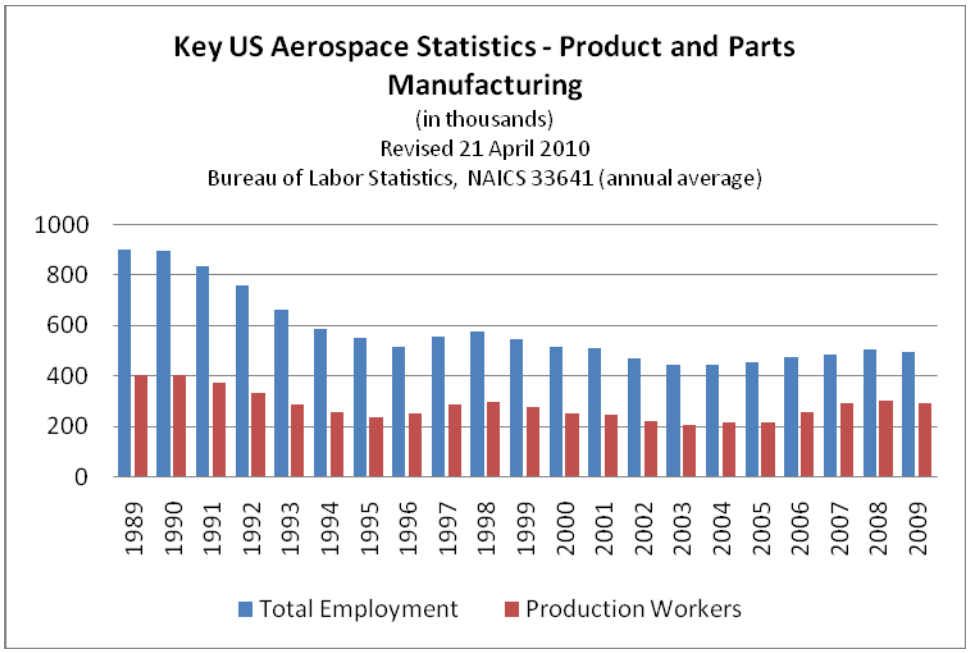


Figure 5.1 Aerospace Product and Parts Manufacturing Employment
Source; US Department of Commerce, International Trade Commission

"a tax credit for companies of 10 percent of the wage cost of an Oklahoma engineering graduate for the first through the fifth years of employment or five percent of the wage cost of an engineering graduate from a non-Oklahoma institution for the first through fifth years of employment. An employer tax credit of 50 percent of tuition reimbursed to a new engineer graduate, based on the average tuition at an Oklahoma public college or university, for the first through fourth years of employment. Tax credits up to $5,000 per year through the first five years of employment for engineering graduates who agree to work for an Oklahoma aerospace company."[45]

In spite of the economic slump, some areas in the aerospace industry did experience growth in 2009. According to the Department of Labor, the Aerospace Industry will add 10% to the workforce between 2008 and 2010.[52] Seventy percent of the jobs in aerospace relate to research and development, production and maintenance operations, and new designs for commercial and military aircraft. In Oklahoma private industry alone, Boeing, announced that it plans to move its C-130 Avionics Modernization and B-1 programs from California to Oklahoma and with this, 550 jobs will be relocated to Oklahoma. FlightSafety initiated building efforts and as a result, Oklahoma can expect up to 300 jobs in the near future. Spirit Aerosystems anticipates bringing 400 new jobs to Oklahoma, while UML opened a new Unmanned Aerial System (UAS) test facility in Lawton, OK. Tinker AFB filled 1200 positions in 2009 and 2010 and expects to hire more.[120] Despite the economic boost, Oklahoma lawmakers suspended the aerospace engineer tax credit due to budget shortfalls.

Whether in economic turmoil or not, multigenerational differences have forced its way to the employment forefront affecting company recruitment and retention processes. More employers realize that millennials are the future workforce, but still have reservations in adapting their company to the life of a millennial employee versus them adapting their life to the demands of the workplace. One executive of a major company summed it in this manner, "For this generation, work is not a place to go;

work is a thing you do."[116] Some reports estimate millennials will have an average of 25 different jobs in their lifetimes as a result of companies' inability to meet their demands of flexibility, telecommuting and the option to go part-time to upgrade or recharge themselves through extended holidays. [112, 113] For some, "their lack of company loyalty stems from watching their parents slog long and hard for their companies – only to get laid off when the economy hits a rough patch. Another reason is that they see staying on in the same job as boring."[113] In a study performed by Michigan State, 44% of the millennial respondents stated they would have no problem reneging on a job-acceptance commitment if a better job offer was presented. [116] In a survey by CareerBuilder.com, 74% of millennial respondents indicated their greatest expectation was higher pay, 61% reported flexible work schedules, 56% reported an expectation to be promoted within a year, and 50% reported they expected more vacation or personal time.[116] Although seemingly demanding and having outlandish expectations, literature also records millennials as being use to "hard work, constant supervision, having their opinions valued and always doing something interesting and juggling multiple technology and a wide array of high-tech gadgetry."[115] Millennials are said to thrive in structured environments with clearly defined guidelines and rules. "Managers will need to give step-by-step directions for handling everything from projects to voice-mail messages to client meetings. It may seem obvious that employees should show up on time, limit lunchtime to an hour and turn off cell phones during meetings. But those basics aren't necessarily apparent to many millennials."[116] These basics are commonly denoted as soft skills. In addition, many millennials seem to have stable relationships with parents so much so that they often look to their parents for guidance.

Companies reported they were surprised when college students interviewing for high-profile jobs insisted that they would have to consult with parents before making job decisions.[115] As a result some companies have begin preparing parent packets for certain job candidates, even developing a separate employment section for college students on their website.[115] Although many millennials have been described as needy, "needing an entire team – and a couple of cheerleaders – to do anything", some analyst believe that in order to recruit millennials, organizations will need to focus on delivering life-balance, and build in the flexibility and the scheduling options that are so important to ensuring the retention of these workers. [112, 114] Employers who seem to be winning the recruitment battle provide millennials an environment where they feel valued, have the freedom to work on multiple projects important to them, have opportunities to work in team environment and use new technologies.[117] Successful recruiting strategies also include time off given as awards, frequent recognition, telecommuting opportunities, full tuition reimbursement and mentoring programs/tools.[118] Retention strategies implemented by some employers include rotating them to different departments (even overseas), offering 'career within careers' allowing young employees to try out different positions, showing them what they can aim for if they stay and providing flexible work schedules. Apparently, the greatest retention tool may be the wealth of opportunities and workplace flexibilities offered by today's companies.

The findings published in this section discuss the processes and challenges the aerospace industry in Oklahoma faces with regard to workforce employment opportunities as voiced by Regional and Future Skills Panel participants.

5.4 FINDINGS

RSP Participants interviewed in the study were asked what aerospace workforce employment opportunities currently exist. Many agreed that near-term (i.e. within 1 year) employment was available for non-entry level Program Management, electronics testing, electronic engineers, robotics, aircraft mechanics, sheet metal mechanics, A&P Mechanics, CNC Programmers and machinist. For mid-term employment or employment that is one to three years away, RSP Participants indicated there will be a real need for individuals holding engineering degrees. Incumbent workers during that time will require some form of leadership and team building skills to be effective in their area of work. Long-term employment opportunities were defined as opportunities that are three to seven years out. RSP Participants believed many opportunities in the long-term would be in the area of composites, avionics, robotics, and quality assurance.

The Industry Leaders expressed many concerns about recruiting the "brightest and the best" young people in to the aerospace industry workforce. "We need a stable of future managers and leaders in the pipeline. It takes 20 years to grow a Colonel in the military; it is the same in business." To develop the managers and leaders of the future, the process must begin now.

5.4.1 AEROSPACE EMPLOYMENT RECRUITING PROCESSES

Determining how to define "fully qualified employee" was a struggle and a time-consuming activity. Through extensive discussions, a consensus was reached and "fully qualified employee" was defined as "able to work without supervision." The research findings for "fully qualified employee" indicate that there currently are no industry-defined standards. It is necessary to have a standard by which a fully qualified employee is defined. This will enable the industry employers to better recruit for job openings, more effectively manage training, and more accurately forecast the workforce needs.

When Oklahoma RSP Participants were asked about the existence of an established employee recruiting process as it relates to each category, a greater number of recruiting methods were identified for touch labor positions than for the other categories. RSP Participants consistently utilized websites, newspapers, career techs, career fairs, various technical/career providers, employee referrals as well as other business entities such as the area Chamber of Commerce and staffing agencies. Popular websites utilized were Craigslist.com, LinkedIn, AeroJobs.com, Monster.com, CareerBuilders.com, UsaJobs.gov and company websites. Craigstlist.com was used for recruiting lower level jobs while LinkedIn was used for higher-level jobs. When using Monster.com, some reported the website flooded their company with a number of unqualified applicants. The use of the classified section in newspapers was limited. Although several companies utilized career fairs, some simply lacked the financial and human resources needed to attend. In addition to career fairs, some companies have adopted open houses, events normally showcased by schools. A company open house, similar to a school open house, is used to provide an awareness of the company by making it available to the community and/or potential employees to visit, ask questions, and tour the facility. Another means of recruiting was through

employee referrals. Employees are given a monetary incentive if they recruit an individual who is eventually hired and remains on the job for defined amount of the time.

Dislocated workers and cross-industry workers such as those affected by the high number of layoffs in Wichita, KS and Tulsa, OK were also identified as integral components of the recruiting pool for many RSP Participants. Ex-military men and women are often recruited because they possess quality training and seemed to be more disciplined than non-military personnel are. Discipline is a key quality, especially when recruiting younger workers.

5.4.2 Aerospace Employment Recruitment Sources

High profiled locations for recruitment are local education institutions. RSP Participants reported recruiting employees from local education institutions where some form of relationship exists. The most common and beneficial type of relationship discussed was one in which one or more of the firm's managers worked at the institution as an instructor. In such cases, the managers are strategically positioned as instructors in certain classes in order to identify students who show great interest and who possess the skills necessary to be successful in a given area. Not only do they look for students with the appropriate technical skills and ability, but are also careful to evaluate soft skills such as work ethic, timeliness, and ability to relate to others. On the other hand, if a manager is not positioned in a school classroom, RSP Participants indicated they often identified certain classes or clubs within the school from which to recruit students.

For the Information Manager category, most RSP Participants reported that recruiting was done through colleges, universities and internship programs. In order to obtain an advantage over other RSP Participants competing for the same students, some RSP Participants instituted programs that provide scholarships to students transitioning from high school to college and/or to those students transitioning through college. Programs, such as this, work to create an awareness of the sponsoring company as well as an awareness of the aerospace industry in general.

For the Program and Business Manager category most RSP Participants recruit and hire internally first. RSP Participants reported the existence of an internal supervisory training program for their employees who display the ability or willingness to function as a manager.

In particular, when recruiting engineers, RSP Participants indicated they provided internships and college fairs for college juniors and seniors. Also utilized were national searches and specialized recruiting services. Of the positions identified by our aerospace RSP participants, the Metallurgical and Optical Engineers were two job skills that were noted as being difficult to recruit within the state of Oklahoma. RSP participants reported that Oklahoma schools do not currently support those areas of study; therefore, virtually all applicants are recruited from out of state. One Oklahoma employer reported that he would need thirty Metallurgical Engineers within the year, which poses great challenges for recruitment. The University of Arizona was reported as being a prominent location to recruit optical engineers; however, RSP participants expressed great frustration in recruiting this job skill because once the new hire discovers his skill set is highly specialized he often demands a higher salary and when the salary demand is not met, he leaves.

5.4.3 Narrowing the Recruitment Pool

As with any applicant recruiting process, at some point applicants are selected for the job for which recruitment occurs. When asked how RSP participants narrowed their applicant pool to make a selection the following approaches were named; general interviews, behavioral based interviews, several levels of testing, background checks, recommendations from education institutions, and trial work periods. In the case of trial work periods, some companies resort to temporary staffing agencies to "try before you buy." This enables them to hire an employee on a temporary basis for a pre-defined period to determine if he or she is a good fit for the company and vice versa. For some larger businesses, a series of phone interviews and then a final panel interview with department managers and leads are also utilized. The levels of testing given to applicants consist of assessments, objective evaluations, drug tests, personality testing, WorkKeys™ and technical skills tests or demonstrations. RSP Participants reported they sometimes expedited background checks by looking on social network/media sites such as FaceBook, MySpace and YouTube. From this resource, managers were able to glean information about an applicant's character. Unfortunately, some RSP Participants have experienced unique difficulties in hiring workers. A criterion set by one firm for making a selection was an applicant's willingness to move to Oklahoma. As stated earlier in this publication, hiring workers to come to Oklahoma has been extremely challenging. Much of this is due to the applicants' neutral and sometimes negative perceptions of Oklahoma and the lack of information about Oklahoma opportunities. Even if hired, depending of the location of the firm, employees find it difficult to remain, thus retention is a problem especially for those RSP Participants located in rural areas. When recruiting engineers, large commercial and government entities indicate at least four different criteria evaluated:

- Degree;
- Grade Point Average (GPA);
- Internships/work experience; and
- Transcript.

An official academic transcript is used to verify a student's degree and GPA. It also provides the recruiter with a list of major classes taken by the student. This gives some idea of how familiar a student is with certain principles and skills. Out of all the tools and methods used by RSP Participants to narrow the applicant pool, resumes and interviews were two elements common to all.

RSP Participants were asked to specify surprises they encountered when interviewing or hiring personnel. Surprises included applicants who:

- brought their girlfriends or significant others with them to the interview;
- answered their cell phone during the interview;
- knew nothing about the company;
- wore inappropriate attire, both to the interview and when reporting for work; and
- not reporting for the first day of work.

Government Service Supervisors expressed some surprises when interviewing applicants as well. Indecisiveness in setting up interview appointments, applicants making statements during casual conversations either prior to or after the interview that caused concern for hiring, discussing unrelated

issues during the interview process that are revealing about character, and inappropriate attire such as sweats and flip flops were some of the surprises they experienced. Interestingly, it was suggested that perhaps the casualness in conversation and attitude might be due to the constant use of social media where possibly too much personal information is shared.

When asked to list 'deal breaker' qualities exhibited by an applicant during an interview, RSP Participants identified actions such as lying, falsification, disrespect and showing no interest. Applicants were generally not given the job if they exhibited any one of those qualities. Touch labor managers indicated that appealing actions during an interview consisted but was not limited to applicants who smile and display a positive attitude. Our RSP participants discussed in depth the issues they have with applicants who cannot pass mandatory drug testing. This is a major problem since many of the jobs pertain to the maintenance, repair and overhaul of aircraft.

In some instances, applicants perform well in an interview but once hired, they fail on the job. For those who fail, RSP Participants overwhelmingly reported many lack professionalism, work ethic, responsibility as well as the ability to multi-task. These characteristics were attributed mostly to those workers who were 32 years of age and younger. In today's competitive society it is becoming increasingly more common for RSP Participants to strategically determine the placement of a new hire within a given workgroup/team. RSP Participants strongly believe any one person can affect the success or failure of an entire team. For this reason, RSP Participants reported that they sometimes employed psychiatric and personality evaluations to assist in placing the right person with the right team.

RSP participants and Government Service Supervisors described what they perceive as gaps that exist between the workforce skills needed and the skills possessed by those eventually hired for their advertised positions. These were:

- Soft skills – getting to work on time, staying on task, working under a supervisor; leaving personal matters at home; observing company-established guidelines
- Relationship skills -new hires do not know how to work well with others or within a team; show respect for others;
- Social responsibilities – new hires do not understand the mission of the company;
- Machining skills – new hires are not ready because of inadequate equipment in training programs;
- Entitlement mentality – expecting perks that other companies or government may provide
- Political will – believing that the government is responsible to keep the aerospace industry going.

Government Service Supervisors also expressed the need for employees to have good interpersonal relationship skills, be able to communicate with customers, and to observe the chain of command. They also mentioned communication skills and grammatical accuracy in email communications because even though this may be a more informal form of communication, one still must be able to express their point effectively. The use of texting habits in email communications was also a concern. An interesting point was also made that "education or the education system cannot help us with this but I think the older generation would be better able to manage the up and coming [employees] if we had more flexibility."

5.4.4 Capital and Incentives

In 2010, the Oklahoma Legislature imposed a two-year moratorium on dozens of tax credits including tax credits for aerospace companies and aerospace employees. The aerospace tax incentives known as the Engineer Workforce Bill one of those incentives placed on a two-year moratorium. Oklahoma aerospace executives indicate such breaks were needed to help stabilize and expand their business in the current economic climate. As compared to other industries, aerospace in Oklahoma has limited access to capital which somewhat limits the aggressiveness of the aerospace awareness campaign. As compared to other states, the tax credits help Oklahoma stay competitive especially with Texas where no state income tax is levied. Appeals to the Legislature are projected in the future in order to reinstate the aerospace engineer tax credit.[45] Some aerospace executives interviewed in this study, indicated that if the aerospace industry had mounted a more organized, industry-focused stand in 2010, efforts to prevent the two-year moratorium of the Oklahoma Aerospace Tax Credit would have been successful. This is supported by the evidence presented by Victor Bird, Director of the Oklahoma Aeronautics Commission in an interview dated 13 October 2010 with the Daily Oklahoman. Mr. Bird stated that the tax incentive provided $3.55 million in income tax credits to 348 engineers and their respective companies in 2009.[46] If Oklahoma is going to build a highly technical workforce, efforts such as this need to be continued and supported by the Oklahoma Legislature.

Both RSP participants and the Industry Leaders discussed training the aerospace workforce. All groups agreed that the workforce must be capable of competing globally where competition provides lower wages with comparable technical capabilities.

5.4.5 Aerospace Employment Forecasting

Taking advantage of forecasting methods was one way many RSP participants attempted to address many of the aforementioned workforce needs. Nearly 80% of those surveyed reported initiating some form of forecasting monthly, quarterly or yearly, while 8% reported they did not forecast at all. Those that did not forecast were reported as having too small of a program or were flexible enough to hire to meet their clients' expectations. Others forecasted semi-annually or every 2-3 years. Most RSP participants reported that their forecast predictions were correct 50% to 75% in the near-term. Some indicated variability experienced in predictions depended on unforeseen economic changes. Our Industry RSP Participants were also asked about the frequency with which they forecast employment predictions. Some indicated that they do not forecast on a regular basis. These companies, generally, expressed that they forecast as they write project proposals and are eventually awarded the associated project contract. Results are displayed in Table 5.1.

Forecasting Frequency	
Frequency	%
Monthly	35
Quarterly	21
Semi-annually	5
Yearly	21
2-3 years	3
More than 3 years	5
We do not forecast	6
Total may not equal 100% because of rounding.	

Table 5.1 - Forecasting Frequency

Industry participants were also asked to discuss the reliability of their workforce employment forecasting. Most companies were predicting their workforce needs 50% to 75% of the time. The responses are displayed in Table 5.2

ACCURACY IN FORECASTING	%
We hire close to 25% of what we predict.	17
We hire close to 50% of what we predict.	29
We hire close to 75% of what we predict.	38
We hire close to 100% of what we predict.	13
We do not forecast.	4

Table 5.2 - Accuracy in Forecasting Workforce Employment

In order to determine what possible employment forecasting can be done, one must understand what workforce exists in the present. Our RSP participants were asked to identify the areas where staff shortages and surpluses presently exist in four broad categories: Touch Labor, Information Managers, Program and Business Managers, and Engineers. This data was collected during a military hiring surge and that is depicted in the high number of Touch Labor and Engineers staff shortages and low numbers in Touch Labor and Engineers staff surpluses shown in Table 5.3.

WORKFORCE REQUIREMENT	STAFF STATUS	%
Touch Labor	Staff shortages	52
	Staff surpluses	0
	Neither	21
	No Response	27
Information Managers	Staff shortages	15
	Staff surpluses	9
	Neither	40
	No Response	36
Program & Business Managers	Staff shortages	40
	Staff surpluses	3
	Neither	33
	No Response	24
Engineers	Staff shortages	48
	Staff surpluses	0
	Neither	21
	No Response	31

Table 5.3 - Current Workforce Employment Status

Flexible hiring conducted in order to meet client expectations was one reason given for not forecasting workforce needs. The best reasons for forecasting workforce employment needs as experienced by the RSP participants were the following:

- Customer requirements and current workforce capabilities.
- Driven by contract award.
- Driven by the economy and industry needs.
- Consider historical trends and current business assessments.
- Based on aircraft fractional sales and aircraft age/need for maintenance.

Employment forecasting is difficult to do because many aerospace industries support the federal government initiatives, which involves federal contracting for large and small business. In this data, only industry participants submitted survey responses. One of the challenges discussed by the Industry Leaders was the task of maintaining their workforce during the recent economic downturn. When asked about forecasting methods one executive stated, “More time has been spent in the last few years trying to weather the storm” than on actual workforce forecasting. In addition, the fact that technology is changing so quickly makes it difficult to predict what jobs will exist in the near term. Because of this unpredictability, skills may need to be broader in spectrum. Industry Leaders also discussed the workforce forecasts for mid- to long-term years. Most of the Industry Leaders considered workforce manpower forecasts between three and five years to be suitable for workforce predictions. One uses the Balanced Score Card approach where one aligns business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals. Others use SWOT (Strengths, Weaknesses, Opportunities, and Threats).

Strengths and Weaknesses are attributes of the company while Opportunities and Threats are attributes of the environment.

Industry Leaders were asked how they thought workforce capabilities would differ 10 years from now. Some of the responses included:

- Very difficult to predict capabilities or workforce needs 10 years out
- Difficult to prepare our workforce for the future when we do not even know what types of technology we'll be using in 10 years
- Continue to expand our manufacturing and design capabilities
- Biggest growth will be in the electronic field.
- Will do more systems development (programming)
- More focus on composites and skills needed in testing equipment
- Need for more versatile engineers who can perform in more than one area

As noted by our participants, the workforce needs may be very different 10 years from now. We cannot even know the technology that will be available in 10 years. Preparing a workforce for the future based on what we know today may be a leap in the dark.

The ability to forecast with some assurance of reliability is critical to describe the aerospace workforce pipeline. As a partial solution, software created for this project is designed to provide a mechanism for aerospace companies to record their current workforce data using the Department of Labor Standard Occupation Code (SOC), their count of "on the bench" employees, their future hiring projections, and their retiring workforce forecasted three years ahead. Aerospace companies can also record their on-the-job training expectations in order to give our education providers a sense of the type of training that needs to be offered by their institutions. It is projected that by the end of Option Year 1, pending funding, a majority of our aerospace companies will input their workforce data. The URL for the Oklahoma Aerospace Workforce Resource Center is http://www.teamaero-ok.org.

5.4.6 Aerospace Synergy Opportunities

Throughout this study, participating Oklahoma aerospace companies realized that many of the day-to-day challenges encountered by each individual company were common among them all. There is a great need for companies to combine their efforts, forge relationships and leverage their resources enabling them to create lasting opportunities for the aerospace industry in the State of Oklahoma. RSP participants interviewed and focus group discussions continually expressed the need and the desire for the aerospace industries to collaborate and communicate with each other in order to advance the aerospace industry in Oklahoma. Many RSP participants talked about the possibilities of sharing training opportunities and training expenses with each other.

5.4.7 Aerospace Opportunity Awareness

In an effort to reach students in rural areas, officials from Oklahoma School of Science and Mathematics (OSSM) have initiated efforts to make curriculum available through online sessions and videoconferencing. The Stafford Air and Space Museum in Weatherford, Oklahoma was recently awarded a $10,000 grant to develop exhibits that highlights aerospace careers. In addition, Oklahoma

State University is the first and only university in the nation to offer advanced degree programs in unmanned aerial vehicles/systems.

Although competitions and programs such as MATHCOUNTS, Mad Science Summer Camps, Project Lead the Way and NASA's INSPIRE have created some forms of awareness, students in the U.S. continue to fall behind other countries. With the cutbacks and restructuring of NASA objectives, many believe today's youth will not get the exposure needed in order to meet the future aerospace intellectual capital demand. The need for awareness is great. This was a major concern expressed in interviews with the top executives of the Oklahoma aerospace industry who participated in the Future Skills Panel.

5.5 Oklahoma Aerospace Workforce Employment Opportunities Implications

The aerospace workforce employment possibilities are promising over the next 10 years. Transition to a knowledge-based economy dictates that Oklahoma produce a knowledge-based workforce. According to research provided by the Governor's Council for Workforce and Economic Development, 2008 Annual Report, Oklahoma's workforce is predicted to peak in 2011 and then begin a steady decline with the projected retiring Baby Boomer workforce. Figure 5.2 provides an illustration of the cyclic predictions for the Oklahoma workforce.

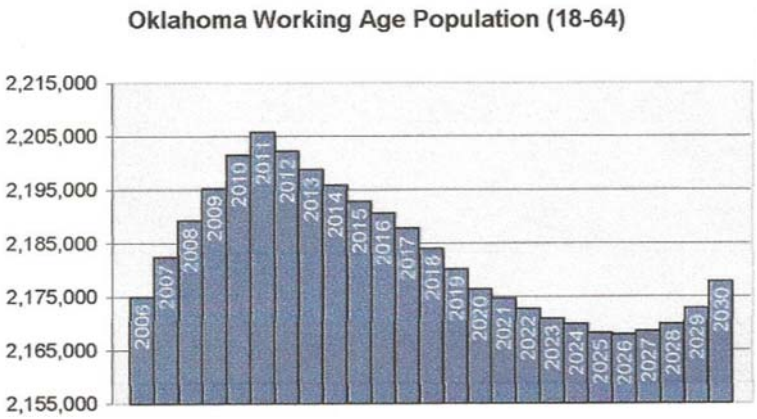


Figure 5.2 - Oklahoma Working Age Population Predictions
Source: Governor's Council for Workforce and Economic Development, 2008 Annual Report.

Based on the research provided by our Oklahoma aerospace industry participants concerning the aerospace workforce employment opportunities, the following implications are provided.

- There is a need to begin an effort to market the aerospace industry in order to recruit the "brightest and the best" young people in Oklahoma.
- There is a gap within the aerospace industry to define exactly what "fully qualified employee" dictates as far as workforce skills and responsibilities..
- There is a gap between the aerospace industry expectations in applicant/entry-year employee performance and the reality of applicant/entry-year employee performance. The need for training in soft skills, which was discussed at almost every skills panel meeting, translates that lack of responsibility, lack of respect, and low expectations have been the rule rather than the exception in the public school experience. This may be a cultural issue; however, it is everyone's problem when it affects the job market and the economic development of Oklahoma.
- There is a gap between what training the industry needs and what education institutions are providing.
- There is a gap between the aerospace industry workforce job opportunities and capabilities and the career training mechanisms that exist in the public schools.
- Tax incentives are critical for encouragement and growth of high tech aerospace jobs in Oklahoma.

- There is a need to better communicate with education providers on aerospace workforce job category labor shortages and surpluses. Better alignment of programs with labor shortages would shorten the work-ready timeline and possibly save companies some of their in-service training.
- There is a critical need for Oklahoma aerospace partnerships to prepare to replace a retiring workforce.
- There is a need for a measurement tool/process that will more accurately match future needs with education resources.

SECTION 6: AEROSPACE WORKFORCE EDUCATION AND PROGRAMS IN OKLAHOMA

6.1 INTRODUCTION

The twenty-first century presents Oklahoma with challenges that demand we rebuild with precision a framework of education that will support the viability of a healthy workforce and economy. President George W. Bush said, "We live in a competitive world. And so we must put policies in place to recognize the competition of the global economy and prepare our people to be able to continue to compete so America can continue to lead." Globalization is now a common trend in commerce, communication, and travel. The youth of today are very different learners than the youth of twenty years ago. The workforce is different in philosophy and commitment with each generation as employees assume the roles and responsibilities within the workforce. As research in this section and comments by the Skills Panel participants will validate, major problems exist with our education system and this affects every aspect of the workforce. While our education system has faltered in the previous 20 years, many foreign countries have advanced their education systems. Using the U.S. as an example, many foreign countries such as China, South Korea, and India have invested in their youth and their education system. At this point, our economic and education leadership are being challenged. Today America faces a new global workforce. Our systems must rise to the challenge.

6.2 SUMMARY OF RESEARCH OBJECTIVES

The objectives in this section include the following:

- To provide an overview of the research in international education that directly affects the aerospace industry workforce and economy;
- To provide an overview of the research in the nation that directly affects the aerospace industry workforce and economy;
- To provide aerospace workforce information regarding Oklahoma education programs provided with an aerospace emphasis;
- To offer the voices of the aerospace industry as they discuss the communication, coordination and commitment of the industry to revise and build a better economy by building a highly qualified aerospace workforce.

The literature review will provide insight into the challenges we are facing in the education of our youth specifically as this pertains to the aerospace industry and the Oklahoma economy. America did not get in an education nightmare in a day, and we will not get out of it in a day; however, until we are aware of what is going on and encourage industry to get involved in our education process, we may not see much of a change. Our Skills Panel participants are very aware that involvement in the promotion of science, technology, engineering and mathematics curricula is a building block for our adventure in rebuilding our education system, and they are fully supportive of providing our teachers and children with the time, energy, and resources to improve and advance the education of the children of the United States.

6.3 LITERATURE REVIEW

In the Aerospace industry, emphasis in education has been in the content areas of STEM. STEM fields include Biological and biomedical sciences, Computer and information sciences, Engineering and engineering technologies, Mathematics and statistics, and Physical sciences and science technologies. Current college graduation rates indicate there are insufficient numbers of STEM degrees being pursued by citizens of the U.S. There was more than a 25% decrease in STEM graduates between 2002 and

2007.[102] In 2010 an article titled The STEM Challenge published in Fortune Magazine reported that there were 4,012,770 ninth-graders in the US in 2001. Of those ninth graders, 70% graduated from high school, 46% were college bound, and 32% were college ready. Of the college ready, 21% would major in STEM and by 2011, of the college ready, less than 13% will graduate with STEM degrees.[22] In similar data provided by the Oklahoma State Regents for Higher Education, Oklahoma high school graduates generated the following data:

- Number of ninth graders in fall 2000: Public = 49,667; private = 1,088;
- High school graduates in spring 2004 was 38,109;
- High school graduates who plan to enter college in the fall of 2004: 71.2%*
- High school students college-ready: English Comprehension: 68%; College Algebra: 32%; College Biology: 24%;**

  *Measure of college intent is the number of graduating seniors taking the ACT.

  **2004 Oklahoma ACT-Tested Graduates Ready for College-Level Work)

In past years, engineering concepts were emphasized during the undergraduate years but have consistently decline in US In a study published by the U.S. Department of Education National Center for Education Statistics for the academic term 2002-2003, the number of degrees by level (Bachelors, Masters, etc.) and by Field of Study comparing STEM fields of study to non-STEM fields of study is discouraging for meeting workforce requirements of the aerospace industry. At the Baccalaureate level, only 16.7% of the degrees conferred were in Science, Technology, Engineering or Mathematics. Only 12.9% of the Master's degrees conferred were in the STEM fields as shown in Figure 6.1.[22]

DEGREES CONFERRED BY LEVEL AND FIELD OF STUDY IN US, 2002-2003					
	Associates	Baccalaureate	Master's	Doctoral	Total
All Fields	632,912	1,348,503	512,645	46,024	2.540,084
STEM fields, total	92,640	224,911	65,897	16,017	399,465
STEM, percentage of all fields	14.6%	16.7%	12.9%	34.8%	15.7%
Biological and biomedical sciences	1,496	60,072	6,990	5,003	73,561
Computer and information sciences	46,089	57,439	19,503	816	123,847
Engineering and engineering technologies	42,133	76,967	30,669	5,333	155,102
Mathematics and statistics	732	12,493	3,626	1,007	17,858
Physical sciences and science technologies	2,190	17,940	5,109	3,858	29,097
Non-STEM fields, total	540,272	1,123,592	446,748	30,007	2,140,619
Business	102,157	293,545	127,545	1,251	524,498
Education	11,199	105,790	147,448	6,835	271,272
English language and literature letters	896	53,670	7,413	1,246	63,225
Foreign languages and area studies	1,176	23,530	4,558	1,228	30,492
Liberal arts and sciences, general studies, and humanities	216,814	40,221	3,312	78	260,425
Philosophy, theology, and religious studies/vocations	804	18,270	6,677	1,983	27,734
Psychology	1,784	78,613	17,123	4,831	102,351
Social Sciences	5,422	115,488	12,109	2,989	136,008
History	316	27,730	2,525	861	31,432
Other	199,704	366,735	118,038	8,705	693,182
Source: US Department of Education, National Center for Education Statistics, Digest of Education Statistics, 2004, NCES 2005-025, October 2005, Table 240-252.					

Table 6.1 Degrees Conferred by Level and Fields of Study, 2002-2003

Not only is the number of overall U.S. students entering STEM fields declining but the number of women and minorities pursuing STEM degrees are already dismal. Statistics have shown there has not been a significant increase in women and minorities in STEM fields in years.[48] These two groups remain an untapped resource for a new pipeline of workers to the aerospace community. STEM education is responsible for providing our country with three kinds of intellectual capital:

- Scientists and engineers who will continue the research and development that is central to the economic growth of our country;
- Technologically proficient workers who are capable of dealing with the demands of a science based, high technology workforce; and
- Scientifically literate voters and citizens who make intelligent decisions about public policy and who understand the world around them.[49]

The top three recommendations of the U.S. National Academies, Committee on Science, Engineering and Public Policy for strengthening the STEM fields of study are:

- Increase America's talent pool by improving K-12 science and mathematics education;
- Strengthen the skills of teachers through additional training in science, math, and technology; and
- Enlarge the pipeline of students prepared to enter college and graduate with STEM degrees.[49]

Only 7.5% of the estimated 270,000 freshmen entering college in the U.S. established engineering as their intended major. This is the lowest level since 1970.[49] Furthermore, although about 70,000 bachelor's degrees in engineering are awarded each year in the U.S., this pool is comprised of such fields as architecture, mining, and civil engineering which are not disciplines widely recruited among aerospace companies. Although graduation rates limit the amount of available talent; likewise, it is further limited due to other industries that compete for the same talent, such as Information Technology, Financial Services, and Energy industries.[6] Additionally, graduates are choosing alternative career fields as shown in Figure 6.1.

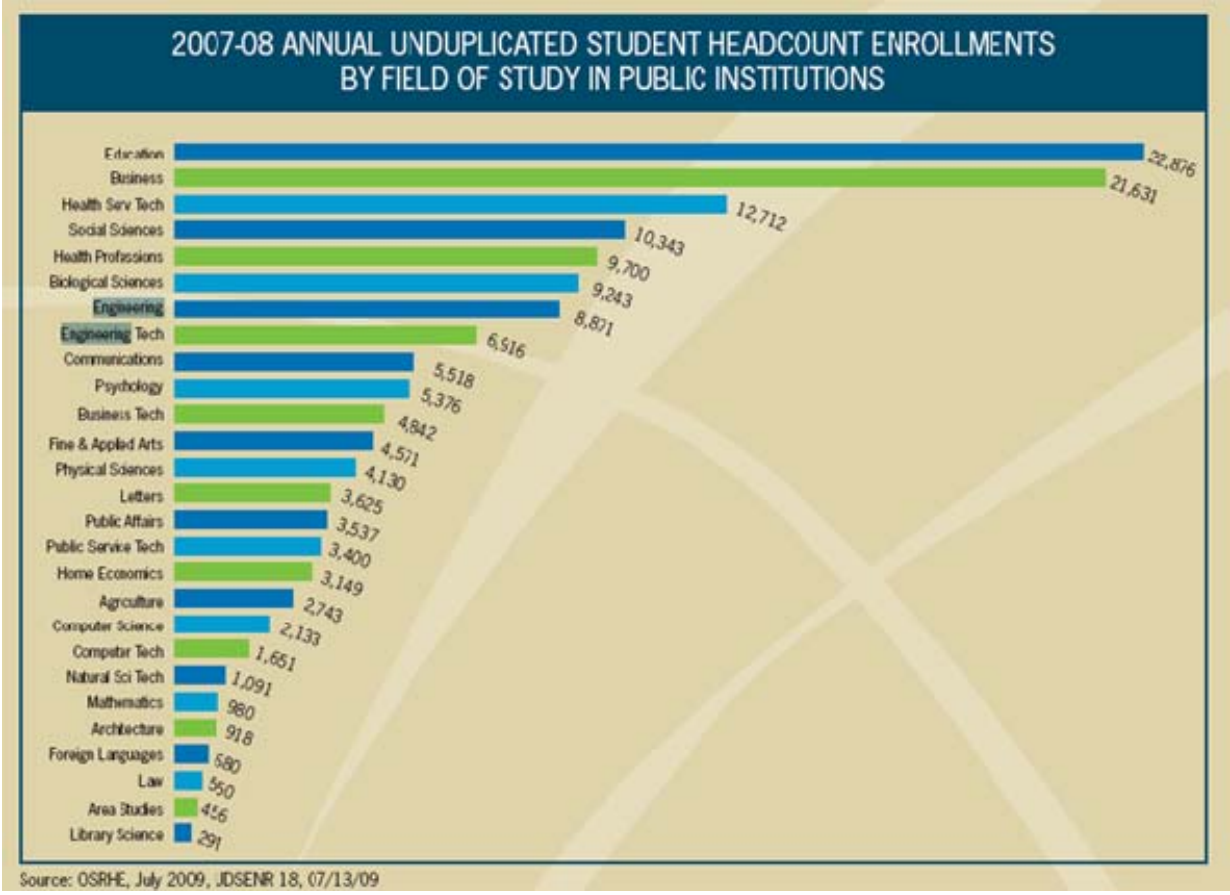


Figure 6.1: Enrollments by Field of Study in Oklahoma Public Institutions
Source: 2009 Annual Report the State of Higher Education in Oklahoma Degrees of Progress

According to data provided by the Oklahoma State Regents for Higher Education, the five year trend of engineering majors in public institutions in Oklahoma is provided in the Table 6.2. While the Enrollment represents all classifications of students enrolled as engineering majors, the Degrees data represents only those seniors who are awarded degrees. While we have seen a steady decline in engineering degrees conferred, there was a rise in degrees conferred in the academic year, 2008-09.

Enrollment					Degrees				
2004-05	2005-06	2006-07	2007-08	2008-09	2004-05	2005-06	2006-07	2007-08	2008-09
6465	6117	5905	6108	6480	1442	1352	1210	1165	1284

Table 6.2 Oklahoma State Regents for Higher Education Engineering Enrollment and Engineering Degrees Conferred

Additional data was provided by the Oklahoma State Regents for Higher Education, with regard to the percentage of aerospace degreed graduates who find jobs and reside in Oklahoma.

- Of the 2006-07 graduates of aerospace-related degree programs, 44% (91 of 205) were employed in Oklahoma in the aerospace industry one year after graduation;
- Of the 2003-03 aerospace graduates, 30% (47-155) were employed in the industry in Oklahoma five years after graduation.

In order to support our post secondary education STEM fields, young people must have a good education foundation upon which to build. Yet, several indicators are hoisting red flags for our economic development and workforce requirements. The Program for International Student Assessment (PISA) is an international evaluation of 15 year old students' academic performance. The first evaluation was given in 2000 and has been administered every three years since. PISA tests competencies in three academic fields: reading, science, and mathematics. It is coordinated by the Organization for Economic Co-operation and Development (OECD), with a purpose of improving educational policies and outcomes. The PISA results are distributed by participating country. Highlights of the 2006 PISA[23] are:

- 57 countries participated including 30 OECD countries and 27 other countries and sub national education systems (such as Hong Kong-China and Macao-China).
- On average U.S. students scored lower than the OECD average score on the science literacy scale. In fact, U.S. students scored 21st out of 30 countries participating. Students from 22 jurisdictions scored above U.S. students in science literacy; 22 jurisdictions scored lower.
- On average, U.S. students scored lower than the OECD average on the mathematics literacy scale. Thirty-one jurisdictions scored better than the U.S. students; 20 jurisdictions scored lower. Although there was no "measurable difference" in the scores of the U.S. students from 2003 to 2006; the mathematics literacy scores where lower in 2006 than in 2003.
- U.S. students also had lower scores than the OECD average score on two of three content area subscales:
  - Explaining phenomena scientifically, and
  - Using scientific evidence.
  - There was no measurable difference in the U.S. performance compared to the OECD average on the third subscale: identifying scientific issues.[23]

On a national level, the National Assessment of Educational Progress (NAEP) is an assessment that is given to children in the U.S. to assess what students know and can do in the following content areas: mathematics, reading, science, writing, the arts, civics, economics, geography, and U.S. history. While NAEP serves as a common metric, a requirement for all states; however, it is not given to all children. It is administered to schools that are selected at random in each state. Schools are selected in proportion to the demographics of the state population. According to The Nation's Report Card published by the U.S. Department of Education, National Center for Education Statistics, when compared to 50 states and the District of Columbia, 10 States scored below Oklahoma on 4th grade mathematics and six states scored below Oklahoma on 8th grade mathematics. Results are similar for reading.[50] National scores of the 2007 NAEP are shown in Figure 6.2.

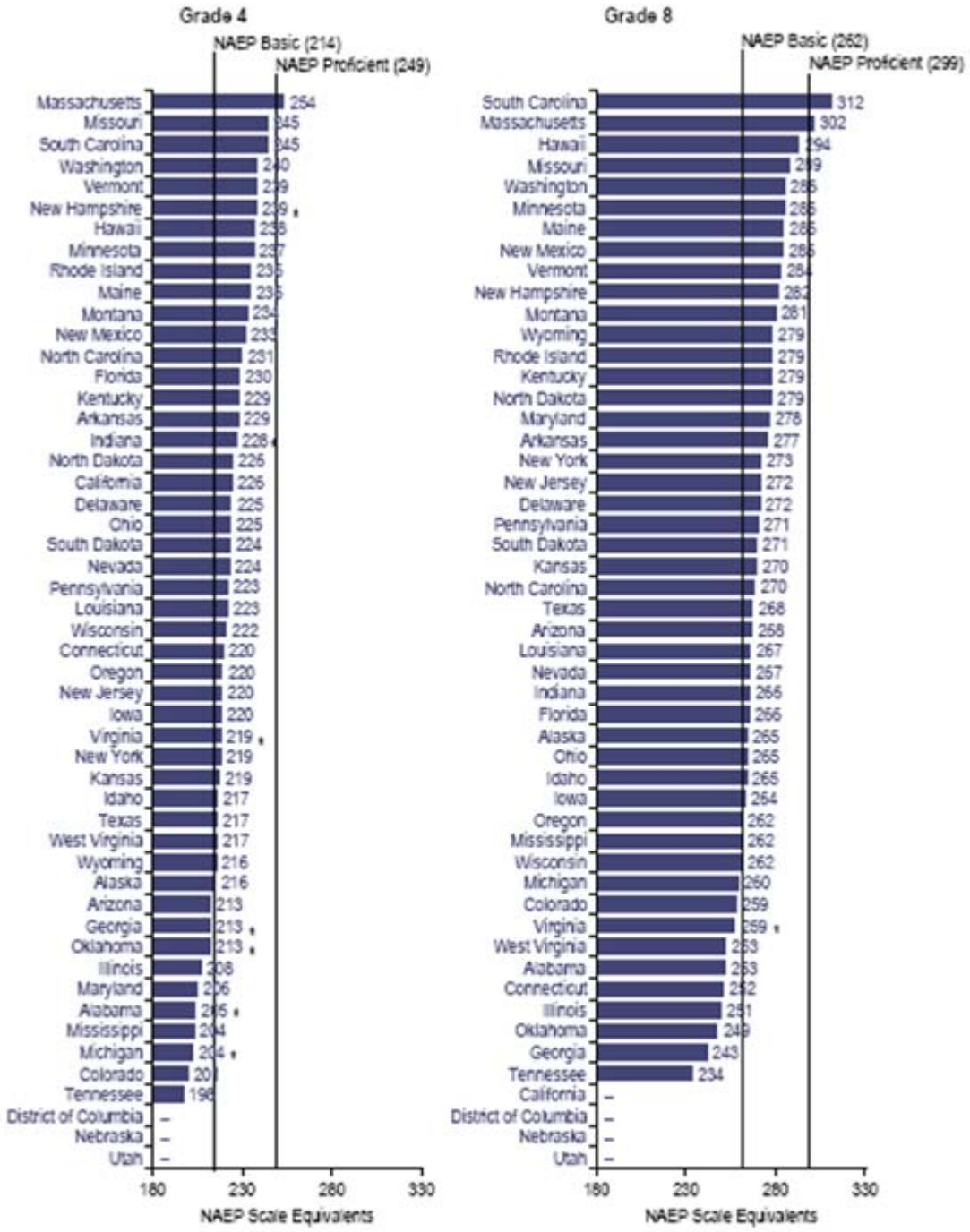


Figure 6.2 NAEP Scale Equivalent State Scores for grades 4 and 8 mathematics standards for proficient performance, 2007

Source: Mapping State Proficiency Standards onto NAEP Scales, 2005-2007
National Center for Educational Statistics. US Department of Education

The American College Testing (ACT) assessment is a standardized testing instrument designed to measure high school achievement for college entrance. First administered in 1959, the ACT has grown to represent academic gains in mathematics, science, social studies biology and English Composition. The ACT is the preferred college entrance examination in Oklahoma. Figure 6.3 illustrates the ACT Oklahoma State Profile[28] for the 2009 graduating class. It represents 27,052 students who took the examination.

The graph compares Oklahoma students' college readiness to students across the nation. The benchmark scores represent the minimum score needed on an ACT subject-area test to indicate a 50% chance of obtaining a B or higher or about a 75% chance of obtaining a C or higher in the corresponding credit-bearing college course. Sixty-seven percent of Oklahoma 2009 graduates who took the ACT in this group have a 50% chance of obtaining a B or better and a 75% chance of obtaining a C or better. According to the benchmarks, 33% of Oklahoma students have a chance of obtaining a B or better and a 75% chance of obtaining a C or better. In every subject area except College English Composition, Oklahoma scored below the national average. This graphic is a solemn picture of the college preparation our students have representing Oklahoma and the U.S.[20]

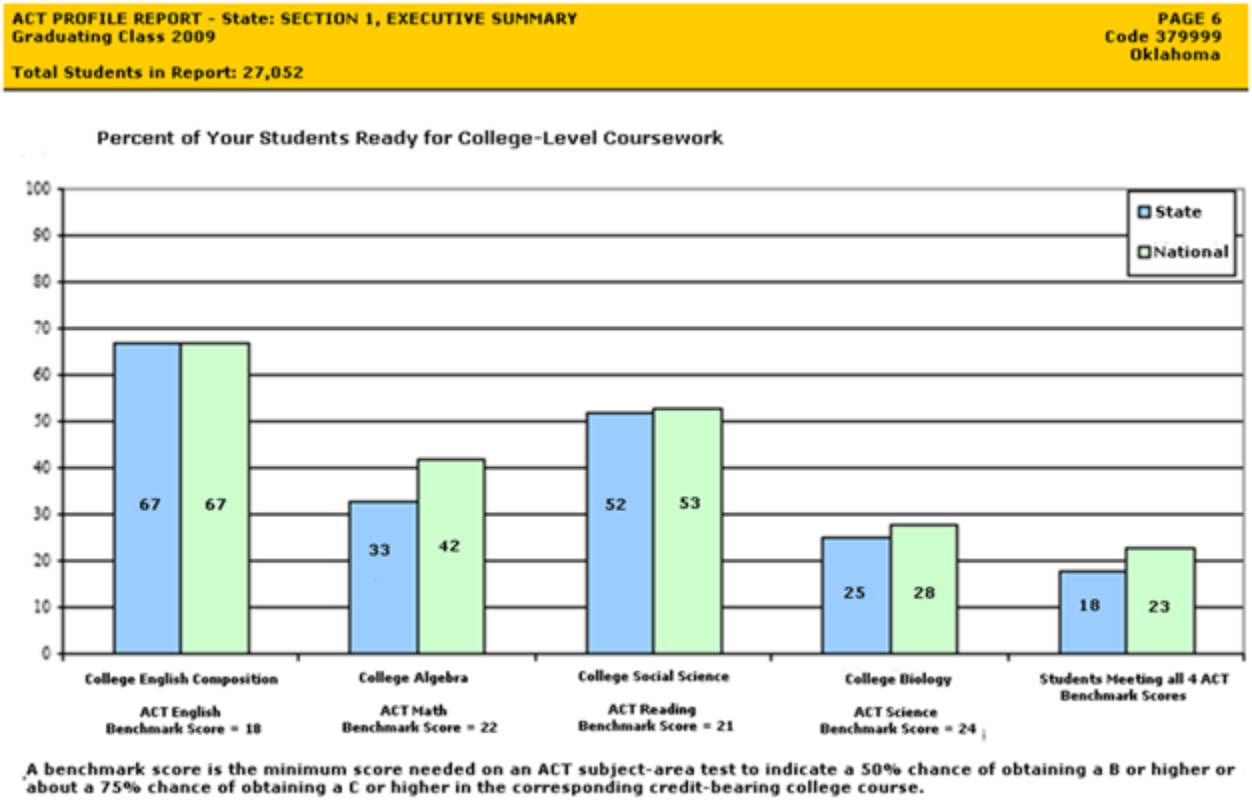


Figure 6.3 - ACT Oklahoma State Profile
Source: ACT Profile Report - State, Graduating Class 2009, OK

Graduation rates are also of concern as young people prepare for the job market and perhaps a career in aerospace. Several different sources give very different rates when describing the graduation rate; therefore, care must be taken to ensure clarity of the methods of calculation and when the tracking process begins for each rate. For example, according to the Alliance for Excellent Education, three rates exist to describe how many students graduate from our public school systems.

- State reported rate for NCLB = 85%
- U.S. Department of Education rate = 78%
- Education Week rate = 71%

Because of different types of calculation techniques, there exists a 14% gap between the State reported rate and Education Week reported rate. While many counties in Oklahoma do well to prepare their students, there are counties in Oklahoma with graduation rates below 50% as well.

While graduation rates and college remediation rates should be major concerns for the academic preparation of our young people, the story is not fully told yet. According to a National Task Force on Public Education[49] in 2005 out of 50 states and the District of Columbia, Oklahoma public schools ranked

- 40th on 4th grade reading proficiency tests;
- 43rd on 4th grade mathematics proficiency tests;
- 32nd on 8th grade reading proficiency tests; and
- 42nd on 8th grade mathematics proficiency tests.

Problems in reading and mathematics proficiencies occur long before the high school years. Our education system appears to be failing our youth and potentially our workforce. Schools must do a better job of preparing our students at all levels for the next level of instruction. Effective preparation entails accounting for multi-generational differences as well. Schools are no longer seen as the sole repository of information. Students now have access to the Internet, the world's greatest and diverse library, in their homes, on their laps and even in their pockets.

Many graduate education programs are pursuing unique avenues to attract and educate multi-generational students. Millennial students in particular are said to be more Internet savvy and possessing interdisciplinary thinking and learning ability and as a result many institutions have 'reformatted' graduate education. "The blurring of boundaries and reformatting of disciplines is nearly universal. We see it across fields from bioinformatics and computational science, and behavioral economics."[119] The proliferation of distance learning programs among graduate programs has also been a part of a concerted effort to engage the millennial student. The U.S. Department of Education reported a 119% increase (209,400 to 457,800) in students taking distance education courses between the years 2000 – 2004.[119] In addition, due to the millennials' need to clearly understand the return on their time, money and energy, successful graduate education programs have begin to place a focus on acquainting students with a variety of career choices beyond that of the typical faculty position. Far too long, many graduate programs have been preparing students for faculty career positions.

Failure to make wide-scale adjustments to teaching methods and environments to reach students inundated with information and technology will continue to diminish the quality of an American education. Educators must determine if by educating today's learners in the same way learners were educated in the 1970's and 1980's is it a realistic expectation to assume that those learners will be sufficiently equipped to be successful in the 21st century. America must remain at the forefront of innovation. Secondary schools must do a better job assisting students in distinguishing the proper career path that best fits for them at their current stage of life. No matter how much parents push, all students are not predisposed to attend a four-year college. However, from the discussions with aerospace industry leaders and supervisors, work-ready and college-ready should be synonymous. When a young person graduates from high school, they should be prepared to make the decisions concerning entering the workforce or continuing their education or both in some cases. Without proper preparation and higher expectations, our economy and our workforce will not be prepared to fill the positions in this 21st century.

6.4 Findings

6.4.1 Definition of Workforce Readiness

In this section, aspects of the roles, programs, and initiatives of education providers in aerospace workforce are discussed. The term "education" provider is used to describe those entities responsible for imparting to students the knowledge, skills and training necessary to be successful in academic settings and the workplace. Education providers in this study consisted of Early Childhood Systems, Public/Private School Systems from Kindergarten through the 12th grade (K-12), Career and Technology (CareerTech) System, Community Colleges/Universities, Government Training Systems, Industry Training systems and Workforce Investment Boards (WIBs). These entities are charged with the responsibility of creating and maintaining a steady pipeline of educated and skilled workers for the U.S. workforce. Education providers at all levels also exist as the hubs of career awareness dispensing information that will inevitably inspire and motivate students to follow a specific career path. Thus, these same education providers have the unsurpassed challenge to mold and develop a world-class pool of learners who are workforce ready.

RSP participants in this study were asked to define aerospace workforce readiness. While this may seem trivial, it was actually a time-consuming, grueling task. The most common qualities listed from RSP participants were core soft skills (e.g. good work ethic, interpersonal skills), basic skills (e.g. reading, math, blue print reading, verbal, writing, etc.), teachable attitude, and knowledge of industry terminology and standards. Definitions varied depending on the task level of the employee. RSP participants also reported workforce ready meant someone who could come in and start working without additional training.

6.4.2 Aerospace Workforce Preparation Programs in K-12 Education

RSP participants previewed the research presented in this section to brief them on education issues and programs within the state. Perceptions of the Oklahoma K-12 public schools were discouraging. When asked about steps to initiate systemic change, several insisted that the public school system required immediate reform or a complete overhaul. RSP participants noted that there remains a problem with the social aspects of influence in today's schools. One RSP participant indicated that all too often schools are perceived as social networks instead of learning institutions. Texting, emailing, picture mailing and conversing on social networking sites have helped create a more social society where certain aspects permeate and influence the school environment. RSP participants believe STEM awareness and education should begin in pre-kindergarten (P or PK) and continue into college years creating a P-20 pipeline.

Currently the graduation rate in some counties in Oklahoma is approaching 50%. A high percentage of those who do go on to college must enter some form of remedial education before enrolling in college-level courses. This speaks directly to the inability of Oklahoma schools systems, in general, to prepare students for colleges and careers and ultimately a life beyond poverty level. An environment of guided instruction, core learning which provides academic challenges, focused application and detailed accountability must be implemented if students in Oklahoma and throughout the U.S. are to maintain global competitiveness. The presumed lack of focused exposure to and/or interest in STEM areas in

primary schools appears to eliminate a large array of career choices available to students. This could eventually create an environment of mainstream users of innovations instead of innovative thinkers and inventors.

In 2007, former Oklahoma Governor Brad Henry stated, "As we enter our second century of statehood, the test will be whether we rise to the moment and transform our state into a global winner based on workforce skills and talent, or passively let our competitive edge slip away."[121] Despite the negative trend of STEM graduates nationally, Oklahoma is beginning to see some growth. According to information provided by the Oklahoma State Regents for Higher Education, Appendix E, Oklahoma engineering programs have more than 6,200 students enrolled on average each year. Oklahoma's college and university engineering programs have produced nearly 6,500 graduates during the past five years. The number of students and graduates are expected to increase in the future. Of the engineering programs offered in the Oklahoma State System, mechanical engineering programs produce the most graduates. Electrical, industrial, chemical and petroleum also produce a significant portion of graduates. Oklahoma ranks 10th nationally in the percent growth of science and engineering degrees conferred since 1996.[107]

RSP participants also reported that to sincerely make a change, focus must be placed on the teaching professionals in the schools, making sure the right people are in the right classes. Major concerns of industry representatives in the Skills Panels were that motivation to obtain a quality education is lacking in our society today. Children today seem less likely to get information in school that particularly interests them. RSP participants believed schools need to explore more avenues to get students involved and participating in activities. In addition, educators at all levels should be of great quality and high energy to keep students involved in learning. Public (K-12) school teachers are in a unique position that places them in the lives of students for a significant period of time each day. During the school day, some teachers, especially at the elementary levels, spend more time with students than the parents do. Teachers can either have a positive or negative influence, but almost never a neutral influence. Students' education, career and life choices can easily be affected by the teacher's ability to relate material to real-world applications, teacher recommendations, teacher's ability to motivate and inspire. This is a critical position of honor and responsibility that has a major long-range impact on our workforce and our economy. RSP participants recognized the importance of the classroom teacher. They noted that instructors who were able to motivate and inspire students should be compensated. Recommended compensation included forms of merit-based pay or simply increased wages; however, accountability was also a necessity. They were also willing and eager to assist by getting involved in the helping to impact the direction of public school education.

When asked to comment on their perceptions of our K-12 education system and less participation in mathematics and science on the part of students, a Government Service Supervisor replied, "I think teachers are God's gift to us. I wonder if it's because you don't see much math and science focus in the younger grades? Because if nothing else, they [teachers] have decided to become math and science

teachers in high school. So you may see it in high school, but if you don't see that good foundation in elementary, you're not going to make it to those AP classes in high school. So there's got to be a way to inspire those teachers that are going to become elementary mathematics and science teachers, and those that are elementary school teachers, even if they are not personally passionate about mathematics and science, to have an appreciation for why their children need to be passionate."

6.4.3 Communications with the Oklahoma Workforce Community

Continued discussions and research indicated the existence of a gap in the skill sets obtained by students in the classrooms and the skill sets required for a highly technical aerospace workforce. This gap contributes greatly to the deficiency of a skilled and innovative talent pool within America. Discussions in the Skills Panels further indicates that the communication between industry representatives and education providers is not efficient, although both agree it is a necessity for the development of a skilled talent pool. Some RSP participants admittedly reported they were unsure of how to communicate with education providers to influence those that are not meeting their local needs. A vital component of this study was to verify the existence of this gap and if verified determine the reason for its existence. Throughout this study, participants in the Regional Skills Panels and the Future Skills Panel emphasized the need for the aerospace workforce community, including education providers, to unite and work collaboratively for the purpose of engaging and expanding the aerospace workforce in Oklahoma. Some of the education providers include Workforce Investment Boards, CareerTech System, College & Universities, Industry Training Operations, and military installations. In this study, we probed industry participants to determine their knowledge of the education providers available to them in the state of Oklahoma. It was important to document if available education resources were being utilized to their capacity. RSP participants were asked their perceptions of education providers and their functions as they relate to supporting their organization's workforce needs. Responses as shown in Table 6.3, are reported as – Current Support, Desired Support, and current involvement through communications.

Survey responses provided insights as to the perceptions of functionalities of each of the service providers. Overall, services that are provided appear to be good. In all responses for "Desired Support," better communications with aerospace workforce needs was mentioned. Better communications and better collaboration among industry and service providers takes effort on both sides of the equation, and both sides appear to be willing to move forward to expand services and outline standards for a better-qualified workforce.

Service Provider	Current Support	Desired Support	Communications
Workforce Investment Boards	• Screens prospective applicants • Supports apprenticeship programs and incumbent worker training • Serves as a connection point for workforce development	• Focus more on post high school job placement • More focus on aerospace industry employment needs • More flexibility with funding	• Appears to be too much duplication of effort, many agencies are attempting to do the same things
CareerTech System	• Pockets of outstanding delivery systems and programs. • Provides access to training programs • Provides specific training	• Create training curriculum to meet the needs of the aerospace industry • Increase instruction in problem solving techniques • Directors who are trained in helping businesses	• Good relationships with industry • Provides quick turn around on training programs for industry specific needs
Community Colleges	• Provides aviation management degrees • Partnerships are established • Provides structural and customized organizational development training	• Ensure their Associates of Aerospace programs reflect industry required skills • Move quicker in planning programs • Curriculum driven by industry	• Relationships need to be developed to better to incorporate input from industry into programs
Universities	• Primary source for recruiting engineers, management, business, sciences, STEM degrees • Expanding programs for aerospace support • Intern programs • Research and IP development	• Interaction with aerospace industry • Workforce-ready graduates with technical and soft skills • Help promote aerospace careers in middle and high schools	• Relationships need to be better developed to incorporate input from industry into programs • Strong partnerships and cooperation
Out-sourced Industry Training	• Used for specialized training • Largest source of training • Targets near-term skills gaps that must be filled	• Training is good but budgets are sometimes the issue	• Beneficial training as long as needs are adequately communicated
Military	• Good resource for skilled employees • Highly disciplined employment base • Fertile recruiting ground	• Better communications with aerospace companies	• Communicate better with the workforce. This is sometimes an afterthought when considering employment

Table 6.3 - Perceptions of Service Providers Functionalities

6.4.4 Aerospace Workforce Programs in Oklahoma Career and Technology Education Systems

The CareerTech System in Oklahoma were widely viewed by RSP participants as a good concept that provided full time student services for career planning, adult development courses, and customized curriculum for specific industry needs. The CareerTech system is a statewide system with the mission to help Oklahomans succeed in the workplace and in life. The System was further noted as providing pockets of outstanding delivery systems and programs that provide structured and/or customized technical, safety, quality, and organizational development training. CareerTech System also offer a

broad range of services for high school students, adults and incumbent workers. RSP participants considered this system as a resource for students who are interested in more immediate, hands-on, relevant instruction. Workforce and college preparation skill training for students are also services provided that help create economic development in local communities. RSP participants stated that CareerTech System created specific training curriculum to meet the needs of the industry. They also viewed them as an excellent alternative career path for those not interested in four-year degrees. Several RSP participants indicated that they currently have strong partnerships established with the CareerTech System. For example, CareerTech has provided the Oklahoma workforce with ready-to-work employees through programs established for Tinker AFB and several aerospace commercial companies. More than 1,200 students have been hired as a result of partnerships. RSP participants commented, in general, that they have been open in continuously working with industry to define job skill requirements. CareerTechs attempt to teach what is needed as determined by the industry.

Most RSP participants believed training received through CareerTech System is industry specific. It is believed they serve to provide workforce with specific skills in touch labor. CareerTechs were believed to provide entry-level technical employees with basic skill sets, such as skills for an entry electronics technician. Some recognized the CareerTechs as entities who supply skills to support the hands-on work accomplished in MRO by providing up-to-date training for industry needs. Positive descriptors used to describe many of the Oklahoma CareerTechs were 'good training, good education, great support and huge cost savings.' Many RSP participants have established some form of partnership with them. Relationships between CareerTechs and many RSP participants were reported to have been leveraged to assist them in meeting mission needs, i.e. programs, education, certifications, etc. CareerTechs were also reported as being receptive to new programs. Education representatives participating in the Skills Panels exhibited a willingness to modify current programs to meet demands. RSP participants acknowledged that CareerTechs have strategically established themselves as a great feeding program for trades and crafts. Unfortunately, these institutions do not provide much interaction for careers in management and administration; however, science and engineer relations are growing.

Although CareerTech System run several concurrent programs to meet specific needs and provide quick turn around on training programs for industry specific needs, RSP participants indicated that they need to be able to keep up with future industry needs. This can be done through regular communication and partnerships. Education providers surveyed indicated there was a great desire to discern what industry needs in terms of education requirements. CareerTech representatives surveyed indicate they are ready and willing to make the necessary modification to programs to meet current and future demands. During some discussions outdated curricula was discussed, as well as outdated equipment, and lack of funding for equipment. Outdated curricula could be a result of inadequate industry standards to guide the curriculum. Outdated equipment was attributed to a result of a slow economy and lack of funding. Also, it is not always good business practice to invest in extremely expensive equipment when enrollment numbers for training are low. Additionally, several Industry RSP participants reported that a majority of students pursue jobs with a minimum knowledge base of technical skills and limited soft skills. Some noted that it is perceived that certain CareerTech System tended to place more focus on high school students than on older individuals.

6.4.5 Aerospace Workforce Programs in Oklahoma Community Colleges

Community Colleges were described as being similar to the CareerTech system in the sense that they served as an excellent career path for those not interested in bachelor's degrees. Community colleges were considered a good entry point for management study and continuing education. RSP participants also reported the community colleges provided higher education and workforce development resulting in similar opportunities as CareerTech, but many of the opportunities were more likely to lead one to obtaining a Bachelor degree. These college types were considered either a resource for students interested in careers that do not require 5-6 years of education or for those working toward a university degree in the future. Many community colleges provide associates degrees in areas such as aerospace program management and other aerospace related fields. In contrast, RSP participants believed CareerTechs provided specific industry-related training whereas the training and skills provided by community colleges are more generalized. This type of provider appears to be slower than CareerTech and major universities to align its curriculum with industry needs. In support of this notion, community college representatives in the study recognized their need to grow and change to help industry meet its demands. For example, Oklahoma City Community College (OCCC) and Rose State College are two of Oklahoma's community colleges currently working with Tinker AFB to admit and educate experienced workers. Some course content applies to engineering degrees and programs tailored to meet industry needs.

6.4.6 Aerospace Workforce Programs in Oklahoma Colleges and Universities

Oklahoma colleges and universities were described as institutions that educated at high levels most commonly providing the four year degrees and graduate degrees in aviation, engineering, management, business, sciences and mathematics. Oklahoma has approximately 41 major colleges, 37 of which offer bachelor's degree programs. Oklahoma State University (OSU), University of Oklahoma (OU), Cameron University, Northeastern State University (NSU) and the University of Central Oklahoma (UCO) are among the top five colleges and universities in Oklahoma. RSP participants strongly believed that the college/university system provides students a quality education that can help industry and technology advancements. Many of the RSP participants used colleges/universities as their primary sources for recruiting engineers and professional staff. Some RSP participants describe these institutions as showcasing programs that continuously evolve to fit industry needs. RSP participants also recognize these entities as vital assets for research and Intellectual Property (IP) awareness and development.

Government Service Supervisors talked about the Design/Build programs that are active at the University levels. When asked to discuss this, the reply was "My experience is very similar to that. I'm an EE, well I was in the past, and my experience is exactly that. The OU grads come out, and I'm an OU grad, and they are very book oriented, technical, that kind of thing. And then I see these OSU grads come in and they are better at doing the troubleshooting, isolation problems, coming up with more creative ideas and I think it goes back to they have a little more lab work up there, a little more hands on. So I think there's a big plus in that. My benefit was I was Active Duty AF so I was a tech for many years. That tech experience would be beneficial if you could emulate that in some kind of way at the colleges."

Surprisingly, the RSP participants surveyed reported that they did not have a great need for degreed programs at their businesses. While Government Service Supervisors discussed the need for the A & P licensure for touch labor type positions, Industry RSP participants discussed the need for quicker training and training that might consist of parts of the A & P rather than the full licensure. Degreed workforce types are needed primarily for engineering, research, business applications, and upper level management. The need to provide financial management, program management and contract management coursework at the Masters level was repeatedly discussed as potential offerings for aerospace engineers. Most RSP participants expressed limited to no formal engagement with Oklahoma universities and colleges. Some attributed the lack of involvement to the location of their business in respect to the location of a major university.

Government Service Supervisors were asked to describe some of the best program aspects they would want to convey to our education providers. One commented, "some of the best new hires that I have seen and have been happiest with are the ones that were one on of the Design/Build teams where they interacted with several other people. They tend to be more adaptable to what we do out here. In my area where we have aircraft sustainment, and you're in charge of maintenance and repair and modification for that AC. So just think of modification stuff, things that are no longer supportable. I have a piece of electronic stuff over here that I can't even get parts for or order anymore. So, the old stuff needs to come out, the new stuff needs to go in, what are you going to put in? You've got new technologies, got analysis of alternatives that you're going to crank into this modification you know those kinds of things that they need to be able to understand. Financial piece and the overall integration of the idea, not just, here Junior go work on this calculus problem. And that's where I see these people that are working on these teams are at least getting a taste for what it takes to work on a team because, we will have a team of engineers Program Management people, specialists, contracting officers, money people, all on a team and we all have a different piece of it. I need to understand what you need so we can hold hands and sing here." This is the type of interdisciplinary activities that were discussed in several of the interviews concerning team work and individual responsibilities at the same time.

Government Service Supervisors were asked if there was a message they would like to convey to our education providers and one stated, "If there is a recommended change to coursework it would be to have an entrepreneur type atmosphere where you have, in an academic setting, your people from the College of Engineering, people from the College of Business, Arts and Sciences, getting together in kind of an entrepreneur type environment under the tutelage of a professor, working toward a solution to a problem to bring something to market. That way everybody gets involved with what this item has to do, how do you finance it; with a certain production rate, how do you tool it; how do you go to the bank and convince them to loan you money to do that." This discussion specifically involved talks about engineers and how graduates could benefit from a whole process-type of experience.

6.4.7 Aerospace Workforce Programs in Private Institutions

RSP participants described out-sourced training as the process by which companies went outside their walls to get industry training for employee development in a variety of areas such as quality systems,

management, or company-specific technical needs. This type of education provider was understood to provide more specialized training courses for the industry. RSP participants reported using this type of education provider for specialized certifications. A limited number of RSP participants indicated most of their workforce skills needs were met by this provider type. Spartan College of Aeronautics and Technology in Tulsa is one such provider. Some RSP participants preferred this type of provider because in their experience, it provides better training than CareerTechs or Community College.

RSP participants located in remote areas and those with limited funding rely heavily on out-source industry training because this type is useful to meet short, targeted, intensive time-sensitive training needs. Moreover, RSP participants believed this type of training was used to target near-term skills gaps where training needs were needed immediately.

6.4.8 Aerospace Workforce Programs in Workforce Investment Boards

Oklahoma WIBs were established in compliance with the Workforce Investment Act of 1998 to act in concert with local elected officials to manage, monitor and continuously enhance Workforce Investment Programs in the Workforce Investment area. They are strategically positioned around the state to align and leverage valuable resources to make the Oklahoma workforce system more demand-driven and efficient.

The Oklahoma Aerospace Triangle, as shown in Figure 6.4, was the target area of this study and therefore seven WIBs were represented: North Central, Central, East Central, Southeast, Eastern, Tulsa and Northeast. WIBs are tasked to work with multiple representatives from industry, education, economic development and employment agency arenas to assist in creating a highly skilled and productive workforce in their respective areas. Despite their mission and presence throughout the state, when asked to describe a WIB and its function most participants had no knowledge of their existence. When RSP participants were asked about the functionality of the WIB, some were familiar with the term 'WIB' but did not understand what they were or how they benefited the state. A few suggested that WIBs could assist with industry workforce needs and provide WIB workers who are trained in helping businesses. Other perceptions were that WIB activities focused more on K-12 education placement and getting people back to work as opposed to helping existing industries with workforce needs.

Figure 6.4 – Oklahoma Aerospace Triangle

A few RSP Participants did highlight some of the challenges facing the WIBs as well as some of the advantages WIBs bring to the industry. It was perceived that more flexibility is needed in terms of

spending because challenges arise when working with federal funds to address state needs. Some also stated the WIBs encounter further challenges because they can only work with a workforce that is difficult to employ. WIBs were believed to provide avenues for people to improve their life through education, job skills, and employment, promoting information about multiple career options to include aerospace. WIBs were described as entities that worked to develop the funding necessary for the development of training required in the industry. They were even denoted as a viable source of funding for apprenticeship programs and training for incumbent worker. It was also reported that WIBs provide incentives for applicants to consider the State of Oklahoma as a residence and place of employment.

6.4.9 Aerospace Workforce Employment in Government

RSP participants considered Government/Military as fertile ground for recruiting disciplined, trainable employees. Many referred to this source as a great place for young people to gain the critical mix of technical education and practical experience. Some RSP participants have worked with the Veteran's Resource Center to provide personalized assistance to veterans. Some RSP participants suggest that too many times the military is a last resort or afterthought when seeking training or trained workers, whereas it should be an immediate option to acquire the best and brightest.

Although skills sets are somewhat broad in some branches of Government, there is very specific training in some fields such as pilot, mechanic, and security. RSP participants view workers transitioning from the Government/Military as disciplined, teachable, mission-oriented and exhibiting more work ethic possibly because of the discipline learned in the military services. Through a better pay system, the government is attracting workers in aerospace at the expense of civilian companies. Some of the RSP participants viewed the government as a competitor for highly trained aerospace workforce manpower, taking well-trained highly skilled workers away from private RSP participants. This comment is perhaps a result of the massive upsurge in hiring by local military bases within the past two years. One aerospace company lost over 80 employees to Tinker AFB in a four month period. Efforts to find replacement employees with adequate training was virtually impossible in such a short period of time.

6.4.10 Industry Reflections on Education

Industry participants were asked to identify one thing they would request from the education providers. RSP participants overwhelmingly requested that education providers incorporate curriculum to help students establish a better work ethic. Work ethic was one of the most reported soft skills that was absent from employees, especially employees under the ages of 32 or those who fall in to the Millennial generation timeframe. RSP participants discussed frustrations with employees who do not report to work on time, who do not report to work every day, and who do not take pride in their work. Many colleges do not require students to come to class consistently or on time and as a result, students, to their detriment, carry those same habits into the workforce. Even though this may tend to be a cultural issue, from the perspective of industry, education providers are expected to prepare students in accordance

with workplace expectations, which may include reducing absences and increasing punctuality. Both directly contribute to achieving workforce readiness.

RSP participants also expressed the need for education providers to equip students with a stronger knowledge of basic skills, problem solving skills and reading comprehension. Specifically, they reported the existence of a gap between technical skills offered in schools and actual skills required to work successfully in industry shops such as MRO machine shops. RSP participants reported that new hires appeared to be overwhelmed and exhibited limited knowledge of processes and procedures.

Several education providers did point out that they were restricted by limited funding, aging requirements, and aging and out-of-date equipment. Variance in responses may be due to programmatic differences in the institutions. Some RSP participants requested the establishment of some form of standard curriculum on general manufacturing certification aimed at all levels to include entry level and transitioning adults including those who are entering the workforce from military service. Several RSP participants also stated the need for new college or technical school graduates to have jet familiarization training. RSP participants have endured costly damages caused during repairs due to employees' lack of knowledge of the entire plane. This familiarization is also needed for the technician who works on aircraft.

Education providers were asked what processes or standards were used to build and maintain a course requirement to service the aerospace industry. The detailed process depended on the curriculum being maintained and the type of certifications that were associated with it. Providers further noted they were informed by industry as to what soft and technical skills are needed in the industry. Providers acknowledged their attempt to customize courses according to employer requests. In the skills panel discussions it was widely expressed that the coursework for the acclaimed A&P License is outdated but still heavily solicited by the aerospace industry. The FAA A&P license is currently the dominant license widely accepted in aerospace. From further discussions, RSP participants indicated because of the proliferation of this license and lack of uniformity in instruction and application, many new A & P License completers still lack the skills and training needed to be productive without supervision.

Some CareerTech providers reported meeting with major RSP participants once a month to discuss items such as needs, program viability, and feasibility of partnership competencies where applicable. University representatives indicated that a similar process took place for them but it was more sporadic. Some providers also acknowledged having an Industry Advisement Committee to help build and maintain course requirements to service the aerospace industry. This committee was available to make recommendations pertinent to new and existing curriculum. Providers also reported researching job trends across the state in order to create new programs. The ONET website was also referenced as a resource to acquire job-related information.

When asked how they update and maintain the coursework so that content remains current with industry requirements many CareerTech System and colleges indicated that they met with some form of Industry Advisement Committee or manufacturing alliance to perform a general review of curriculum. Most indicated they only met with such committees about once a year with a few exceptions.

Furthermore they noted that the advisory committee worked to approve curriculum but the actual meetings are general and do not consist of detailed investigations of the curriculum.

A few providers had an advisory board that met regularly to discuss industry requirements such as those requirements approved by the FAA. Although there were few providers who reported receiving constant feedback from the Industry RSP participants, they noted when dealing with a certification program, the process is slow on making change and adaptation. Almost all providers reported that communications with K-12 representatives in an advisory forum were non-existent. Moreover, representatives from the K-12 system reported being unaware of industry needs. There appears to be overwhelming communication gaps between K-12 and industry as well as K-12 and other education providers.

Education representatives readily admitted that more work was needed on forecasting industry needs. They also acknowledged the need for more "hands-on" training with the use of cutting-edge technologies. Due to funding limitations, the equipment and facilities needed to provide the required training is unavailable. Representatives suggested having an effective centralized aerospace resource center to assist in bridging the communication gap. Providers reported that industry seemed to have a limited vision when it came to training. In specific, they want training for the "today." This demand is difficult to meet from an education provider perspective because they have to undergo strict procedures to develop and approve curriculum for any training. Once the proper approval is granted for new curriculum and/or training, that training may no longer be in high demand by industry due to market changes or the training may now be supplied by another source. While industry cannot forecast individual company needs, it should be able to forecast a general requirement industry wide, regionally or statewide based on retention, retirement and general growth data. This is where Aero Work Force Panels can create a forum and statistical consolidation forum.

When attempting to meet the 'immediate' demands of industry, education providers are challenged with providing a balance between the needs of the industry and not over saturating the market with graduates. By the time they graduate the first class of specialty engineers or workers, these positions may no longer need filling or there may be a limited number of positions available, leaving a large number of graduates without jobs. Providers also indicated, ultimately education is just the base where experience builds on implying that some form of on-the-job training should be expected. Better relationships would assist with current program availability because some providers report sometimes a specialty program or course is offered but there is limited participation that in effect cannot be justified financially so the program or course is discontinued. Education providers also complained of poorly defined job descriptions, which make it difficult to align workers with the training necessary for them to successfully execute their job in the workplace. Providers also indicate that a big problem is that industry is not necessarily aware of the standards being taught in the schools. One education representative indicated without industry buy-in, "…it is difficult to plan a certification program where the students will have jobs with skills acceptable to the industry."

Education providers were asked if they believed disconnects existed between what they provide and what industry needs. Many overwhelmingly thought there was a lack of support and communication between industry and the education facilities and felt that relationships could be better. These

relationships are vital because many providers are challenged with budget issues that directly affect the access to adequate facilities, equipment, and tools necessary to educate a highly skilled workforce.

When asked about the specific obstacles that exist to meet industry workforce skills requirements, many education providers referred to the lack of funding and the lack of collaborative efforts between education providers and industry professionals. To provide some of the training requested, certain facilities and equipment are required; both of which can be extremely expensive. Providers indicate that in the cyclic nature of the aerospace industry, it is not feasible to invest in the huge expense in equipment when the demand for training may not be there three years from now. Furthermore, industry sometimes donates equipment but by the time of donation. However, at that point, it is usually worn out or outdated. To share in the financial burden of providing updated tools and materials, education providers expressed the need for financial investments from the industry. However, some companies are forced to use antiquated tools and/or equipment due to financial constraints, so when they donate this equipment to the CareerTech systems, it is obsolete. Providers reiterated that there should be definitive partnerships between industry and education to ensure effective communication and constant flow of information. This would allow industry needs to be effectively communicated and documented, and eventually met.

Company internships are available with some of the participating industries. However, providers reported some of their students had problems when participating in company internships. The skills learned during internships are considered supplemental to a student's education. Companies were not allowing students to obtain hands-on experience, which limited educational experiences and prevented some students from obtaining relevant skills for the workforce.

Though industry representatives agreed that a lack of communication exists, they indicated operation or instruction needs to be at a more rigorous level. For example, designed curriculum should provide instruction above the Federal Aviation Regulations. This issue of low academic standards in our education system was also a concern of the Industry Experts. Several expressed much concern about the rigor of the coursework in the education system. They also discussed the necessity of students learning to "stick with something until they finish." This is one of those attributes that advanced content coursework strengthens.

Both industry and education providers were asked how to best communicate actual workforce skills to the education institutions. Participants suggested leveraging social networking and other web technologies, creating more partnerships, creating collaborative website which industry displayed needs, enhancing the existing dialog, hiring teachers by placing them in the industry work place for summer months. This would enable teachers to experience the industry functions first hand in order to understand better the academic requirements of the workforce. Internships, partnerships in mentoring between

teachers and experts in the field, and utilizing industry professionals to teach in the classroom were all suggestions for bringing the industry into the classroom and the classroom to industry. Government Service Supervisors also discussed mentoring.

Some participants in the study further highlighted opportunities in education, research and emerging technologies in Oklahoma. The Knowledge Is Power Program (KIPP) Outreach charter School, Northeast Academy for Health Sciences and Engineering, and the Oklahoma School of Science and Mathematics (OSSM), all located in Oklahoma City, were schools identified by study participants as high achieving schools in the STEM areas. In addition, OSSM has initiated efforts to make curriculum available through online sessions and video conferencing in rural areas and at some of the CareerTech sites. Rose State is another institution that is teaming with Oklahoma State University to offer aerospace programs at their Midwest City graduate degree programs in aerospace-related fields. Additionally, MRO University, an Oklahoma aerospace education and training institution, established in 2010 was created to meet the aerospace training needs.

The Oklahoma State Regents for Higher Education has outlined the aerospace and aerospace-related programs in the public colleges and universities in Oklahoma. These can be found in Appendix E.

6.5 Oklahoma Aerospace Workforce Education Implications

Throughout this study, RSP participants and Industry Leaders have expressed the necessity for industry leaders and education providers to work together to communicate, collaborate, and coordinate functions and coursework related to the aerospace workforce preparation. Many good, purposeful discussions took place between industry representatives and education representatives. It is clear that communication gaps lead to other gaps in the system. Based on the research concerning education in the U.S. and in our state, our P-20 education must do a better job at preparing our population for the workforce, at whatever level that may be. This is not just a public school problem. It is a complex issue that has many tentacles, only one of which is the education system. It involves educators, parents, industry representatives, government officials - it involves everyone. In Skills Panels and all other interview sessions, teachers were highly respected, highly commended, with very high expectations on student achievement.

The implication from this portion of the study are listed below.

- Develop effective youth mentoring programs through partnerships with industry and schools;
- Provide peer mentoring for teachers to help with student achievement;
- Develop more partnerships between industry and education;
- Provide opportunities for teachers to aerospace industry shadowing activities in summer;
- Provide and promote internships in summer for teachers;
- Financially support the needs of the education communities;
- Facilitate Integration of the curriculum across various content areas;
- Help teachers better understand real world aerospace applications within current curriculum;
- Model our programs with other countries that have had success;
- Encourage more hands-on, interactive, project-based approach to learning;
- Execute some caution taking into account the generational differences;
- Educate teachers in the STEM curriculum;
- Allocate more funding for math and science specialists;

- Initiate career fair/science fair possibly mobile;
- Provide summer academies for teachers, students, and counselors;
- Create virtual social/professional networks for students to cooperate, compete, share and join in aerospace related projects, information, learning; and
- Establish relationships with national and global organizations to share best practices and future requirements.

SECTION 7: AEROSPACE RETIRING WORKFORCE

7.1 INTRODUCTION

According to research, within a decade, the United States may not have enough workers to fill expected job openings. When the Baby Boomer generation does finally retire, it has the potential of creating a massive hole in the infrastructure of the aerospace industry. A labor shortage as described could leave as many as 30-40 percent of the jobs vacant. Additionally, the primary job opportunities are in the health care and social assistance. This section will discuss the effects of a workforce loss and the preparation of the aerospace industry.

7.2 SUMMARY OF RESEARCH OBJECTIVES

The aging workforce is an issue in almost every profession. It is especially critical in the aerospace industry because of the potential knowledge lost in manufacturing particularly at the touch-labor level. In this section the objectives are:

- Provide a literature review of the background on the aging workforce and why it will critically effect our economy;
- Provide reports on industry needs as related to the expectations of an exiting workforce;
- Investigate and document both near- and long-term processes our aerospace companies are employing in order to prepare for a retiring workforce; and
- Gather information from Human Resources and managers who are currently dealing with retiring workforce issues in the workplace.

7.3 LITERATURE REVIEW

According to the Congressional Budget Office, people born between 1946 and 1964 are recorded as the most prosperous generation in U.S. history.[5] Denoted as baby boomers, this group is reported as being employed at salaries that are consistently higher than their parents are and have accumulated more private wealth. To date, a number of them have reached the point of retirement eligibility and over the next ten years, several millions more will reach that milestone and go on to retire. In the next ten years more people would be comprised in this group than any other. Collectively these individuals make up today's aging workforce, more than 40% of the American labor force.[54] Unfortunately, the U.S. is not reproducing at a rate that would ensure the replacement of an aging workforce should workers retire at the time of eligibility. This aging issue not only affects the U.S. but also countries like Italy, Germany, and Japan. A 2007 study indicated that Italy and Germany will experience a 47% and 43% decline in their worker population respectively, by the year 2050.[65] Worker shortages in Japan are expected to decrease by 0.7% a year between 2000 and 2025 and 0.9% thereafter. Due to the lower birth rates and smaller immigration populations, countries like Japan, Germany and Italy are expected to feel the affects more than others.[56] Labor shortages can make it difficult for companies to delivery new technologies at the rate necessary to meet the current demands of customers both commercial and military. In the U.S., this leaves many pondering the questions of whom or what will fill the remaining jobs or will the U.S. lose work and competitiveness as a result of declining human capital. In our research the use of foreign nationals was given by some as the answer to the question of 'whom,' while the use of technology was presented as the answer to "what' will fill the remaining jobs. In this present day many industries, aerospace and defense included, require U.S. citizenship for employment so the proliferation of foreign nationals could not coexist in such industries unless specific laws and regulations are modified. If

technology is to be used one must decide just how aggressively technology should be leveraged to fill the ensuing labor shortage gap. Whatever the answer is, the population of individuals in the baby boomer age group eclipses those groups that succeed it. Without a doubt social or government programs aimed at supporting retirees will experience an immense amount of strain.

This in particular creates great concern because of the inevitable budgetary pressures that will be felt by the U.S. federal government. The population of retirees will grow much faster than the taxpaying workforce they leave behind which make it difficult to fund federal programs such as Social Security and Medicare.[27] This means that the tax dollars of an even smaller workforce will be tasked with the intense pressure to support an even bigger dependant population.[65] Social Security and Medicare benefits, once thought to be guaranteed for all U.S. retirees, will likely be drained completely before many can actually receive any benefits barring the insertion of a robust financial plan by the federal government. Although today's older workforce is said to make more money than those that preceded them, the question remains have boomers actually accumulated enough wealth to sustain them once retirement occurs. Some have saved less thinking they would receive the full amount of benefits entitled to them under the current law. Yet others have long dismissed the idea of receiving full benefits let alone any portion and have scrambled to save more, which has caused them to delay retirement for an indefinite number of years. The current economic downturn has further created a sense of urgency in the minds of many to think more strategically to ensure a stable future. In addition, with the imminent departure of so many knowledgeable human assets from the workforce, the nation and most companies are bracing themselves to ensure business viability for the near and long-term future.

Group	Participation Rate			
	1988	1998	2008	2018
16 and older	**65.9**	**67.1**	**66.0**	**64.5**
16 to 24	68.4	65.9	58.8	54.5
16 to 19	55.3	52.8	40.2	33.8
20 to 24	78.7	77.5	74.4	71.3
25 to 54	82.9	84.1	83.1	82.5
25 to 34	83.3	84.6	83.3	82.4
35 to 44	84.6	84.7	84.1	83.2
45 to 54	79.6	82.5	81.9	81.7
55 and older	**30.0**	**31.3**	**39.4**	**43.5**
55 to 64	54.6	59.3	64.5	68.1
55 to 59	65.7	69.5	73.1	75.9
60 to 64	43.4	46.8	54.1	59.7
60 to 61	53.6	56.5	62.0	66.8
62 to 64	36.3	39.9	47.2	54.7
65 and older	**11.5**	**11.9**	**16.8**	**22.4**
65 to 74	16.1	17.7	25.1	30.5
65 to 69	20.1	22.5	30.7	36.9
70 to 74	10.9	12.5	17.8	22.0
75 to 79	6.1	6.6	10.3	14.3
75 and older	**4.2**	**4.7**	**7.3**	**10.3**

Table 7.1 Civilian Labor Force Participation Rate
Source: US Department of Labor Statistics

Table 7.1 illustrates the labor force participation rates for the years 1988, 1998, 2008, and the projection for 2018 paint a picture of growth of the retiring workforce and the projections of the participation rates of the non-retiring workforce. The projection illustrates the diminishing number of labor force participants as the population ages.[12]

Figure 7.1 provides a projection for the numeric change in age in the labor force from 2010 to 2018. The swells in the graphs are representative of the Baby Boomers and their retirement window. The next swell is not so large but it does occur during the Baby Boomers children's generation. Some of the research calls this group the Boomerangs.[12]

Although Social Security and Medicare are national concerns, there also exist other pervasive issues that touch businesses across the U.S. as a result of aging workforce. Some of the most dominant issues are:

- knowledge capture,
- knowledge transfer,
- skill set and knowledge replacement, and
- loss of leadership.

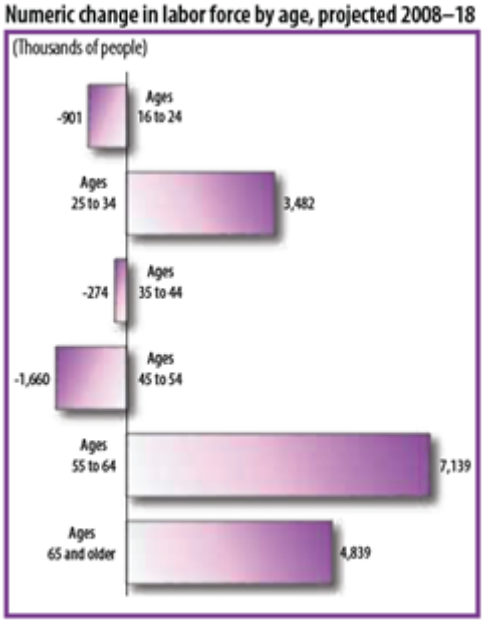


Figure 7.1 Numeric change in labor force by age, projected 2008-2018

With the departure of so many workers, so goes hundreds of years of collective expertise. In many cases, workplaces consisting of younger personnel will be left void of the strategies and processes that were necessary to the viability of the company. The younger workforces standing in line to replace the retiring workers are often viewed as lazy and lacking work ethic, which leaves some managers concerned about the future workplace. On the other end of the spectrum some younger low to mid-level managers who actually have an awareness of the aging workforce are wondering about the future state of their company's high-level leadership since some of their older counterparts will be transitioning out of the workplace in the near future. Companies have determined if these issues are not addressed, they could suffer a huge decrease in their service and/or production, loss of corporate earnings, and in some cases be forced to eliminate certain areas of their business. A 2010 study by Accenture indicated that more than 50% of industry executives surveyed and interviewed thought that there was the potential for decreased business performance due to the changing workforce demographics.[58] More than 65% had little confidence in their company's ability to execute programs to develop the leadership necessary for the future.[58]

In response to the glaring aging workforce predicament, several companies have begun to establish enterprise wide programs and practices. In contrast, others have yet to respond. In a 2008 survey of 118 organizations conducted by the Institute for Corporate Productivity (i4cp), 71% of the companies had yet to incorporate retirement forecasts to address knowledge transfer practices.[59] Only about 33% were reported to incorporate a skills gap analysis into their retirement forecasts. In a similar study conducted in 2008 by the National Association of Professional Employer Organizations, 28% of the 404 small businesses surveyed reported they were currently establishing plans to create an environment for knowledge transfer to new hires. Only 4% had actually created formal procedures to create such an environment.[10] These figures suggest little has been accomplished by many organizations to ensure stability should an immediate wave of retirements occur. Table 7.2 taken from the Bureau of Labor Statistics[81] illustrates the steady decrease from 1998 to 2010 of the percentage of workforce who are under age 55 and the steady increase of the workforce aged 55 and older. The statistics also project that there will be a steady increase in the percent of our aging workforce who remain in the workforce.

Civilian Labor Force Percentage (Group/Total Employed Population)					
Age	**1998**	**2008**	**June 2009**	**June 2010**	**2018**
16-24	15.9	14.3	12.6	12.2	12.7
25-54	71.7	67.7	68.1	67.8	63.5
55+	12.4	18.1	19.4	20.1	23.9

Table 7.2 Civilian Labor Force Percentage and Projection
Source: Bureau of Labor Statistics.
http://www.bls.gov/news.release/ecopro.t01.htm

Concerning academic, 26% of the STEM degree holders within the American labor force are reported to be age 50 and older. Forty percent of STEM doctorates are age 50 and older. Comparing STEM bachelor degree and doctorate degree holders, reports indicate that they leave full-time employment at age 62 and 66 respectively.[18] Not unlike other industries, the U.S. aerospace industry finds itself with a graying workforce that is presently at the front doorsteps of retirement. In studying the U.S. aerospace industry's response to the issue of retirement, these factors threaten its ongoing stability. Moreover, congress has determined that the aging workforce is an issue that threatens to affect the future competitiveness of the aerospace industry.[60] The approaching workforce retirement has been described as a virtual "silver tsunami" of skilled workforce reduction which will leave the aerospace industry void of its institutional knowledge base.[61] In a 2009 workforce study performed by Aviation Week, the average age for workers within the aerospace and defense industry is 45. This same study reported 43 as being the average age of engineers, while 54 was reported by Boeing as the average age for aerospace engineers in specific. The mean age of the national workforce is 39.9. In whole, 9% of the workforce is over age 60 and 29% of the workforce are between age 50 and 60. According to the U.S. Department of Labor, over 58% of the Aerospace workforce is over the age of 50.[62] According to *Launch into Aerospace*, several companies report that over half of their workforce will be eligible for retirement in 10 years.[24]

RETIREMENT/ATTRITION	AVERAGE % ELIGIBLE RETIRE 2008	% RETIRED 2008	% ELIGIBLE RETIRE 2011	% ELIGIBLE RETIRE 2013
Engineering	8.3	2.3	14.5	17.3
Research & Development	15.3	15.0	21.1	24.8
Enterprise IT	10.4	4.2	13.5	15.8
Engineering Technician/Aides	12.6	3.6	17.5	22.1
Program Management	13.8	4.5	15.7	25.1
Financial Analysis	12.0	6.9	15.0	19.0
Business Development	18.0	7.5	19.7	25.4
Non-Exempt Touch Labor	11.4	6.1	15.8	19.5

Table 7.3 Retirement Attrition

In Aviation Week, 2009 Workforce Study,[63] aerospace retirement data was captured by job category. In 2008 a greater percentage of workers in the Aerospace Research and Development area retired than any other as indicated in Table 7.3. The percentage of workers eligible to retire is captured through calendar year 2013. Forecasts for 2011 indicate that research and development, business development

and engineering technician/aides will be affected more than others. In 2013, the number increases further noting that the areas of research and development, engineering technician/aides, program management and business development are impacted the most. In specific, shortages in key occupations like A&P Mechanics, Aerospace engineers, Electrical engineers and others are becoming more and more apparent as the industry struggles to make provisions to replace a workforce that has been employed since before 1969 when humans first walked on the moon.

With the uncertain future of Social Security, Medicare and pension plans, some companies have had to modify their retirement eligibility requirements. Depending on the company, retirement eligibility may be computed differently. The majority of RSP participants surveyed in this study indicated that except for those workers under a union contract, retirement eligibility is determined by age and years of service. Some had a minimum age of 55 with either 10 or 15 years of service. Others varied in the age and years of service.

Surprisingly, another issue is keeping the aging workforce on the job. According to a study conducted at Oklahoma State University titled *Facts about Contemporary Grandparents Rearing Grandchildren (GRG)* by Dr. Tammy Henderson, between 1980 and 1990, there was a 40% increase in the number of children living with their grandparents. According to the research, almost 5.5 million children are living with their grandparents and over one-third of those children are being reared solely by a grandparent. As shown in Figure 6.6, 48% of grandparents raising grandchildren are 55 years old or older. The study states that 30% of the grandparents quit their jobs to care for the children. Therefore, 70% do not. In 2003 alone there were approximately 70,116 grandparents living in Oklahoma, 45,135 of which were grandparents solely caring for their grandchildren.[67] RSP participants in the study were asked what type of effect they believed the aging workforce would have on their organization. Six common answers were:

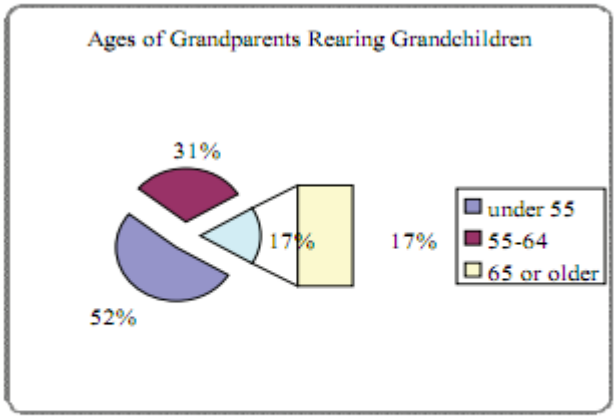


Figure 6.6 Age of Grandparents Rearing Children
Source: Facts about Contemporary Grandparents rearing Grandchildren (GRG)

In the Oklahoma State of the Workforce Report 2008, approximately 38% of Oklahoma's population was age 45 and older, 35% were age 24 and younger.[64] Another statistic of concern is that Oklahoma City and Tulsa metropolitan statistical areas (MSAs) are home to more than 58% of Oklahomans. As the issue of aging workforce becomes more apparent, such facilities realize they could suffer a large gap in skilled workers if not handled decisively.

7.4 FINDINGS

In this study nearly half (44%) of RSP participants indicated that 25-49% of their workforce was age 55 and older, while 28% of RSP participants indicated 50-74% of their workforce was also above age 55. In some ways, the significant economic meltdown has compounded the aging workforce issue. Roughly, 38% of RSP participants indicated that their retiring workforce situation today is worse compared to two

years ago. The companies report key leaders are leaving, people are walking off the job faster than they can hire, longer lead-time is now required to fill skill set voids, and increased costs due to training for new hires. This becomes especially frustrating when company retirement paths/plans are not firmly established and in place.

RSP participants in this study were asked if they had performed a study/analysis of the demographics of their workforce to determine what percentage will be retiring in the next three years. Such analysis would also include an inventory of skill sets needed when replacing retirees. Most RSP participants were aware of the issues and were actively taking precautions to address them, while some, although aware of the issue, had not yet begun to investigate its potential impact. Specifically, 26% of the RSP participants surveyed reported that they had not forecasted retirement rates to ensure they would have adequate workers/skill sets needed once older workers retired. On the other hand, 34% reported they forecasted 2-3 years ahead and 26% indicated they forecasted 4-5 years ahead.

In contrast, as devastating as the economy has been, research indicates its downturn has actually provided many RSP participants some much needed security. Nearly half of the RSP participants stated their situation was about the same in comparison to two years ago, while 13% indicated their situation had improved. When asked how they thought their retiring workforce situation would be two years from now, 19% thought their situation would improve and 60% thought they would be unaffected. In this study, there arose two dominant sides to the aging workforce dilemma. Some companies welcomed the retirement of workers. These companies have even instituted early retirement packages. For these companies, when workers retire it creates less health care expenses for the company and helps lower wages for incoming workers, thus they are able to save money or distribute money to other business resources. Companies in the study reported having men and women age 70 and above still working. These companies also report, the longer the older worker remains on the job, the more money they occupy and thus prevent employers from offering competitive salaries to new employees. The economic condition has also caused companies to re-evaluate their employee retirement packages and thus expected changes to these packages encourage some to retire at current offerings.

At the other side of this discussion are RSP participants who witness their workforce postpone retirement as a result of the economic downturn. These RSP participants report the number of actual workers retiring has been much less than what was previously forecasted. This comes as a relief to many companies concerned about knowledge capture. This delay of retirement has come about because workers realize they will live longer and need the additional financial support due to the potential unavailability of Social Security and adequate health care benefits. Furthermore, many lost money in their retirement funds due to the recent economic meltdown. That comes as added motivation to delay retirement. Simply put, the economy has forced many to stay in the workforce so that they can generate adequate financial stability to live comfortably the remainder of their life. In addition, many in the Oklahoma workforce have delayed retirement not only to support themselves but also to support their grandchildren. Oklahoma ranks in the top 10 of grandparents raising grandchildren.[67]

Furthermore, this does not account for the Baby Boomers who are also helping support their children. The speculation is that retirement-eligible workers may be delaying retirement in order to help with the financial support of their children and grandchildren.

7.4.1 Little to No Affect

Less than half of the companies denoted that the aging workforce would have little to no affect on their current operations. In the study, we found that these companies regularly participated in skills assessments of employees and utilized training matrices to ensure that each manager and team were equipped to do their current job and encouraged to learn should other opportunities arise. Continuous research and forecasting on workforce was also incorporated as ongoing activities as a means to ensure near and long term company progress. As a result, these companies are positioned to capitalize during times when so many others are suffering. As an example, while conducting this research an employer in a skills panel discussion indicated he had to lay off over 300 workers and that another nearby company hired most of those workers. The hiring company was one of the few companies who indicated they were minimally affected.

7.4.2 Increase Awareness Among Younger Workforce

Enterprise level awareness of the aging workforce issue is crucial as it affects every level of an enterprise. Such wide scale awareness serves as a catalyst for many companies to initiate measures to prevent negative effects that are certain to follow should no actions be taken. Companies reported many young workers did not have a clue about the issues of aging workers, which is to say, as a company little to no awareness programs were in place. For instance, some companies readily admit entering workforce personnel were not included in their planning for the future replacements. Although some companies held voluntary retirement workshops, younger workers did not see a benefit in attending because they felt they were too young to retire so why attend. There were a limited number of companies that engaged younger employees verbally in an informal setting to bring about retirement awareness.

7.4.3 Lack of Available Workers

Because the retiring workforce has caused a shortage of available workers, this has left RSP participants in a situation, where losing one individual would require hiring two workers just to replace the one. Some RSP participants indicated they are beginning to hire temporary workers, who may be older, but who are excited about being hired, having benefits, and being able to just work part of the work week. Government RSP participants indicated their workers are retiring and finding jobs with large corporations. Future research will reveal if the flow of government retirees to industry will provide industry with the much needed boost to sustain itself.

7.4.5 Decrease in Productivity and Increase in Worker Injury

Decrease in productivity and increase in worker injury are sometimes byproducts of not having enough available workers. Depending on the type of work, such as touch labor, older employees may not be able to perform as quickly as their younger counterparts. Attempts to provide flexible work days were

presented as options although there were reports of problems by some RSP participants. For example, one employer indicated he tried to implement a ten hour day/ four day work week (4/10) on two different occasions, but it failed due to physical drain and strain on employees. Employees' hands suffered from working on gearboxes too long. In such cases, employees are placed in a situation where working longer hours a day adds more physical demand on their body. RSP participants did report, despite the drain and strain on all employees, there was no increase in worker's compensation claims by the older workforce but there was an increase in personal time taken. With the younger workforce, there was an increase in personal time, sick leave usage, and worker's compensation. A contrast between the young and old is also seen in the amount of hours worked. Older workers accrued an abundant amount of hours, whereas the younger generation had no hours available, seemingly using them as soon as they accrued them.

7.4.6 Need for Training

RSP participants would like to hire new workers to help address the retirement issues but want to avoid paying overtime costs. These costs can grow to astronomical amounts because new hires tend to spend more time learning how to do the job and then must spend additional time actually doing the job to ensure deadlines are met. This has normally caused several hours of overtime to be expended. Companies are paying for training for replacement employees and then paying overtime hours just so new hires can be able to satisfactorily perform the job. The excess time translates into added cost. Furthermore, technology is evolving so fast that specialized and up-to-date training is absolutely necessary. When hiring new employees, a larger amount of training is needed to keep up with the workload that was done by the retiring individual as well as the new workload requiring new technology.

7.4.7 Limit Key Business Relationships

RSP participants reported that this issue is perhaps one of the most challenging to overcome. In the event that someone retires many of the business relationships that person maintained are unavailable to the new replacement. One employer said it best, "there's a big difference in having a person's business rolodex versus actually having a working relationship with the people in the rolodex." Many times, there are a number of years invested in key relationships that new hires just are not equipped to sustain or leverage.

7.4.8 Knowledge Capture

In response to the training and worker availability issues, knowledge capture becomes vitally important. The implications that accompany a mishandled issue such as aging workforce brings knowledge capture to the forefront of the minds of many. Knowledge capture consists of strategies and practices used to identify, create, represent, distribute, and enable adoption of processes, actions, insights and experiences. In general, the knowledge that is captured and later transferred is knowledge that has helped to sustain the viability of the organization. It is a part of the core foundations of profitable business operations. Ideally, if companies establish programs and policies to facilitate knowledge capture and transfer, cost of training will be cut significantly and production can be maintained at a profitable level. In this study, approximately 71% of RSP participants indicated they currently have too few policies/programs in place to ensure knowledge capture.

KNOWLEDGE CAPTURE/TRANSFER ACTIONS	%
Recruitment of younger workers	35.9
Incentives to delay retirement	5.0
Flexible work hours	23.1
Engaging older workers as mentors for younger workers	43.6
Extended professional development for your younger workforce	35.9
Internship programs	30.8
None	23.1
Other	12.8

Table 7.4 Knowledge Capture and Transfer Actions

RSP participants were asked what steps they had taken regarding knowledge capture and transfer because of the potential retirement of the aging workforce. Results are provided In Table 7.4. Participants were able to select all actions that best captured their current efforts. About 44% of RSP participants reported using mentoring as the primary vehicle to transfer knowledge to the younger workforce. Almost 36% of the RSP participants increased recruitment of younger workers and extended the amount of professional development made available to them. Nearly a quarter of RSP participants reported their respective companies had done nothing to address this issue. These respondents blamed budgetary constraints. Unfortunately, if this issue continues to go unaddressed, these companies may be forced to pay in other ways to the detriment of their company.

7.4.9 APPROACHES TO KNOWLEDGE CAPTURE

To address knowledge capture and transfer, RSP participants in this study indicated they are more apt to establish processes as a means of facilitating a standard way of performing on-the-job tasks. These processes are evaluated, documented and adopted such that when new employees are acquired, the job knowledge can be easily transferred and/or referred to if review is necessary. RSP participants in the study contributed the establishing of repeatable processes/standards not only to good business practices but also to certification requirements. Standards are put in place to be maintained and followed in order that it may be done the same each time. RSP participants further stressed the increase of documentation of processes being executed within the company. This includes the improvement of activities to ensure processes that deal with daily job execution are developed and well documented as opposed to depending solely on job descriptions to explain job execution. One employer commented that it was not clear whether knowledge was captured or just the process was recorded, which was a great concern. RSP participants reported a job description alone does not convey the actual day-to-day duties and responsibilities that are to be accomplished. One employer reported a situation in which three workers out of a five-person team retired at once and the actual day-to-day tasks of these employees were unknown to key personnel.

In some instances to capture knowledge, specialized teams are created to monitor various work areas and observe the tasks being performed by workers. These teams take videos and photos, interview workers and document work as it is performed. The team then evaluates the documented observations against established company standards to ensure that all of the regulations are being followed and no short cuts are being taken. If the team discovers that the process has been improved in any way, measures are taken to modify the documentation of existing process and associated procedures to

make it lean. The new process is then adopted by the applicable department and/or entire work place where applicable.

The observing teams consist normally of personnel who have a working foundational knowledge of the process being executed such as former mechanics who are familiar with repair procedures being observed for an engine. Some RSP participants report having similar teams denoted as Lean teams. They attempt to capture the best methods for performing a certain task in order to lean it out. RSP participants also reported using an approach where supervisors interviewed workers every six months to capture issues or new discoveries that could be used to streamline processes. Another method used to address knowledge capture and transfer is with the use of internships. During internships, a mentor teaches an intern student the specifics of his job. The intern student is usually offered a permanent position upon graduation and continually trained and mentored. The intern student may then become a mentor once he develops and understands his job at a sufficient level. RSP participants describe it as a revolving wheel. This approach ensures that knowledge is being transferred to the younger workforce. Other creative approaches used to overcome the knowledge gap: involve military veterans with disabilities as trainers, collaborating with universities and other local businesses, expanding traditional leadership development programs to include a variety of capabilities, and cross training.

RSP participants have implemented more avenues for cross training, in attempts of making workers more flexible. This is extremely important in the context of labor shortages because it makes it easier to replace a skill set when someone leaves. To address knowledge capture and transfer, some RSP participants reported reducing workload schedules of certain personnel by as much as three days so they can use them to train the younger workers. Others have hired retired engineers on an as-needed basis for mentoring. Although knowledge capture remains an important issue, smaller companies in this study recognized the need for knowledge capture but indicated it as being too costly because it was needed on a daily basis and it slows down production thus their company could not stay competitive. In other words, they do not have enough trainers to train the new employees and perform the tasks.

Once knowledge has been captured, in order to reuse it in an optimal manner, proper management is vital. Effective knowledge management practices make consistent, continuous knowledge transfer less challenging for an entire enterprise. RSP participants provided a number of ways in which they actively manage the knowledge they captured. They reported creating private company databases to share information pertaining to job descriptions, establishing work groups to discuss issues, and developing FaceBook-like sites to connect with various employees to share knowledge. These types of efforts align with many of today's corporate initiatives to employ knowledge-based systems where ideas and knowledge are gathered online. Knowledge is normally stored in a database that is easily accessible to employees within select department areas. Proper knowledge management also includes ensuring the stored information is current. Knowledge can be captured in any work related environment.

7.4.10 Issues

The tasks of capturing, transferring and managing knowledge are all important to the continued competitiveness of a business but there remains an issue that is common to many businesses – actually getting the information from individuals who have taken 'personal' possession of it indirectly by having

acquired a high level of experience over the years in a specific work area. RSP participants described this as someone in their workplace who will not willingly divulge key job information. This may be due to an individual's personality, desire for job security or both. This attitude is often seen with the older workforce. RSP participants reported, once the younger workforce began to increase, the older workforce became fearful of being replaced. To get around those people who withhold information due to job security, some have used the approach of capturing the knowledge of the older workforce by asking them to document what types of things they do to be more efficient at their job. Some have also taken a personal approach by doing one-on-one meetings with employees. They begin going to older employees and acknowledging their efforts and introducing them to younger workers. Other RSP participants addressed this issue head on by including it as a requirement as a part of their performance. In specific, employees were assessed on their ability to teach and mentor other employees they were responsible for managing, thus if their subordinates are not experienced in performing key job functions they are held accountable. This becomes a part of their job requirements and weighs heavily on their performance evaluations, promotions and/or incentives.

Another issue that arises is the occasional friction between young and old workers. The older workers are used to performing tasks a certain way and the younger workers want to move away from traditional ways and find more creative ways to perform the same task. RSP participants indicate they sometimes have difficulties with younger workers who do not want to understand the traditional methods. Such challenges also make it difficult to transfer knowledge. RSP participants report a need for additional work/training on the correlations and relationships between the younger and older workforces.

During the Skills Panel meetings, employers also discussed other issues keeping people from retiring right now. These issues include the uncertainty of health care now that the new health care law has passed, the lost assets caused by the stock market bust in 2008 which left many people holding on to their jobs because of the uncertainly and instability of their retirement funds.

7.4.11 Near- and Long-term Steps

The aging workforce has caused several issues within the workplace and has brought several political repercussions to the forefront. It is vital that the aerospace community including the RSP participants as well as the aging workers in question be strategically positioned to address this issue both in the near- and long-term future. From this study, we discovered several companies are in fact aware of the issues and are aggressively addressing them, yet there still remains are large number who have made little to no headway. As previously reported, researchers have termed the imminent retirement of the baby boomers a silver tsunami. Such a wave of retirement is bound to leave companies and perhaps the country crippled in a number of areas if decisive steps are not taken. RSP participants in this study were asked to recommend near- and long-term steps to aid in addressing this issue. RSP participants strongly

admonished others to put some type of plan in place to combat the problem of knowledge transfer even if the plan is not a good plan initially.

RSP participants suggested getting more proactive in sponsoring retirement workshops to inform the retirees about their benefits such as take home pay. Such workshops should also be marketed to the younger workers as a means to cultivate company loyalty as they need to be aware of the benefit to staying with a company for many years. RSP participants should also be proactive in looking for those who are interested in moving up the ladder and teaming these workers with older workers. RSP participants do caution, if pairing young and aging workers, make sure the older workers do not think this is a way to get rid of them but more to transfer the knowledge. Although approaches between the generations are different, some RSP participants have seen this type of teaming work incredibly well especially when the two express a true willingness to work together. To facilitate an intergenerational work environment or team, it is recommended that next generation training on how to communicate between the generations be pursued. Furthermore, RSP participants indicated that if such an on-the-job relationship is to work, employees, primarily the younger ones, must not only view daily tasks as just a job, but as an integral component of the organization's mission. For example, a mission might be to support the American warfighter. Each so-called job is really about seeing the whole mission. RSP participants must foster, among workers, a sense of pride in the job and the mission no matter what the job is. Other recommendations include developing a database of retired personnel categorized by labor categories who will commit to be available for some form of contract work (i.e. mentoring and training) or question and answer activities. Some RSP participants recommended continued near- and long-term analysis of the risk factors involved with the aging workforce. Finally, others recommended identifying and leveraging more funding opportunities for training or hiring to assist RSP participants with the training cost.

7.5 Oklahoma Aerospace Workforce Employment Implications

Employment issues have helped everyone evaluate where you are in your professional growth and prosperity. Some of the implications that came through the voices of the industry are:

- Initiating in-house programs to upgrade mid-level managers to find individuals who can "learn and grow,"
- Provide more training for specialized skills which account for about 70% of the employment needs;
- Begin to prepare for the exodus of the Baby Boomer aerospace worker;
  - Share practices and procedures that are already in place among companies;
- Consider possible use of technology over number of job opportunities;
- Become more proactive in sponsoring retirement workshops to inform the retirees about their benefits such as take home pay;
- Increase awareness of the employment opportunities that exist in aerospace;
- Provide mentoring coursework for the person who is capturing knowledge once the retirement group is actually retired;
- Help businesses find ways to network to support their employees;
  Facilitate and encourage knowledge management and not just developing a process

SECTION 8: WORKFORCE BEST PRACTICES

8.1 INTRODUCTION

The U.S. civilian aviation maintenance workforce is estimated to include close to 275,000 workers and provide a $39 billion impact to the U.S. economy. Eighty-five percent of those jobs can be attributed to MRO that accounts for 233,237 workers. An estimated 200,000 of those workers work in FAA certified repair stations. Most repair stations are actually small businesses. MRO alone accounts for 60% of the $39 billion impact and parts manufacturing and distribution account for 38% of the market. Although often not widely seen, the MRO impact on the US economy is critical to the continued security, viability and overall health of America. ARSA Executive Vice President Christian Klein said, "Maintenance may be the least visible segment of the aviation industry, but…repair stations make significant economic contributions throughout the country."[4]

8.2 SUMMARY OF RESEARCH OBJECTIVES

A required component of identifying gaps within Oklahoma practices in the aerospace industry in relation to the rest of the nation as well as to the global platform was to collect a survey of best practices for workforce development used in military installations, namely U.S. Air Logistics Centers; civilian MRO markets; international MRO markets; and the Emerging Technology markets. Best practices are defined as procedures, techniques, and methods that have been identified by a community as being effective means integral in delivering services, products or other outcomes that create benefit or opportunity. In this section of Best Practices, comparison states were selected based on the following justifications. As Figure 8.1 illustrates, AeroStrategy estimates that California, Texas and Florida employ perhaps one-third of the aviation maintenance economic activity followed by Washington State, Georgia, Oklahoma, Arizona, and Connecticut. Because Washington, Georgia, Arizona, and Connecticut are very similar to Oklahoma in aviation maintenance activity, these were chosen to examine their Best Practices that may be applicable to Oklahoma aerospace economic activity.[91]

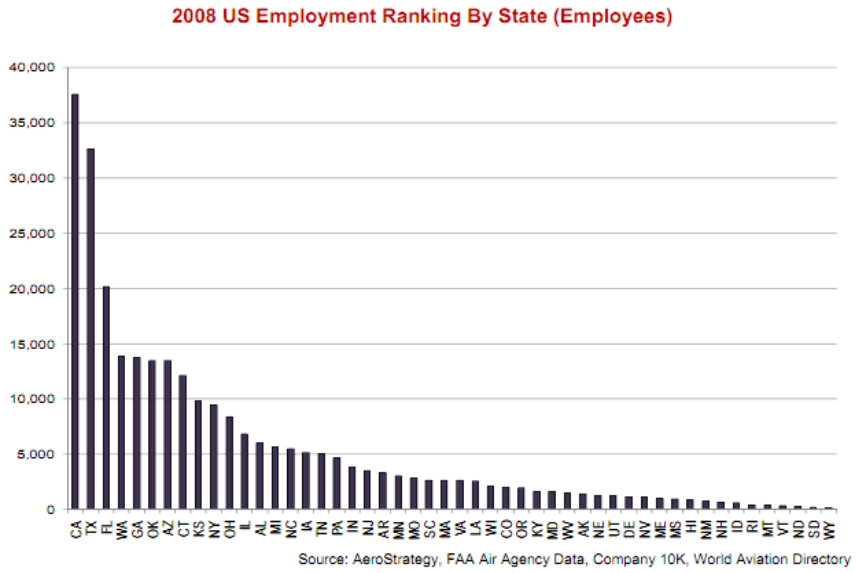


Figure 8.1: Aviation Employment Ranking by State

Additionally, since Oklahoma has the largest Air Logistics Center in the Unites States, it seemed reasonable to investigate the two other states that have Air Logistic Centers: Utah and Georgia where Georgia is already listed as similar to Oklahoma. Also included in the Best Practices section are two states that seem to be emerging in aerospace economic activity: North Carolina and South Carolina. International Best Practices were considered for some of the nations who have FAA Aviation Repair Stations. These countries are: El Salvador, Canada, China, Brazil, Hong Kong, and Germany.

Furthermore, in this section, we highlight several best practices leveraged by a number of these states and countries, which have proven instrumental in providing a competitive edge in adding value to the development of their pipeline of a highly skilled workforce. Best practices leveraged to attract and equip students and existing workers were of particular interest. Although a number of best practices were identified, only a collection of those were documented in this report. Those documented were identified as practices the Oklahoma aerospace industry could implement with a high level of success.

Throughout the survey, it was discovered that states utilized similar program concepts and strategies, thus supporting the effectiveness of the utilized program across multiple states or countries. The objectives guiding the research in this area were:

- To provide an overview of research in aerospace workforce best practices; and
- To provide the Oklahoma aerospace community with information about activities in other states that are somewhat similar to our demographics.

8.3 US Civil MRO Market

California

California is ranked 1st in aviation maintenance employment employing approximately 37,566 workers in this area. In aviation maintenance specifically, the state is ranked 1st with more than $5 billion impact on the U.S. economy.[4] California is responsible for nearly 25% of the aerospace industry in the US. It boasts several NASA centers, four Air Force Bases specializing in research, design and testing of military and commercial aerospace systems and approximately 5300 aerospace companies. Two of the largest companies are Lockheed Martin and Northrop Grumman.[14] In 2010, they were ranked number one and two in defense contracts, respectively. In a survey of best practices within the state of California, we discovered the establishment of organizations and the implementation of programs to fuel workforce development. Better equipping Workforce Investment Boards (WIBs) to enable them to align training services more effectively was one strategy utilized in California. The California Space Authority (CSA) utilized a Workforce Innovation in Regional Economic Development (WIRED) grant to spearhead an initiative to identify and document the supplier skills necessary to remain competitive as it relates to supply chain management transformation. A survey developed by the Antelope Valley College entitled the 21st Century Supply Chain Transformation Survey was used to assist in evaluation and collection of data. Results from the overall study highlighted many of the challenges and opportunities facing suppliers within supply chain management as it relates specifically to aerospace and defense industry. The information collected was used to familiarize and equip WIBS with the area of supply chain transformation to assist them in better meeting workforce and economic needs.[69]

The Aerospace Community Development Program is a program developed to implement avenues to reach and introduce young people to the aerospace career field. It also works to provide professional development for existing aerospace employees.[70]

The STEM Inventory is an online database of innovative STEM programs sponsored by California organizations and others across the nation. It provides a variety of programs available to parents, students, teacher and professionals in the California area. It provides continuous STEM awareness. It is hosted by the California Space Education and Workforce Institute at the web address: *http://www.csewi.org/stem* .[70]

The Mentor Match Program is a program that attempts to establish relationships between industry professionals and university students in an effort to guide students in selecting career paths in aerospace. The program has teamed with *http://www.Icouldbe.org*, a prominent virtual mentoring website, to facilitate the mentor-mentee relationship.[70]

Space Blog is a website for space professionals to post new information, network and discuss aerospace topics and interests. The site is open to students and professionals. The site is located at http://csewi.org/blog/ [70]

Stanford Model STEM Mentoring Program

The Stanford Model STEM Mentoring Program is an outreach program which involves the mentoring of grade school students by local engineers and scientist. The local professionals come to student classrooms 2-4 hours a week for the entire school year to provide technical support for class projects, experiments and demonstrations in mathematics and science. The program begins with students in the fourth and fifth grade. The program attempts to pair the student and the same mentor together throughout the remainder of the student's grade school and high school years.[70]

STEMTRAX is an online collaboration site (www.innovatecalifornia.net) that enables California universities and aerospace businesses to engage and connect for various research and development efforts. STEMTRAX is a vehicle for industry to leverage university-conducted research and for universities to obtain industry-led funding/support for projects of interest. The overall goal of STEMTRAX is to "improve the partnership between aerospace industry and universities in the California Innovation Corridor to 1) enhance the California academic community's aerospace-related education and 2) increase the amount of highly-trained technical and professionally developed students capable of meeting California's aerospace workforce needs."[70]

The *Scientists and Engineers—Alternative Routes to Certification and Hiring (SEARCH)* is a project developed to provide a career transition pathway for professionals already in the science, engineering and math fields to become public school teachers. It is specifically design to enable professionals to change professions and enter a fast track path to becoming a teacher. This project is managed by the California Space Education and Workforce Institute (CSEWI).[70]

WASHINGTON STATE

The state of Washington has an aerospace labor force of about 82,000, 7000 of which are engineers. There are approximately 650 aerospace companies on record. Washington's aerospace industry produces approximately $32B in revenues with its largest market bases being China ($4.1 B), the United Arab Emirates ($2.6B), Japan ($2.0 B), Ireland ($1.8 B), and India ($1.6B). In 2009, it was the largest exporter among all US states. In second is California ($7.0B), then Connecticut ($6.2B), Texas ($4.8B) and Kentucky ($4.7B). Washington is ranked 4th in aviation maintenance employment employing approximately 13,898 workers in this area. In aviation maintenance, specifically, the state ranks 5th with more than $2.58 billion impact on the U.S. economy.[4]

Washington residents and companies have greatly benefited from aerospace taxes and incentives. Washington has received $1,750,000 in appropriations to the Washington Aerospace Training and Research Center and $400,000 for the Spokane Aerospace Technology Center. It has also established the following aerospace tax incentives:[71]

- Reduced Business and Occupation (B&O) Tax Rate Decrease (from .484% in 2003 to .2904% in 2007 for aircraft repair facilities. Decrease expires in 2024),
- Business & Occupation credit for pre-production development expenditures,
- Business & Occupation credit for property/leasehold taxes paid on manufacturing facilities,
- Retail Sales and Use Tax Exemption for computer hardware/software/peripherals,
- Retail Sales and Use Tax Exemption for Computers
  - Effective December 1, 2003, manufacturers and processors for hire of commercial airplanes and component parts of commercial airplanes were eligible for a retail sales and use tax exemption on purchases of computer hardware, software and peripherals used primarily in the development, design and engineering of commercial airplanes and component parts of commercial airplanes. Expanded in 2008 to include software and peripherals used primarily in the development, design and engineering of aerospace products or in providing aerospace services. Expires 2024.

Washington also developed Industry Workforce Skills Panels which included 15 panels consisting of partnerships of industry, labor, and education alliances. Results from the industry-wide skill panels yielded the following results:

- Employers were provided with direct access to identify needed skills sets and the ability to participate in the continuous improvement of the system;
- Workers with better skills, jobs, and career opportunities;
- Employers with more efficiency, less turnover, and higher profits;
- Expansion of skill standards to meet employer needs;
- Educational programs that address key economic clusters and on-the-job learning strategies;
- Local and state information about employers' skill needs;
- Policy recommendations based on real-time information; and
- Agency outreach and partnership development.

Washington also benefits greatly from innovations in its education and training programs. Aviation High School was established at South Seattle Community College. Some of the classes offered are astronomy,

calculus, and aerospace engineering denoted as 'Flight by Design'. A Boeing grant funds the 'Flight By Design' class. The recent graduating senior class was given an opportunity to fly on Alaska Airlines new Boeing 737-800 as an incentive for successful matriculation. [72]

Education institutions and industry representatives have established Apprenticeship programs that provide preparation of students in occupations such as machinists and aircraft mechanics. The programs provides students with a combination of technical instruction and supervised, on-the job training all of which leads to a state-issued, nationally recognized occupational credential.[95] Such on-the-job training helps to ensure that students are trained in the necessary skill areas and possess the experience necessary to be impactful once employed.

Washington also utilizes Job Skills Programs, which provide customized highly specialized training to meet employer demands. Such training, many times, is customized to employers' specific needs and is often offered at employers' jobsites. In addition, two new training centers are being built to provide customized industry-driven training to incumbent workers and new students. The centers are operated by different entities. The first is operated by Spokane Community College District and the other will be operated by Edmonds Community College and the Aerospace Futures Alliance. Based on advances in research, these centers develop and implement new training curriculum. Once implemented, the centers distribute the new curriculum to other training providers across the state of Washington. The training provided will be offered in flexible or stackable formats to allow students to combine multiple training components to obtain certificates and degrees of choice. [73]

The **Center of Excellence for Aerospace and Advanced Materials Manufacturing** is a platform for industry, education and training providers to communicate workforce needs, exchange ideas, and determine an agreeable avenue to pursue to ensure issues expressed are addressed. The Center of Excellence performs the following actions:

1. Coordinates training programs across the state,
2. Shares curriculum and best practices with training providers,
3. Markets aerospace career opportunities to high school students and adults, and
4. Supports seamless educational transitions through the development of educational pathways from high school to higher education programs.[73]

The Boeing Company has leveraged the innovative research capability of prominent Washington universities such as the University of Washington and Washington State University through collaborative research initiatives. Projects includes research in areas such as clean technology, alternative/renewable fuels, next generation materials, fuel cells, and next generation technologies, among others. This provides a pipeline of funding, experienced scientists, training and relevant research to all entities involved. An example of such collaboration efforts is, "The Washington State University, University of Washington, and Pacific Northwest National Laboratories are collaborating with key private sector firms, leading research universities/labs across country, Boeing, the Port of Seattle, and the airlines industry to develop scalable jet bio-fuels production and distribution channels—with Seattle's SeaTac first to market."[73]

GEORGIA

Georgia is ranked number five in aviation maintenance employment, with 238 aerospace companies and employing approximately 25,000 workers in aerospace product manufacturing and in air transportation support activities. Georgia ranks 2nd in military and civilian net gains from projected military base closings. Nearly 15,000 aerospace workers are employed at Georgia's four Air Force bases. Georgia ranks 7th largest in high tech employment in the Southeast and 6th nationally in aircraft manufacturing according to the Harvard Cluster Mapping Project. The industry's top employers are Lockheed Martin, Gulfstream Aerospace and Engineered Fabrics. In aviation maintenance specifically, the state ranks number seven with more than $1.7 billion impact on the U.S. economy.[75]

Georgia has developed a Work Ready Region (WRR) initiative which is designed to link workforce and education together and align economic development at the local, regional, and state levels. It includes seven counties and the Ft Benning Army Post site. The WWR is in close proximity to Ft Benning which promises an ample supply of highly skills labor. A preferred vender for advanced training, Advanced Manufacturing Center of Excellence, will provide aerospace training. Georgia is among the highest producers of aerospace graduates in the nation. The state also has more than 157,000 people in aerospace related occupations. Georgia has one of the world's most traveled airports in Atlanta, and six other regional airports. There are expanding military bases such as Ft Benning (receiving Ft Knox through the BRAC) and has one of the fastest growing ports on the eastern coast.[75]

Many military spouses are not eligible for unemployment insurance when they leave their jobs and relocate with their spouse. Some states have passed laws that will allow military spouses who move for military-related reasons to collect unemployment: Texas, Florida, Kansas, Kentucky, Georgia, New Mexico, and North Carolina.

Some of Georgia's Tax Incentives include.[76]

Quality Jobs Tax Credit

- Companies that create at least 50 jobs and pay wages at least 110% of the county average are eligible to receive a credit of $2500-$5000 per job, per year, for up to five years, based on the scaled system below. Credits may be used to offset the company's payroll withholding once all other tax liability has been exhausted and may be carried forward ten years.

Job Tax Credit

- Strategic industries such as distribution, technology, manufacturing, telecom, processing companies and their headquarters qualify for Georgia's Job Tax Credit

Mega Project Tax Credit

- Companies that employ at least 1,800 net new employees, and either invest a minimum of $450 million or have a minimum annual payroll of $150 million may claim a $5,250 per job per year tax credit for the first 5 years of each net new job position. Credits are first applied to state corporate income tax with excess credits eligible for use against payroll withholding. Credits may be carried forward for 10 years.

Retraining Tax Credits

- A company's direct investment in training can be claimed as a tax credit – 50 percent of the employer's direct cost up to $500 per, per approved training program. The total amount of credit cannot exceed $1250 per employee per year. Training programs must be approved by the Technical College System of Georgia. This tax credit can be used to offset up to 50 percent of a company's state corporate income tax liability. The credit is available to all Georgia businesses that file a …Georgia income tax return. The retraining program must be for quality and productivity enhancements and certain software technologies. Unused credits can be carried forward 10 years. These credits can be combined with other tax credits.

Existing Industry Job Tax Credit Bonus

- Companies that have been doing business in Georgia for at least three years can claim a one-time additional $500 tax credit for every net new job they add between 2006 and 2011.

ARIZONA

In a study by the US Commission on Aerospace and Aviation Industry, the state of Arizona was ranked 8th in the country in total employment and 4th in employment per 1,000 workers.[77] The study concluded that aerospace workers in Arizona were on average paid 52% more than the wages paid for other occupations. Raytheon is the top aerospace employer in the state employing over 11,000 workers. Davis-Monthan AFB is considered the largest military installation in Arizona employing more than 8,000 workers. Other high profile companies and organizations include Northrop Grumman, Boeing, Honeywell, Lockheed Martin, General Dynamics as well as some astronomical observatories and research programs. Arizona is ranked 7th in aviation maintenance employment employing approximately 13,445 workers in this area. In aviation maintenance specifically, the state ranks 3rd with a $2.7 billion impact on the U.S. economy.[4]

Employers in Arizona that aim to create new jobs or supplement the training of incumbent workers can access The Arizona Job Training Program. This program is defined as a job-specific reimbursable grant program that consists of two primary components: Net New Grant and Incumbent Grant. The Net New Grant component provides employers with up to 75% reimbursement of expenses used for eligible training. The Incumbent Grant provides employers with up to 50% of expenses used for eligible training to be reimbursed. Arizona also boasts a number of Registered Apprenticeship Programs across the state. These programs exist to provide candidates with classroom instruction as well as on-the-job training in order to create more of a workforce ready employee. The duration of these programs are gauged either by a desired time reached or competency level obtained by participants. This program is paid for by a combination of employers, associations or labor sponsors. Not only do these organizations pay for training but they also provide varied wage increases to program participants according to the level of skill gained.[78]

"Arizona has more than 100 registered apprenticeship programs in such industries as agriculture, forestry and fishing; mining; construction; manufacturing; transportation, communications, electric, gas, and sanitary services; and public administration. More than 3,100 apprentices are currently registered in apprenticeship programs in Arizona."[78] Proponents of the registered apprenticeship programs

highlighted several benefits for the employers and participants involved. Benefits to the employer were identified as:

- Developing a reservoir of skilled workers, many of whom are potential supervisors;
- Lowering costs by increasing productivity as employees become more skilled;
- Reducing labor turnover and absenteeism through employee motivation to learn new job skills;
- Receiving State and National recognition for efforts to train people in skills necessary to become contributing members of society;
- It provides a more flexible workforce because of greater employee skills; and
- Creates customer satisfaction generated by quality workmanship." [78]

Benefits highlighted for the apprentice were,

- Receiving related instruction to supplement on-the-job training;
- Earning while learning;
- Receiving formal on-the-job training from a qualified worker;
- Receiving regular pay increases as job skills increase; and
- Acquiring a skill allowing the apprentice to compete more effectively in the labor market.

Workforce development partners across the state of Arizona have also combined efforts to create a network of resources that together provide free services to employers statewide. The resource center is denoted as the Arizona Workforce Connection. According to the Arizona Commerce Committee,[78] the Arizona Workforce Connection provides:

- Seamless Access to Workforce Resources
- Employee Recruitment
- Labor Market Information
- Job Training and Hiring Tax Credits
- Customized Training and Skills Upgrading
- Solutions to Common Employee Barriers
- Pre-Layoff Assistance.

The Governor's Council on Innovation and Technology is tasked with enhancing university research and education, inspiring cooperation between industry and academia and developing high quality jobs in Arizona.[79]

With the purpose of assisting businesses of all sizes become more competitive, the Arizona Manufacturing Extension Partnership (AMEP) located in Scottsdale, AZ provides business access to other businesses, several thousand manufacturing and business specialists, new technology and industry practices. AMEP is a non-profit service.[79]

Aerospace, Manufacturing and Information Technology Cluster (AMIT) provides a platform for members to voice concerns to government officials with a concerted voice. It aims to create business relations between companies inside (namely its members) and outside of Arizona.[79]

In an effort to better provide a local and national platform for its unique strides in optics, Arizona has an entity denoted as the Arizona Optics Industry Association (AOIA). Consisting of start-ups, research entities and larger aerospace companies, this organization represents a range of products and services encompassing optical design and engineering, fiber optic components, high precision optical fabrication, high volume precision plastic optics, optoelectronics, software and optical coatings/thin films, and so forth.[79] Participants in the Oklahoma skills panel research reported visiting the state of Arizona in an effort to meet their business needs in optics.

The state of Arizona utilizes a P-20 Council**,** which provides guidance on issues that encompass pre-school to post-graduate education levels. Arizona has also initiated an effort to bridge the gaps among education and workforce and economic development groups specifically in the southern region of Arizona. This effort is formally denoted as Innovation Frontier Arizona (IFA). A $5 million award provided by the United States Department of Labor, IFA attempts to bring under one umbrella the government, private sector, education systems, economic development strategies and financial resources to better meet the needs of the industries within its service region. IFA reaches beyond the traditional K-12 education system to address the P-20 range which encompasses pre-kindergarten through post graduate college. Southern Arizona was specifically targeted because of its rich source of aerospace and defense and information technology jobs such as scientists, engineers and intelligence technologists. IFA works to ensure that workers in this region are equipped with the proper training to facilitate the use of existing and new technology. Moreover, it strives to ensure that students in this area will graduate with the core STEM skills essential to support the mission and vision of the industry.[79]

TEXAS

A century ago in 1910, the first U.S. military flight occurred at Fort Sam Houston in San Antonio, Texas. Since then, Texas has remained on the cutting edge of aerospace and defense. In the state of Texas, the aerospace and aviation industry alone employs close to 170,000 workers. Aerospace workers on average can expect a wage of $1,200.00 a week with an annual salary of about $63,000.00. Texas is ranked 2nd in aviation maintenance employment employing approximately 32,673 workers in this area. In aviation maintenance alone, the state ranks 2nd with more than $4.4 billion impact on the U.S. economy.[4] Texas is the home of NASA's Johnson Space Center and four major airlines. Texas also has six Air Force Bases and three Naval Air Stations. The state is known for military aircraft development, space exploration and aerospace-related research. Texas ranks in the top ten nationally in: Industry Employment, Manufacturing, Capital Investments, Aviation-related patents, and prime contract awards.[108] The population of U.S. Air Force personnel ranked first in the nation in 2006. In addition, Texas has more airport types than other states with 1954 airports and over 40,000 FAA certified pilots. Texas has 36 public high schools that offer aeronautical courses and 14 FAA-approved aviation maintenance technology schools. Companies in Texas have benefited greatly from the state's incentive and awards:

- In 2008, a $850,000 Texas Emerging Technology Fund (ETF) was awarded to Falcon International in partnership with the University of Texas Permian Basin for development of ballistic panels;
- In 2008, a $1 million Texas Enterprise Fund was awarded to Albany Engineered Composites (AEC) to expand operations with hopes of bringing over 300 new jobs and more than $41 million in capital;

- In 2008, a $1.67 million TEF award was presented to Rockwell Collins for operation expansion;
- In 2008, a $750,000 ETF award was announced for StarVision Technologies to assist in developing a product to improve satellite performance;
- In 2007, Port San Antonio was awarded a $38.8 million Texas Military Value Revolving Loan (TMVRLF) to assist in entering the international air cargo business; and
- In 2006, a $5.5 million TEF grant was awarded to Lockheed Martin and a $456,000 TEF grant was awarded to TRACE Engines. Combined, both were expected to bring close to 900 new jobs to the state.

The Alamo Area Aerospace Academy is a training and educational partnership that provides aerospace industry-related education, training, and work experience to area high school students. It assists students in transitioning from high school to college or directly to a workplace upon high school completion. The Academy program provides college credit and a paid internship experience for participants.

The North Central Texas Workforce Board partnered with manufacturing industry associations and community colleges to develop supply chain logistics skills training and certification. The project was funded by a President's High Growth Job Training Initiative grant.[69]

Texas provides economic development incentives on both the state and local levels. However, Texas is not as aggressive as other states concerning the use of statewide incentive programs.

Connecticut

Despite Connecticut's median hourly wage for aerospace engineers being lower than the national average by more than five dollars, the state was ranked 7th in manufacturing value added per production worker by the U.S. Annual Survey of Manufacturers and number three per capita gross state product by the U.S. Bureau of Economic Analysis and Bureau of Labor Statistics in 2007. Connecticut is ranked 8th in aviation maintenance employment employing approximately 12,109 workers in this area. In aviation maintenance, the state ranks 6th with more than $2.29 billion impact on the U.S. economy. Connecticut is known for its innovative research, design and engineering of jet engines and helicopters. Moreover it is the worldwide headquarters for United Technologies Corporation and its subsidiaries Sikorsky, Pratt & Whitney and Hamilton Sundstrand.[82]

To become more competitive, several small and mid-sized companies in Connecticut provide their technicians and production workers training in supply chain management. The training provided assists to address workforce needs in fabricated metals, aerospace and medical supply chains. This training effort is executed through a joint effort between the following Connecticut-based entities: workforce investment boards, aerospace component manufacturers and community colleges. This project extended to companies in Massachusetts also.[82]

The Connecticut Community Colleges' of Technology (COT) is an organization that accounts for much of the technology oriented engineering and technician training at many of the community colleges across

the state. COT directs the Regional Center for Next Generation Manufacturing which aims to develop highly skilled workers in manufacturing by providing educators and students with learning opportunities and new technologies in manufacturing. Such efforts expose educators and students to cutting edge technology, thus keeping them abreast.[82]

Aerospace and defense manufacturers are given access to a collection of programs like continuous improvement, training and education and manufacturing optimization and research to create highly skilled workers and more competitive business entities. These programs are provided through the Connecticut Center for Advanced Technology (CCAT). Many of the programs are funded through federal or state resources and thus are either free or provided at discounted rates for eligible companies.

- Aerospace Research and Development Tax Credits - Companies with gross income below $100 million receive a credit of 6% of all research and development expenses incurred in Connecticut. If the credits cannot be used they can be redeemed with the state for 65 cents on the dollar. The credits can also be carried forward until they are used. (Note – credit is available for companies earning more than $100 million, however different rules apply.)
- New Jobs Creation Tax Credit - Create 10 or more new jobs 60% of the employee's withheld CT income tax for up to 5 years.
- Displaced Worker Tax Credit - Hire an employee let go because of restructuring (at least 10 employees let go from same place of employment.) $1500 per employee.
- Human Capital Investment Tax Credit - In-state job training and work education programs for CT employees. 5% of the costs and expenses. May be carried forward for 5 years.
- Service Facility Tax Credit - Any building constructed or renovated for financial services, business services, health care, transportation & warehousing, telemarketing, engineering and computer networking. Based on new jobs created: 300-599 15%, 600-899 20%, 900-1,199 25%, 1,200-1,499 30%, 1500-1,999 40%, 2,000 or more 50% Does not apply for facilities in an enterprise zone.
- Credits for Manufacturers: Apprenticeship Training Tax Credit - Qualified apprentice program in manufacturing or plastics (machinist, tool & diemaker, etc.), Up to $4800 per year Examples of trades include machinist, toolmaker, tool and diemaker, tool and machine setter, machine tool repairer.
- Machinery & Equipment Expenditure Tax Credit - Year over year expenses for new equipment for companies with less than 800 full-time employees. 5% of the incremental increase in expenditures for machinery & equipment. 10% credit for companies with fewer than 250 full-time employees.
- Manufacturing Facility Enterprise Zone Tax Credit - Locate in an enterprise zone and have 150 employees.

8.3.1 Emerging States

North Carolina

North Carolina has over 350 aviation and aerospace companies, which employs over 23,000 workers. Wages earned by aerospace workers in NC are 35% higher than the overall NC average. The aerospace industry as a whole supports over 88,000 jobs directly or indirectly. The estimated economic impact of aerospace on the state is $11.8 billion. The US Department of labor has projected an increase in manufacturing jobs in the state by 1,532 jobs by 2017.[47]

Eight of North Carolina's universities and numerous community colleges have programs and centers that support and enhance the ability of North Carolina's aviation and aerospace firms to innovate and grow.[85] North Carolina has an advantage over many states because its use of occupation extensions, which enables community colleges to be reimbursed for non-credit course enrollments. "The FAA A&P modules are offered as both credit-based and non-credit programs at some colleges. Common non-credit courses offered with direct relevance to the aerospace industry are aviation maintenance, industrial maintenance, electronics, and welding."[84]

North Carolina's Customized Training Program is a well-respected program across the United States. The curricula for the training programs are developed as a result of working closely with colleges and interested companies. Two companies who currently have customized programs established are HondaJet in the Triad, through Guilford Tech and Spirit Aerosystems in Kinston through Lenoir Community College.[85] The North Carolina state government was aggressive in recruiting HondaJet in putting together an $8 million incentive package. The funding was from a Job Development Investment Grant (JDIG) program. "As part of the agreement:

- HondaJet must retain the 50 workers at their Greensboro headquarters for the duration of the 12-year grant;
- 283 new workers will design, engineer and manufacture the new plane. The average annual salary for the new jobs will be around $70,000 a year plus benefits.

Over the life of the grant, the N.C. Department of Commerce estimates the project will:

- Generate a combined cumulative gross state product value of $943 million;
- Produce a combined positive, cumulative net state revenue impact of $21 million; and
- Contribute up to $2.2 million to the Industrial Development Fund for infrastructure improvements in rural and economically distressed areas of North Carolina."[86]

The incentive for Spirit Aerosystems is reported to be more than $200 million. Not only through incentives but also through its TransPark area, North Carolina encourages out of state companies to make the state its future home.

"The North Carolina Global TransPark (GTP) is a multi-modal transportation park offering environmentally permitted prime commercial real estate along with excellent shipping capabilities via air, truck, rail or sea. It owns more than 2,400 acres, including a 300+ acre state Certified Site with advantages such as:

- Access to an 11,500-foot runway, with an Instrument Landing System (ILS) being upgraded to Category III;
- Cargo facility/warehouses with runway access;
- Building/hangar sites offering airfield and highway access;
- Special construction financing options available for qualifying buildings;
- FTZ #214 provides exemptions or reductions in customs duties; and
- Access to a 33,000-square-foot training/conference center."[87]

North Carolina has also established a host of STEM-related schools and programs. "Andrews Aviation Academy offers high school students in Guilford County the opportunity to jump-start a career in aviation by preparing them for the technical training and certification needed by the FAA."[87]

Learn and Earn Early College High Schools are also becoming more widely spread across the state. These schools are located on two-year and four-year college and university campuses around the state and allow students to earn a high school diploma as well as an associate degree or two years of college credits in up to five years. All this is done at no cost to the student.[87]

The concept of Redesigned Schools is also being utilized by some North Carolina schools. Using the redesigned concept, high schools are transformed into smaller schools with an associated academic theme. "Teachers in a redesigned school adopt a theme or common way of teaching. Often, the themes connect to the knowledge-based economy into which students will graduate — biotechnology, information technology, health sciences, engineering or international studies, for example. Their goal is not to prepare graduates for a specific career, but to create an organizing theme that allows students to prepare for college and any career they may choose."[57] In addition, North Carolina, in cooperation with the New Schools Project, has initiated The North Carolina 1:1 Learning Initiative which aims to provide low-income minority students and their teachers with laptop computers, providing these students with extended access to instruction, guidance and information.

Project Lead The Way (PLTW) is an organization that partners with middle school and high schools to provide stimulating STEM education to students. This is done in an effort to prepare students for exciting careers in STEM-related fields.

North Carolina also utilizes Career Academies which are high schools that include a mixture of college prep, and career related classes such as engineering, computer programming and finance. An integral component of these schools is a paid internship graduation requirement. Paid internships are seen as an opportunity to prepare students for work and as well as identify a business that would possibly hire them in the future. In 2009, North Carolina data showed a four-year graduation rate of 87% for the students who completed career-related and technical courses compared to the overall statewide four-year rate of about 72%.[88]

North Carolina industries have invested in local high schools as feeder programs. "Pisgah High School in the west works with a local aerospace company in an apprenticeship relationship. In the Piedmont Triad there is a new Aviation Academy at Andrews High School that is forging a relationship with industry and Guilford Tech."[84] North Carolina also utilizes College Application Week, which is a designated time for graduating high school seniors to apply to college online through CFNC.org website. The College Application Week provides additional college awareness for students.

In addition, a study was conducted to analyze the types of skill requirements for BRAC recommendations at Fort Bragg and Pope AFB. They determined permanent job gains in housing, education, aviation, recreation and retail. Results from the study also determined increases in health care and social assistance, waste services, accommodations and food services. The state is providing services that link contractors with federal contract work. It focuses on the development of defense-related businesses. Furthermore, to provide support to current NC businesses and recruitment of new businesses, the state leverages The Aerospace Industry Sector Development Partnership. It is comprised

of several organizations with the state. Through various interactions it also attempts to maintain a quality workforce and business climate for NC companies. Among other organizations, the North Carolina Aerospace Alliance (NCAA) and The Advanced Machining Center (AMC) aim to develop capabilities and training to support the military and commercial workforce. Specifically the NCAA "develops capabilities to manufacture critical aviation parts supporting military facilities and defense sub-contractors" and AMC "offers training in machining, metal forming and CAD-aided design. It develops curriculum for a state-wide consortium of fourteen schools providing aerospace workforce training"[84]

Tax Credits

- Article 3J Tax Credits
  - Provide tax credits to qualifying businesses for job creation, investment in business property and in some cases investment in real property.
- William S. Lee (Article 3A) Tax Credits
  - Repealed for business activities that occur on or after January 1, 2007.
- Article 3J
  - Credits became effective for taxable years beginning on or after January 1, 2007.
- Research and Development Tax Credits
  - Provide tax credits for qualified North Carolina research expenses during a taxable year.
- N.C. Ports Tax Credits
  - Provide tax credits toward income taxes paid by businesses or individuals using ports facilities at N.C. Ports at Morehead City and Wilmington.
- Renewable Energy Tax Credits
  - Provide a tax credit of 35% of the cost of renewable energy property.

SOUTH CAROLINA

In 2003, the South Carolina Centers of Economic Excellence Programs created over 2000 Knowledge-based jobs and invested over $500M in talent and infrastructure at South Carolina research universities. South Carolina was ranked as one of the top 10 states in employment concentration for:

- Chemical Engineers (60% more than the national average)
- Chemical Processing Operators (63% more than the national average)
- Chemical Technicians (29% more than the national average)
- Computer Control Programmers and Operators (54 % more)
- Industrial Engineers (45 % more)
- Industrial Production Managers (25% more)
- Nuclear Engineers (6% more)
- Nuclear Technicians (94% more)

South Carolina has successful incumbent worker training with Ready SC TM and Apprenticeship Carolina TM. Through Ready SC TM on state Technical College Systems, more than 250,000 have been trained. Apprenticeship Carolina TM helps businesses develop their own apprenticeship programs.[89] As of mid-April, the state- funded ready SC™ worker training program at Trident Technical College had graduated 1,700 workers for the existing Boeing fuselage assembly plant, and another 1,300 applicants had qualified for the eight-week training program. The state expects to spend up to $33 million over the next

15 years on the program to train workers for the Boeing plant.[4]

All state incentives are performance-based, including the Job Tax Credit, which can reduce the state's already low 5 percent corporate income tax by up to 50 percent based on job creation; and the Job Development Credit, which can allow companies to receive a rebate on a portion of new employee's withholding taxes that can be used for their specific infrastructure and facility improvements. In addition, local county councils have the authority to negotiate fees in lieu of taxes that can reduce a company's property tax by more than 50 percent for up to 20 years.[86]

South Carolina has been instrumental in developing the program Jobs for America's Graduates (JAG). JAG-South Carolina (JAG-SC) is based on a national model that has proven success. It is a program geared towards high school students to increase the chances of graduation and to help students develop the skills necessary to be successful in the workplace.[89] In this program, students participate in a three-year opportunity, two years in HS and one year as they transition to post-secondary education or employment opportunities. They take courses that teach competencies determined by industry as basic skills that are essential for successful employment. As a result, the program has lowered absences, raised scores, and increased responsibility and skill set of young people.

South Carolina has also established "Quick Jobs" training. Below are some of the activities:

- For dislocated workers and eligible adults for ongoing training in South Carolina's Technical College System.
- Particular focus on Advanced Manufacturing; Construction Trades, Energy, Health Care, and Transportation and Logistics.
- 24 courses at 16 technical colleges.
- Implemented a Career Readiness Certificate program utilizing WorkKeys™
- One Stop Shop for job opening and resume submissions

Tax Credits

- No state property tax
- No local income tax
- No inventory tax
- No sales tax on manufacturing machinery, industrial power or materials for finished products
- No wholesale tax
- No unitary tax on worldwide profits
- Favorable corporate income tax structure

8.4 International MRO Repair Stations Best Practices

When it comes to best practices within the workforce, many international companies incorporate American best practices while U.S. companies sometimes incorporate International best practices, as the research shall show in the ensuing documentation.

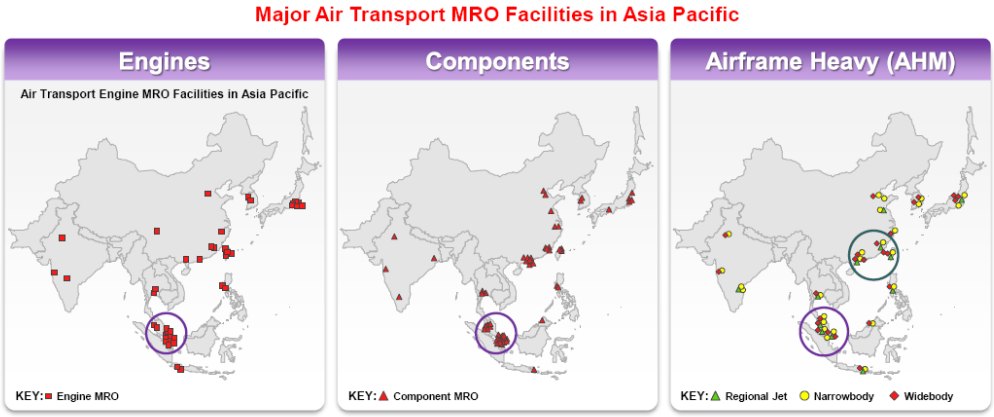
Asia

Asia has become a centralized MRO hub since the 1990's push into the market. The integration of supply chain accessibility, technology, and workforce population has made it a lucrative

location. While many countries suffer the burden of cross-industry allure from aerospace to the electronics and automotive fields, Asia is not suffering this phenomenon. Additionally, unlike in the U.S., where one has to go out of the way to lure students to train as A&Ps, aviation engineering has become a more desired career field in both Singapore and China. Many take pride in doing aviation.[90]

Challenges to the aerospace MRO community in Asia is that although human capital training is becoming more affordable in Asia Pacific due to the rise in urbanization, especially the middle-class societies, it is not within the reach of most aspiring locals. Overcapacity is another issue challenging market participants and many have to move overseas to complete their training. However, considering the overall aerospace industry, the total infrastructure required to keep pace with the boom remains largely deficient.[122]

With the advent of Commercial Aircraft Corporation of China (COMAC) created in 2008; based in Shanghai with plans to build and design their own large passenger aircraft, the need will increase for needed MRO facilities.[2] The Major Air Transport MRO Facilities in Asia Pacific are shown in Figure 8.2.



Air Transport MRO Key Success Factor	S. Korea	China	Singapore	Hong Kong	Taiwan	Japan
Number of key Air Transport MRO suppliers	2	> 25	> 30	6	3	7

Figure 8.2 MRO Facilities in Asia[2]

With an emphasis on technology and training for workforce best practices, a shift has become prevalent between knowledge-based training and competency-based training. ST Aerospace President Tay Kok Khiang underscores the shift. Once, "We tended to train people to make sure they understood how the airplane worked--and hoped they picked up the rest." Today, "the emphasis is more toward getting them to understand how to work on the airplane? It can be more complex."[92]

CHINA

As China races to become the leading provider for Asian MRO, China's aerospace market is already the fastest growing aerospace market in the world. China's civil aviation service providers achieved a 17.1% increase compared with last year (2009).[7] China would need 3796 aircraft in the next 20 years to meet demand some of which is created by rapid increase in Chinese tourism, development of middle and western regions as well as cross-region migration. The current number of airports in China as of 2010 is 166 and will increase to 244 by 2020.[90]

With China's frantically expanding aerospace industry, there is need of incorporating many foreign technologies and or expertise because of its late start in the field. It also does not have a rail system linking commodities, industrial sites and MRO facilities. Another challenge facing China is less concrete, it is more in overcoming negative perception regarding developing world class aircraft.[90] One way to overcome this is by joint ventures but, as China considers joint ventures, some key issues in foreign businesses doing business in China include business and cultural differences. Add to this, new maintenance equipment being built into new airplanes/jets and the need for skilled workforce is increased exponentially.

It seems part of China's dilemma includes ones other countries are experiencing as well; workforce, knowledge capture, best ROI, less capital and more expense. Most current efforts include Joint Ventures so as to incorporate established OEMs and aerospace industries best practices within the new companies.[2]

Finally, one company, BHA is utilizing best practices from the U.S.A in China. It seeks to rid the stereotypical Chinese factory with a new facility located in Beijing's port city of Tianjin. With 520 employees, there are requirements for them to take three months training at a vocational school, an additional 5-6 weeks training before actually working on the shop floor and then they have a mentor for six months. "Under Chang's unashamedly American style of management, BHA has sought to adopt the best work practices from the USA and then improve on them. Staff are encouraged to talk to management and raise issues: Chang says he meets regularly with workers in an effort to create better dialogue. BHA also encourages workers to come forward and admit to mistakes so problems can be quickly rectified and others can avoid making the same slip-up. This may sound like common sense to a Westerner, but is no easy feat in a country where it is important to "save face." [92]

HONG KONG

According to Airline Update, Hong Kong has four MRO companies as of 25 October 2010, two of which are located in the city of Lantau. One of the larger ones, HAECO, was established in 1950. HAECO has reported an overall reduction in the occurrence of maintenance errors, due to its strategies in quality assurance. To help maintenance organizations achieve the dual goals of identifying factors that contribute to existing errors and avoiding future errors, HAVO adopted aspects of the MEDA process in Hong Kong. [8]

It is a basic six-step process for operators to follow as illustrated in Figure 8.3. [123]

- Event – Scope of Error Investigation
- Investigation.
- Data Analysis
- Prevention/ Corrective strategies.
- Feedback.
- (Additional) - Training

This principle is key to a successful investigation. Traditional "blame and train" investigations assume that errors result from individual carelessness or incompetence. Starting instead from the assumption that even careful employees can make errors, MEDA interviewers can gain the active participation of the technicians closest to the error. By following this principle, operators can replace a negative "blame and train" pattern with a positive "blame the process, not the person" practice.

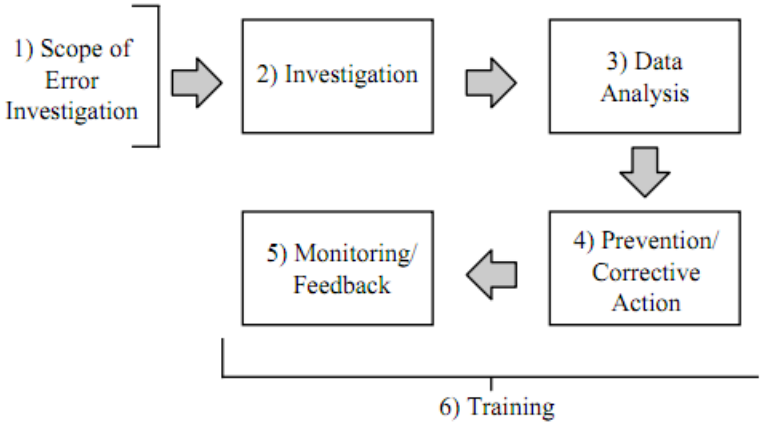


Figure 8.3 The Six Reviewed Elements of Maintenance Error Investigation, Analysis, and Corrective Action
Source: Learning from our Mistakes: A Review of Maintenance Error Investigation and Analysis Systems

SINGAPORE

As noted in Figure 8.4 depicting MRO Facilities in Asia,[8] Singapore is the Hub for Aerospace MRO as well as other manufacturing industries. Singapore is a small island situated at the tip of the Malaysian peninsula that has dedicated itself to being a world-class manufacturing center.

Figure 8.4 MRO Facilities in Singapore
Source: Aviation Today. Asia's MRO Hub[35]

Singapore was named the world's most competitive place for business, while the World Bank dubbed the island nation the "world's easiest place to do business." More than 8,000 manufacturers are located in Singapore, and while the country feels the pressure from China's emergence every bit as much as Western nations do, Singapore expects to double its manufacturing output to $300 billion (US$192

billion) within the next dozen years.[9] Additionally, Singapore is ranked No. 1 by the "Doing Business" project of The World Bank Group in terms of the ease of conducting business. The island nation is home to more than 100 aerospace companies, which have captured a quarter of the Asian MRO market. In 2008, the industry employed 19,000 people. Singapore's aerospace industry has grown at an average rate of 13% since 1990 to become the most comprehensive MRO hub in Asia, according to the Brazilian company, Embraer.[8] The expanding capabilities of Singapore come as the North American commercial aircraft MRO business faces headwinds, according to Frost & Sullivan. "Low-cost Asian and Latin American MROs are capturing considerable market share and turning the heat on the MROs in North America." Aerospace workers in the U.S. and Europe earn approximately $30.00 per hour. Whereas in Mexico they earn approximately $500 per hour, and finally in China they earn between $0.50 and $2.00 per hour.[8]

To meet the demand for this increased business opportunity the Singapore Workforce Development Agency (WDA)'s Aero/Aeroplus program transitioned to the Aerospace Workforce Skills Qualification System (WSQ).[94] The Aero program began in 2002 recruiting job seekers willing to re-skill into the aerospace industry. It also trained skilled aircraft technician to meet new regulations and turnaround time by offering enhanced classes and on-the-job training with close supervision.[93] Growth in the Asian MRO market is depicted by the illustration in Figure 8.5.

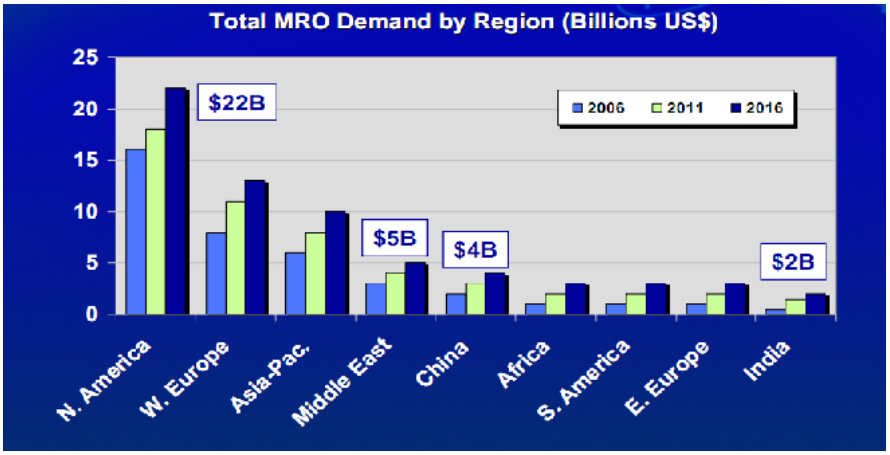


Figure 8.5 MRO Demand by Region
Source: MRO Industry and Emerging Markets, SH&E International Air Transport Consultancy

As the demands for operational skills and competencies on the job increased, WSD once again consulted industry to come up with qualifications for workers to meet through intensive training and assessments. WSQ came out of that initiative and is a national qualification awarded by the Singapore WDA. Employers know that individuals who have this qualification are benchmarked to local and international best practices and standards. The Singapore WDA utilized all major MRO companies for the assessment metrics and those companies are also part of the Industry Skills and Training Council which oversees training and develops needs.[9]

AMERICAS – BRAZIL, CANADA AND EL SALVADOR

BRAZIL

The emerging aerospace MRO business in South America (S.A.) includes seven out of the fourteen countries comprising S.A. Brazil has the largest presence of companies with eight located in their country. Three of the businesses are located in Sao Paulo but the largest company, TAP Maintenance & Engineering - Brazil, headquarters in Rio de Janeiro. With a staff of 2650 and an annual production capacity of 2.2M/year man hours they have become the leader in Latin America MRO market and are ranked among the 10 main aeronautical maintenance companies of the world.[95]

Two countries in South America, Argentina and Brazil are successfully utilizing the glamour of space and subsidized tuition to attract young students to the STEM classes and related fields, especially engineering.[46] One way in which TAP continues refining the workforce best practices is training. The company has developed dedicated programs to the constant recycling about 2,000 technician in update practical of aeronautical maintenance. This service is also offered to the customers of the company.[95]

CANADA

Canadian global market share of the MRO industry is estimated at 5% and credits that portion to being the home to many top aerospace companies.[96] Based in Longueuil, Quebec, Pratt & Whitney Canada (P&WC) is one company highlighted in this section for it best practices.[97] It is a world leader in the design, manufacture and service of aircraft engines powering business, general aviation and regional aircraft and helicopters. They are committed to maintaining a progressive and healthy workplace where people feel valued and inspired to excel professionally, grow personally, and realize their full potential. To achieve this, they engage in best-in-class employment practices in the areas of: Rewards and Recognition, Learning and Development, Health and Safety, Supportive work environment, and Employee Engagement. P&WC recognizes and rewards outstanding contributions through a variety of awards from honorary, monetary and other types of rewards. They also offer comprehensive benefits, savings and pension plans, as well as financial support for parental leaves and adoptions.[98]

Their professional learning and development program combines the best of many resources to provide employees the tools they need to progress. Program elements include educational assistance, in-house and online training, a scholarship program for employees' children, leave for university studies and alliances with educational institutions to offer on-site education.

Keeping employees healthy from hire to retirement is the goal of the Health & Safety programs. In addition to emergency services, they offer many programs that help prevent health problems and promote a healthy lifestyle. Services include an on-site medical clinic, general medical services, online e-doctor, emergency health services, a flu vaccination program, and a wellness and assistance program. The health and safety performance is considered an industry benchmark.[124]

P&WC promotes a flexible and supportive work environment to help employees balance professional and personal responsibilities. In some locations, they offer on-site daycare, physical fitness facilities, recreational clubs, and one-stop services like cafeterias and automated teller machines. Their leave of absence program lets employees defer part of their salary to finance time off.[124]

The annual Employee Survey measures engagement and ensures they sustain a high-performance culture. Survey results are discussed and translated into tangible action plans that are reviewed by Senior Management and monitored throughout the year. Making their voices heard is only one of the ways employees can take pride in making a difference in their work environment. [96]

EL SALVADOR

Aeroman is located in Taipa La Paz in El Salvador. It is an aerospace MRO facility and is a member of the AVEOS group, a Canadian firm, which purchased 80% in 2006. The best practices utilized by the company are loyalty, both to the customer and towards employees, as well as engendering loyalty of the employee towards the employer by encouraging a good, fair workplace where all take responsibility in their job duties. Honesty, leadership, respect and promoting a company identity within the workforce are heavily encouraged and promoted. The core values are the basis for the workforce, but providing current and leading edge computer-based training and on-site training in new disciplines are also encouraged and provided.[96]

In March 2009, a free zone called San Jose Aviation emerged in El Salvador. This is more a strategy than direct competition between companies. It is developing a cluster of companies to become the South American Hub. Major pro for businesses is $4,500 a year vs. $44,000 in Canada and in 2005 Universidad Don Bosco launched a 2-year mechanics course. Additional best practices recommended are to implement English programs in the first school years, promote exchange programs with other prestigious institutions with MRO knowledge, and to attract world aviation institutions to train local universities in aviation knowledge.[66]

EUROPE – GERMANY

There are currently 27 aerospace Maintenance, Repair and Overhaul companies and organizations in Germany as of November 2010, five of which are located in Hamburg, three located in Frankfurt, two in Dusseldorf and the rest spread throughout Germany; of those 27 companies, Lufthansa comprise more than one fourth.[14] Hamburg, Germany is the base for Lufthansa Technik AG, the primary MRO facility for Lufthansa Airlines, with 31 subsidiaries and affiliates worldwide. As of the third quarter of 2009, the employed 19,742 staff with an increase of +4.0% from last year, partly because of an increase in the vocational trainees and a total of 307 young people beginning apprenticeships.[14]

In 2005 Lufthansa Technik Group, in cooperation with the City of Hamburg, but within a company-operated environment, began a 10-month training course offered to 24 secondary modern school "leavers" aimed at awareness for the young people as to the requirements for apprenticeship in metal

working and engineering industries. Another best practice includes training 787 young people for their later highly responsible careers in aircraft maintenance, 186 commenced further specialist training toward 15 different types of skilled jobs. Lufthansa Technik hosts 500 practical work experience placements for schoolchildren; it also supports more than 450 industrial student internships and undergraduate engineer project leading to full professional qualifications.[99]

The main focus of German MRO workforce best practices seems focused on training. It starts with introducing the industry to young school children, aligning cities with the industry, and ongoing incentives for continuing education while on the job. For example, Lufthansa Technik Training (LTT) works with three different forms of training; classic classroom, practical and e-learning training. These are blended and coordinated so the cost of tuition is defrayed.[19] One of these blended methods is the "Human Factors" course which is intended to improve skills such as judgment, communication, teamwork and stress resistance. It is also a priority to provide an environment where the learned skills can be put into practice.[100]

8.5 United States - Air Force Air Logistics Centers (ALCs)

The United States Air Force consists of field organizations separated into four primary areas, each of which consists of several sub-components. The four areas include: Major Commands, Field Operating Agencies, Direct Reporting Units and Reserve Components. There are approximately nine Major commands, 35 Field Operating Agencies, four Direct Reporting Units, and two Reserve Components, which are best known by many as the Air Force Reserve and the Air National Guard. The Air Force Material Command (AFMC), headquartered at Wright-Patterson Air Force Base in Dayton, Ohio, exists as one of the nine Major Commands. It is strategically structured to address eight mission areas through the utilization of a variety of centers. The centers are organized into five core types: Product Centers, Air Force Research Laboratory, Test Centers, Air Logistics Centers (ALCs), and Major Specialized Centers.[102]

ALCs are tasked with maintenance and sustainment of air and land vehicles which include avionics, electronics, composites, air frame and munitions. ALCs address expected and unexpected (e.g. emergency) depot maintenance. The expected maintenance or programmed depot maintenance are those maintenance actions that are generally planned and scheduled such as a routine vehicle check-up. This is not the case for unexpected or unplanned depot maintenance where an aircraft may need emergency maintenance due to failures sustained in an attack during a mission.

In 1995, McClellan AFB in Sacramento, CA and Kelly AFB in San Antonio, TX were closed due to the Base Realignment and Closure (BRAC) process used by the Department of Defense to redistribute workload, personnel and funding to other bases. BRAC is done with the intention of better equipping the US military. Currently there are three functional ALCs within the United States: Tinker AFB located in Oklahoma City, OK; Hill AFB located in Ogden, UT and Robins AFB located in Warner Robins, GA**.** In Table 7.1, a list of the weapon systems/programs supported by each existing ALC is depicted.

Workforce Development

The Air Force Materiel Command (AFMC) Logistics and Sustainment mission is straightforward: 1) Get the force to the fight; 2) Keep the force in the fight; and, 3) Prepare the force for the next fight.[88] Sometimes the people making up the workforce can become lost in the process, but the Air Force addressed this in their Depot Maintenance Transformation (DMT) 'Workforce Development' initiative, promoting a change of consciousness on the depot floor to develop leadership skills and a workforce which is not one dimensional, i.e. multi-skilled.

The Air Force Materiel Command (AFMC) Logistics and Sustainment mission is straightforward. The steps for the Workforce Development initiative are:

1) Get the force to the fight;
2) Keep the force in the fight; and, 3) Prepare the force for the next fight.[88] Sometimes the people making up the workforce can become lost in the process, but the Air Force addressed this in their Depot Maintenance Transformation (DMT). Table 8.1 shows the functionality assigned to each ALC.[101]

	Hill AFB	Tinker AFB	Robins AFB
Programs Supported and Logistics Managed	Aircraft Airframe • F-16 • A-10 • C-130 (Portion) • Aircraft Commodities • Landing Gear, Wheels & Brakes • Composite/Low Observable Structures (B-2) • Power Systems • Hydraulics and Pneudraulics • Avionics - F-16 • Instruments and Display Indicators • Electro-mechanical Support Equipment • Photo / Recon / Imagery Depot Core Capabilities • Air Munitions • Small Weapons • ICBM Missile Systems • Space & C3I – Mission Planning – Tactical Shelters, Rigid Wall – (Radomes & Radome Structures) • Software – ATE – OFP – TPS	SSM Responsibilities – E-3 – B-1 – B-2 – ATCALS – Propulsion Programs Managed – B-52 – C/KC-135 – CLS – Propulsion Product Group – Common Airborne Accessories Product Group – Cruise Missile Product Group – High Frequency Global System	Provide Management Support for – F-15 Eagle – C-5 Galaxy – C-17 Globemaster III – C-130 Hercules – C-141 Starlifter – U-2 Dragon Lady – All AF Helicopters and Special Operations Aircraft – All AF Support Equipment Vehicles – Space and Special Systems – Avionics: 17K Items and Over 370 Systems – Electronic Warfare: Over 13K Items

Table 8.1 Programs supported by ALC

'Workforce Development' initiative, promoting a change of consciousness on the depot floor to develop leadership skills and a workforce that is not one dimensional, i.e. multi-skilled.

The steps for the Workforce Development initiative are:

> **Step 1:** Focusing on leadership skills, series and non-series specific skills and the certification process defines the future state for the workforce.
>
> **Step 2**: Leadership skills will be driven down to the depots predominantly from the AF/ILMM & AFMC/A1 and supported by the AFMC/A1 Strategic Workforce Action Team (SWAT). AFMC will also be able to leverage results from another group that is addressing the logistics Professional Development Framework (PDF).
>
> **Step 3**: For series and non-series specific skills, AFMC will continue with the current process of using Civilian Training Plans (CTP). AFMC expects the credentialing process to be primarily driven from the top.
>
> **Step 4:** To attain the future state for each individual in the workforce, AFMC expects to use Career Development Plans – a good guide has been developed by OO-ALC on behalf of AFMC and is in line with guidance from AF/ILMM and the AF workforce development CONOPS.
>
> **Step 5:** Multi-Skilling is the combination of two or more journey level series in a single position. AFMC will leverage the work of the Flexible Workforce Integrated Process Team (IPT) into the overall initiative.[101]

This initiative 26 January 2010 was furthered by Secretary Donely and Chief of Staff Gen. Schwartz who signed a memorandum endorsing four new initiatives to close the gaps that currently exist in the civilian workforce population. They emphasized New Employee Orientation, Continuous Self-development, Completion of non-residence Professional Military Education, and Civilian Acculturation and Leadership training.[89] With a focus on empowering the employee to not settle for the minimum, the new hire has opportunities at whatever entry level/series they enter the Air Force civilian workforce. Figure 8.5 is introduced to new hires and an Individual Development Plan is derived from civilian development continuum, encouraging continuous self development.[68]

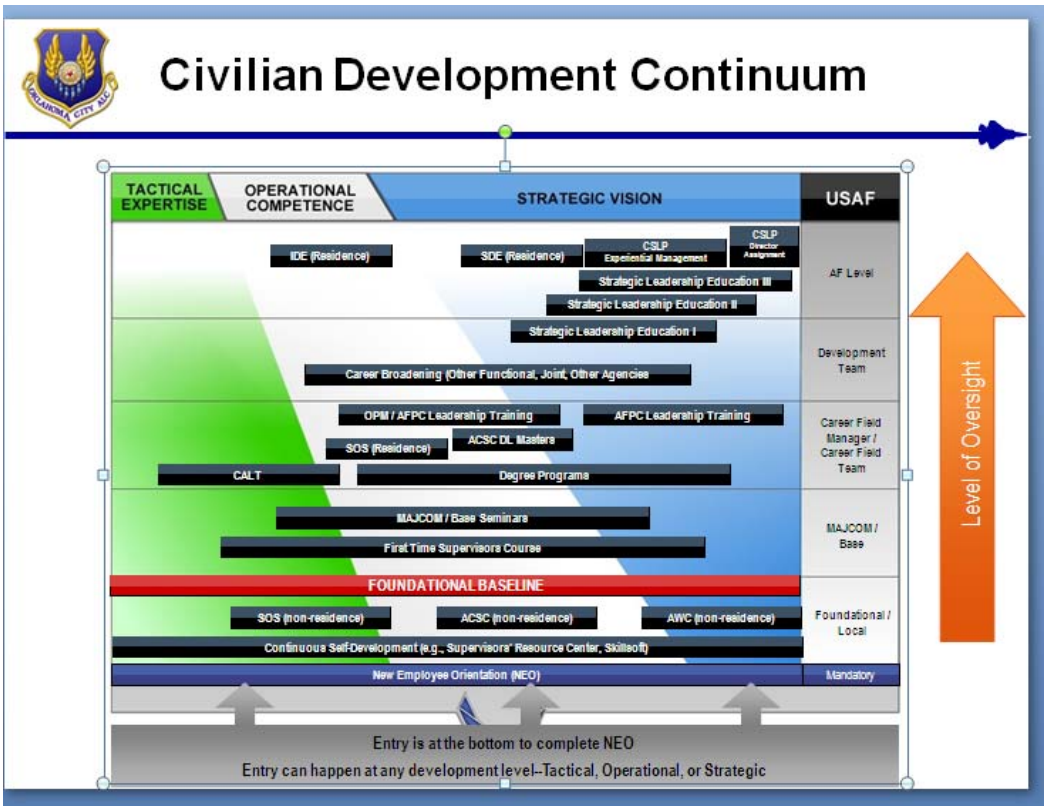


Figure 8.6 Air Force Civilian Development Continuum

The Civilian Acculturation and Leadership Training is modeled after Officer Training School curriculum and develops similar skills and knowledge used to develop officers with a focus on communication, leadership and problem-solving.

Ogden UT – Hill AFB (OO-ALC)

There are a number of initiatives which are across all ALCs. These include benchmarking the best production programs, identifying industry leaders in various processes and incorporating lean principles within the workforce. Also the focus is on the formal training of this workforce into "multi-skilled, maintenance-ready technicians and managers. By embedding these initiatives into the maintenance culture, reductions are being made in shop flow days and cost. Ogden Air Logistics Center has reduced the A-10 wing, F-16 wing, and F-16 stabilizer repair flow days by 39%, while on-time delivery has improved to 100% and 98% for A-10 wings and F-16 wings, respectively.[103]

Oklahoma City, OK – Tinker AFB (OC-ALC)

Emerging from the Workforce Development initiatives and Secretary Donely's initiatives out of AFMC Headquarters, Tinker AFB implemented their Civilian Force Development plan. This includes development programs for supervisory, intermediate, journeymen and professional employees to better their job position.[103]

Supervisory Development Program (SDP)

This program selects employees who have evidenced self-motivation, initiative on the job, and shown leadership competencies. These employees are groomed for future supervisory positions and put into a candidate pool to be accessed first when filling first level supervisor positions. They must meet certain

qualifications; they can self-nominate themselves, they must have a certain level of education, and they must have endorsement from both their supervisor and their organization. If nominated they will take 5 classes totaling 21.5 days including soft skills, financial, lean facilitator, HR and customer service.[103]

Intermediate Leader Development Program (IDLP)

Employees who take advantage of this program have options for career broadening and developmental opportunities. They self-nominate in May and the program, which is cross-organizational and cross-functional, is available for those planning to remain "Tinker assets". Its main purpose is to build future leaders and develop the workforce. There are series level qualifications. Some of the best practice development opportunities offered are attending leadership luncheons, job shadowing, vectoring sessions, OU/OSU Executive Leadership Program, Federal Executive Board- Executive Leadership Program and the Oklahoma Certified Public Manager Program.[103]

Employee Enhancement Program (EEP)

Journeymen who wish to apply for this program must have high potential. It prepares them for leadership roles. The program accepts data call Nov – Jan and series level qualifications apply. It is a one year program with three groups of 26 each per year. EEP helps develop the ability to lead change, create employee networks and build realistic career plans.[103]

TOPS

The goal of TOPS is to competitively move employees into positions that maximize their potential, education and experience. There are three series and it allows employees to transition to specific GS series based on their education, experience and performance. Once again, the employees self-nominate via the AF Personnel Center website or through an interactive voice response system. [103]

Civilian Tuition Assistance Program (CTAPS)

This program provides monetary assistance for mission related course. It is designed to benefit AFI 36-401 and covers 75% of tuition/$187.5 maximum per semester hour with a yearly cap of $3500. There are applicant requirements and qualifications which are listed on the Tinker homepage under the Education and Training tab.[104]

Warner Robins, GA – Robins AFB (WR-ALC)

The 402nd Maintenance Wing, Warner Robins Air Logistics Center has transformed the way it handles C-17 heavy maintenance and modifications. It embedded program management and materiel support into production activities, shifting the focus on material from supply to aircraft delivery due-date performance. This new process, it says, makes work stoppages due to shortages a rarity. The 402nd MXW has adopted *industry best practices, including AS9100 registration, and it has improved its work scope by grouping personnel into multi-skilled teams*.[2]

8.6 Oklahoma Aerospace Workforce Best Practices Implications

To address effects of the economic pressures, states across the United States are creating new employment strategies and initiatives that:

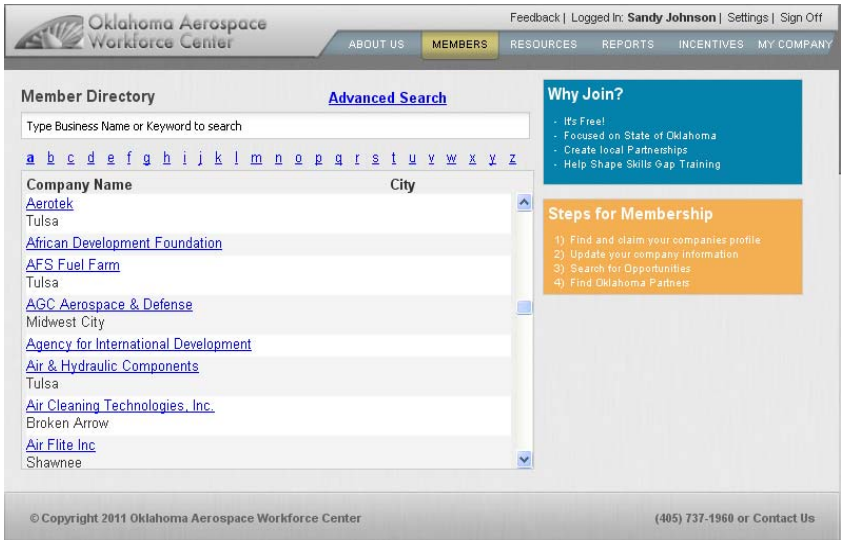
- Continue to assess the current workforce pool and incoming workforce needs;
- Continue labor studies to identify workforce areas of need;
- Develop recruitment, retention, and training strategies;

- Recruit workers from non-aerospace industries;
- Provide workers with infrastructure, social services, quality of life (to retain them);
- Train and educate local workforce by providing more specific technical classes;
- Work with education providers to establish appropriate STEM curricula for P-20;
- Establish partnerships with key institutions to coordinate a workforce response;
- Respond to the unique needs of military and federal civilian spouses and their families;
- Streamline licensing transfer processes; and
- Offer training, educational access, and tuition assistance, particularly for veterans who may have served in areas parallel to job categories in aerospace.

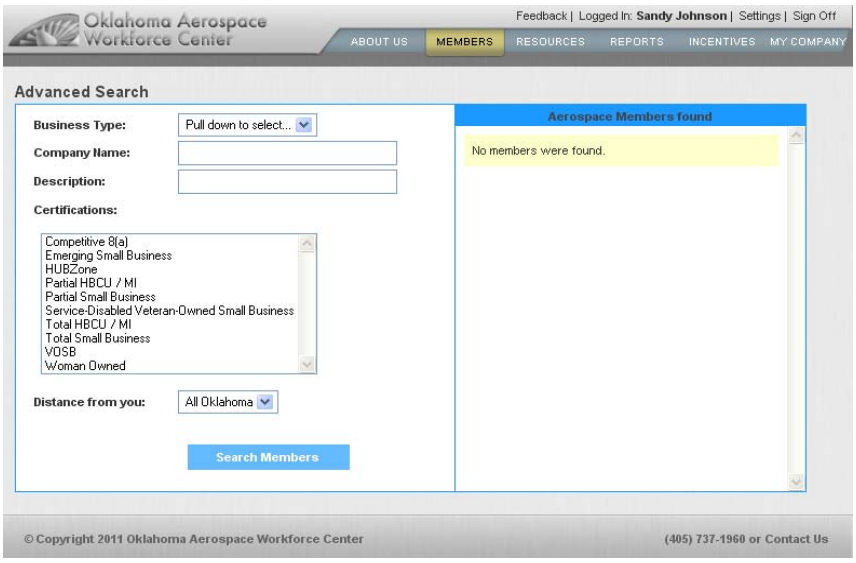
SECTION 9: OKLAHOMA AEROSPACE WORKFORCE CENTER WEBSITE

The purpose of the Oklahoma Aerospace Workforce Center Website is to design and develop a continuing process to update and revise the workforce requirements for the aerospace industry in Oklahoma. The following screenshots will provide some information about the website, its functionality, and its navigation. The reader is encouraged to log on to the site at http://www.teamaero-ok.org. There are many other features that go beyond the scope of providing a process to update and revise the workforce requirements. Other functions are provided for the benefit of the aerospace user to provide opportunities to network, to find contracting opportunities, and to publicize capabilities of aerospace companies within the state of Oklahoma. Explanations for each of the screenshots are provided below the graphic. All data input by aerospace companies will be aggregated to ensure privacy and security of workforce information. Reports will be generated for the Oklahoma Department of Commerce and the Oklahoma Aeronautics Commission. This critical workforce data will help forecast the supply and demand needed by the industry and will assist the education providers in their program planning by providing compiled data with regard to the aerospace workforce statistics.

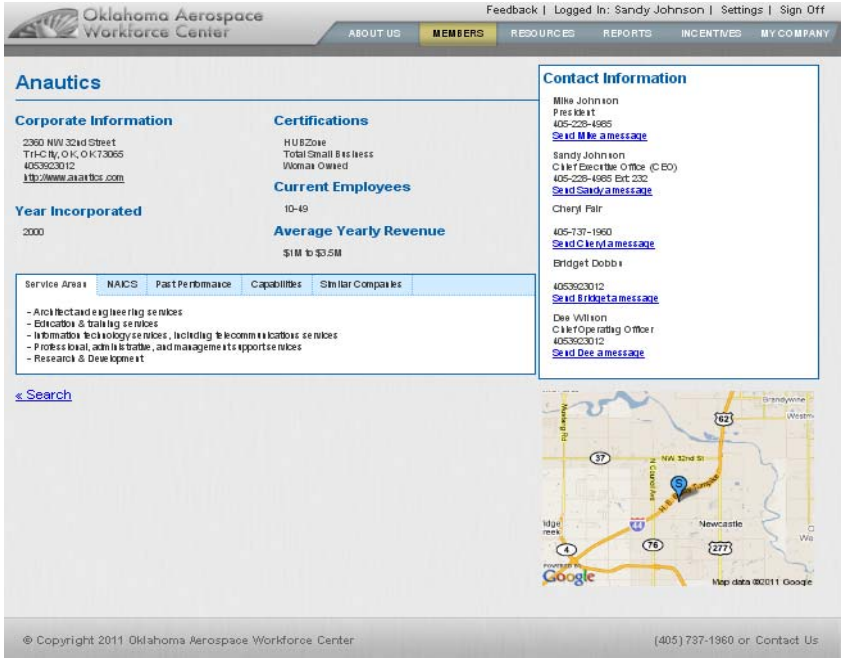
Website Front Page – informational page. Social media features will be developed in Option Year 1, pending available funding.



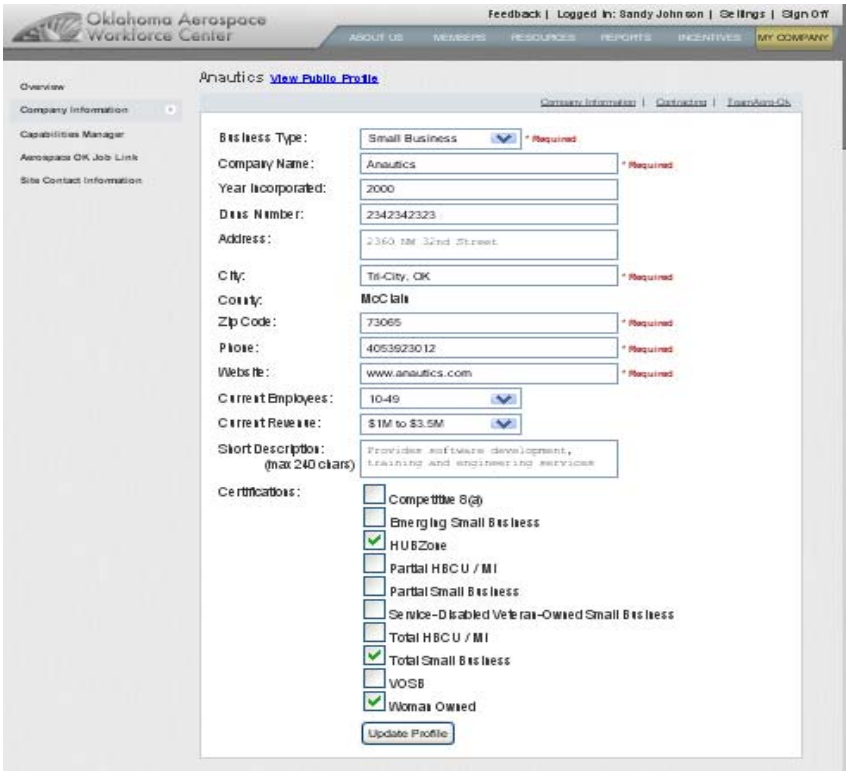
Member Directory – Members of the Oklahoma Aerospace Alliance and the Oklahoma Aeronautics Commission were input into this database. Aerospace companies can be searched by name or by specific attributes of the company.



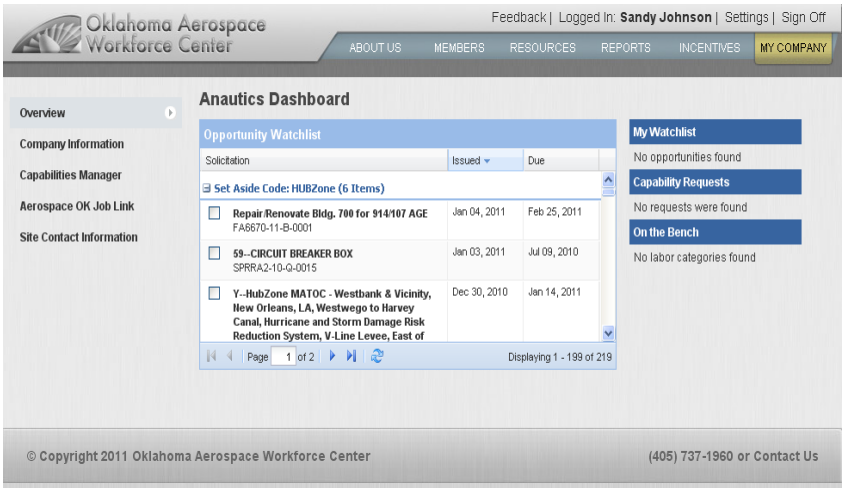
Advanced Search – A user can search for an aerospace company in Oklahoma by specifying Company Business Type (i.e. Large business, small business, Government, Education Institution, Other), by Company Name, by description of work capabilities or by certifications.



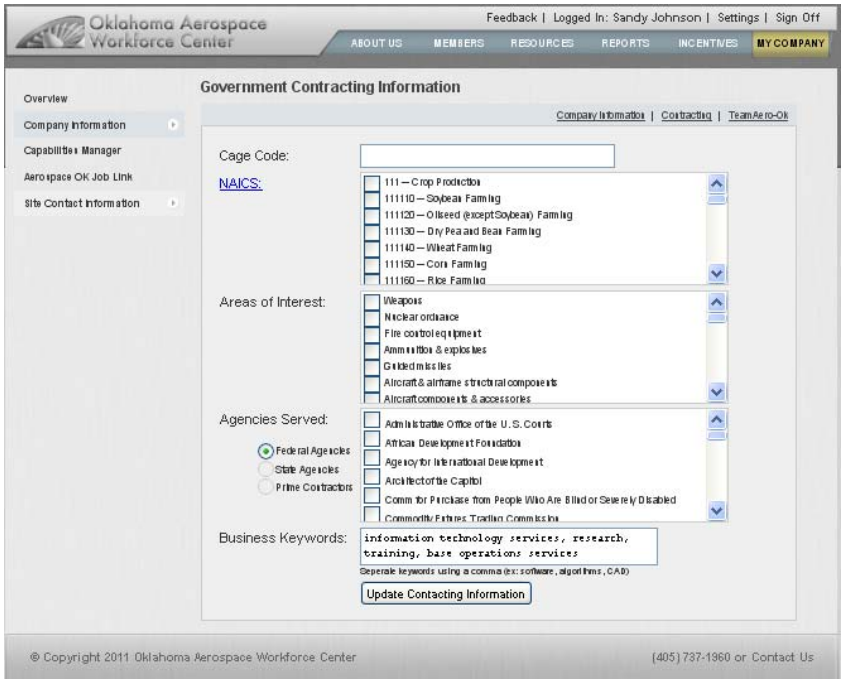
Company: Public View –
This view gives the company profile including Corporate information, Certifications, Current Employee count, Year Incorporated, Average Yearly Revenue, Contact Information and a Map to the corporate office.



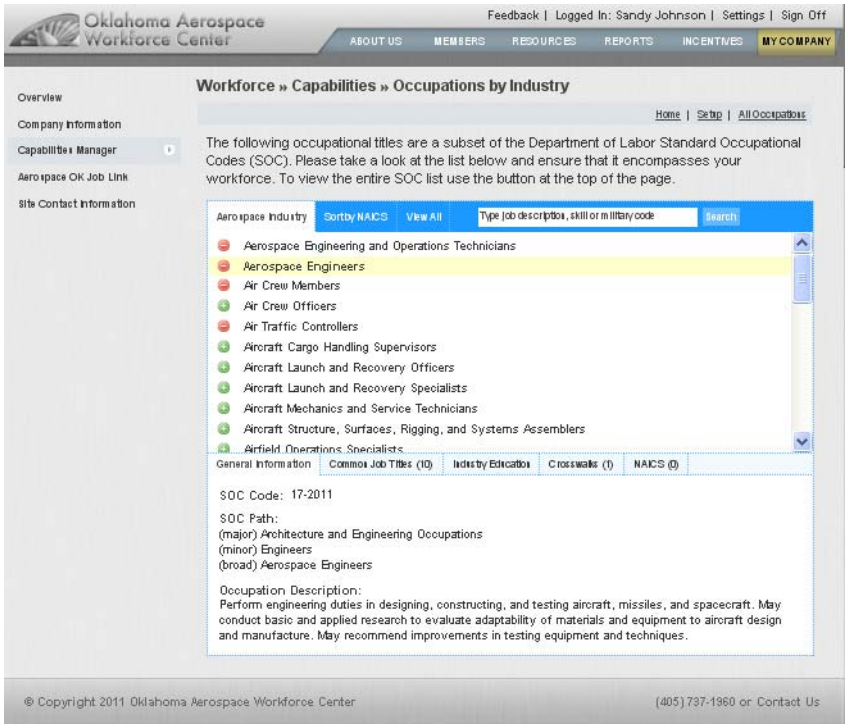
Company: Update General Information –
Once a user has logged in through a secure validation process, company profile information can be entered to update the Profile page as shown in the previous screenshot.



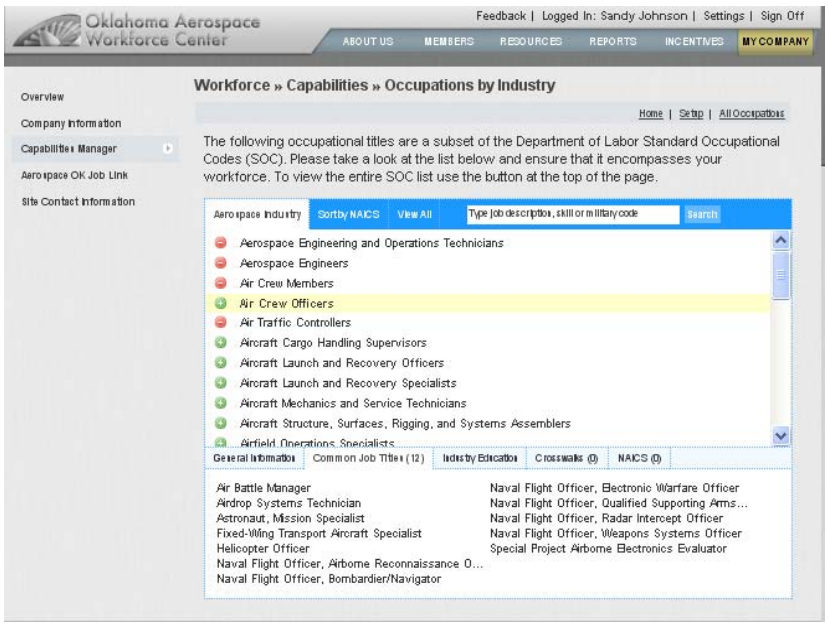
Company: Dashboard – Each user has a dashboard that provides a navigation bar at the left which is used to input company information as well as workforce data. Functions on the right navigation bar are in the Option Year 1, scope of work, pending funding. The Dashboard in the center provides real-time data from Federal Business Opportunities (FedBizOps). The user can access information and check box opportunities that are selected a potential opportunities.



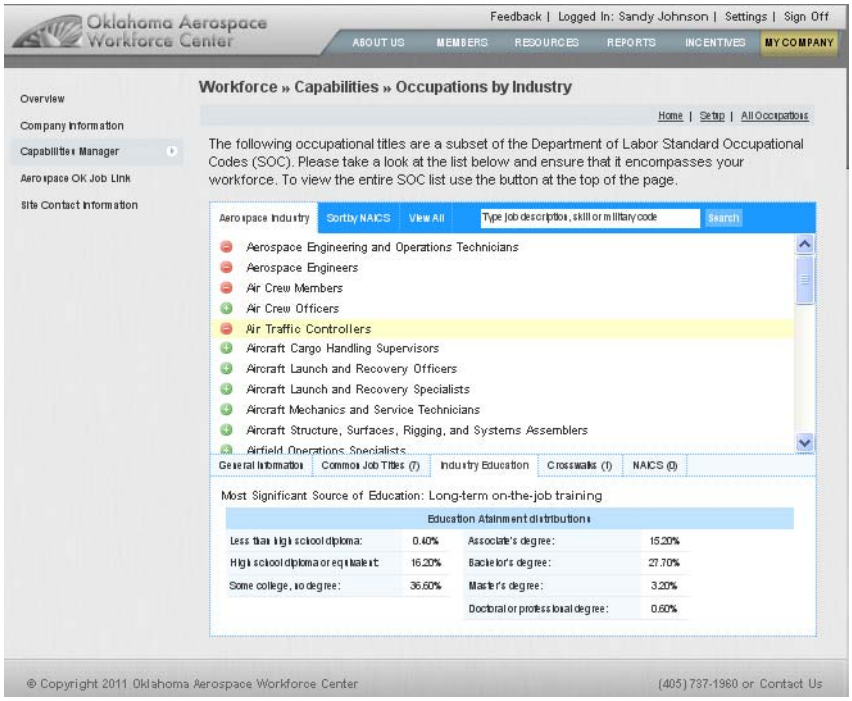
Company: Update Contracting Information – Screen provided to update NAICS codes, Areas of Interest, and Agencies Served. This information will provide quick references for networking capabilities.



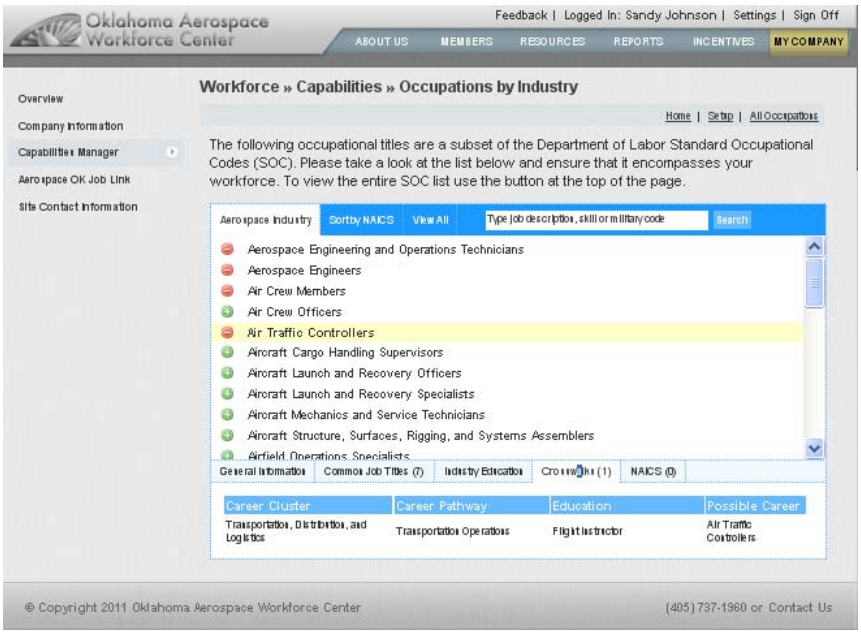
Company: Workforce Capabilities – Opportunities by Industry –
This is the beginning of establishing a database of company employees. The titles are a subset of the Department of Labor Standard Occupational Codes (SOC). Companies will record their employee base by Occupational Codes. For each job title, general information is provided such as the occupation description, Common Job Titles, Industry Education, Careers and NAICS codes.



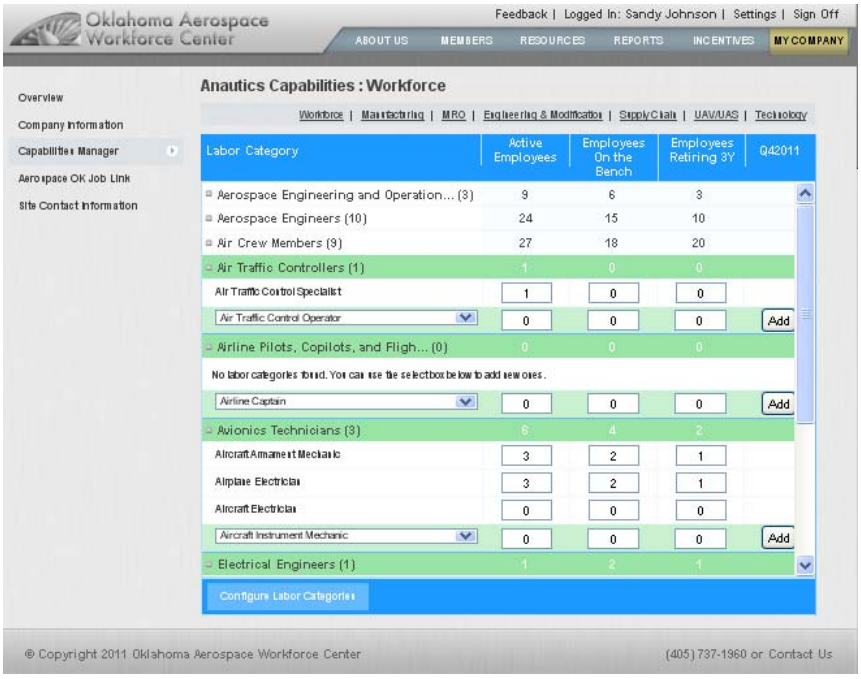
Company: Capabilities Manager –
Common Job Titles are provided in order to assist the user in categorizing their workforce to the SOC. Each job title provides a list of common job titles that may be used for the given SOC.



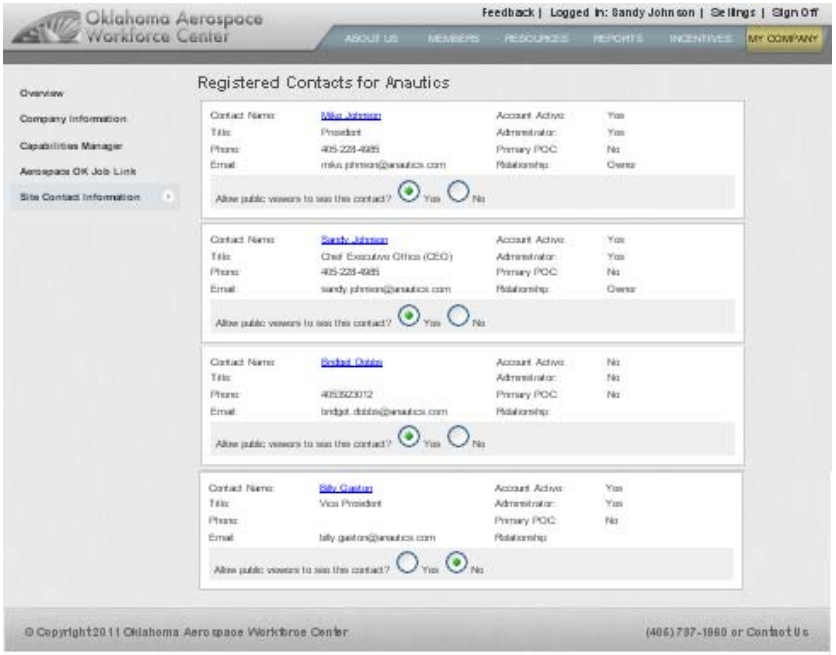
Company: Capabilities Manager –
Industry Education requirements are provided for each job title. This will aid the user in determining the appropriate job title for their employee based on Common Titles and Education requirements.



Company: Capabilities Manager –
Crosswalks: Career Cluster, Career Pathway, Education, Possible Career information is provided to assist the user in categorizing the employee to the proper job category.



Company: Aerospace OK Job Link: Standard Occupational Codes : Standard Job Titles – Once the general Job Titles are selected, the user can then drill down to the specific common title using a drop-down menu. User will input the following: Current number of employees (under the specific job category), Number of employees "on the bench" (not currently charging directly to a contract," and number of employees within the specific job category who are within three years of retirement.



Registered Contacts – user can allow or disallow company user access to the workforce database. This is provided so that data is secure and private by only allowing one person to submit workforce data or change company profiles.

SECTION 10: SKILLS GAP ANALYSIS SUMMARY WITH RECOMMENDATIONS

During the research study, the participants were asked after attending five skills panel activities to brainstorm what is needed from the industry to move forward now to take action to improve the aerospace workforce in Oklahoma. Many of these recommendations for action are included in this section of recommendations and in the Option Year 1 proposal.

1: BETTER IDENTIFICATION OF INDUSTRY NEEDS

- Create a Governor-appointed position where the appointee will coordinate all state resources used to support attraction and growth of the aerospace industry. This person should be agreed upon by Common Education, Higher Education and CareerTech and be able to build collaborative efforts among the education providers, be accountable to the governor, be responsive to industry customers to oversee all the workforce issues related to aerospace business attraction projects for the benefit of the growth of the Oklahoma economy and the improvement of the quality of living in Oklahoma.
- Develop standard job descriptions, certifications, licensures to aid industry in better defining their existing workforce;
- Identify or establish an approved aerospace working group to include both industry and education providers that will serve as a formal platform to communicate actual needs across the industry;
- Provide Oklahoma industry ongoing access to the Aerospace Workforce Center website to report workforce information so that the state/industry will have a better picture of their workforce pipeline;
- Continue current Skills Panels, transforming them into working groups with action items to specifically address solutions for gaps revealed in this report;
- Investigate and encourage large company to small company mentoring programs to build and grow relationships and allow mentoring companies to help others identify weaknesses and provide them with guidance to meet their immediate needs using proven processes; and
- Enhance methods, tools, and techniques to ensure aerospace companies have access to information and training for workforce forecasting to assist them in identifying and addressing future needs.

2: AEROSPACE EDUCATION STANDARDS FOR EDUCATIONAL FACILITIES AND EDUCATION CURRICULA

- Establish a standard communication platform between industry working groups and education working groups to ensure that providers are aware of what industry expects from incoming employees, primarily at the entry-level;
- Identify a collection of industry experts to better define their core job skills standards so that the education providers could better plan their program curricula to fit those standards;
- Investigate partnerships between education providers and industry that would aid in providing up-to-date equipment to education facilities for workforce training;
- Discourage teaching to the state mandated tests;
- Prioritize education to target high impact jobs;
- Support extension of days in school year; and
- Support Oklahoma Aerospace Alliance Education and Training Day at the Oklahoma

Aerospace Summit.

3: Shorten the Timeline from When an Employer Identifies an Employment Need to When that Employer has a Productive Worker

- Create collaborations between industry and P-20 systems to establish internships, co-ops, tours, fairs;
- Identify introductory aerospace courses most needed by entry-level personnel and establish widespread curriculum among education providers (basic instruction in: Introduction to Soft skills, general manufacturing, familiarization with jets, six sigma, lean, ITAR, FAA regulations, aerospace standards);
- Leverage company scholarships for teachers and students to attend education entities or company sponsored summer academy and Aerospace Summit Mentor/Teacher program;
- Establish programs to place industry personnel in schools to ensure students are aware of aerospace industry opportunities and requirements so students know what is expected upon entering an aerospace career field;
- Highlight companies with successful employee mentoring programs;
- Establish core job skills standards and certifications to ensure consistency in job descriptions and job requirements enabling employers to know exactly what skill set they are hiring;
- Establish stable, consistent communications with education providers on aerospace workforce job category labor shortages and surpluses; and
- Better align programs with labor shortages in order to shorten the work-ready timeline and possibly save companies some of their in-service training.

4: Improve Worker Agility (ability to move from one area or industry to another) and Provide Suggestions for Developing a Cross-Industry Training Curriculum which Would Provide Aerospace Workers with Greater Agility and Capability within the Overall Workforce

- Develop a working group which would determine what requirements are necessary to "improve" worker agility;
- Work with Tinker AFB and our other military installations to determine best practices they use to "broaden career paths" of employees and determine what is applicable to the industry;
- Develop additional certifications, standardized skill sets that would go across industries; this would involve utilizing working groups from: health care, energy, manufacturing, aerospace, agriculture, logistics, etc.;
- Develop a consortium of cross-industry personnel so each can better understand the functions of the other; and
- Encourage investigations of application of skills in the cross-industry meetings.

5: Assistance for Incumbent Workers with Employee Growth and Development

- Develop collaboration platform for industry officials and research college/universities to research solutions to existing industry problems, provide workers with access to research and emerging technology;
- Define and develop cross-industry training curriculum in order to accomplish tasks in Recommendation 4;
- Spearhead incentive programs to train or re-train existing workers;
- Provide better awareness of Workforce Investment Boards (WIBs) to industry and leverage

their resources;

- Encourage participation in the MRO university;
- Establish methods to educate WIBs on industry area needs;
- Incorporate programs other states (e.g. Washington and Arizona) utilize to provide reimbursement for expenses used for eligible training;
- Coordinate efforts to speak to parent groups to help them understand why children need to prepare for the STEM curriculum as early as the elementary grades; and
- Coordinate job fairs for youth.

6: Near-term and Long-term Workforce Opportunities and Solutions

- Near Term
  - Better utilize ex-military, dislocated workers, and cross-industry workers to fill parallel skills positions within the aerospace workforce
  - Begin a campaign in the public schools to educate young people on the aspects of the aerospace industry with a focus on middle school because of early intervention for STEM;
  - Determine Best Practices in University programs to recruit engineering majors;
  - Determine how to recruit more women and minorities into the aerospace programs;
  - Develop a program to alleviate the causes of early voluntary attrition; and
  - Build up the Aerospace Summit to facilitate more networking within and across industries.
- Long Term
  - Work at the state government levels to build rigor in middle school and high school curricula that includes the STEM curriculum;
  - Develop programs for state-wide internship programs for teacher/counselor during the summer months with aerospace industries;
  - Include K-12 administrators and counselors as part of working/focus groups;
  - Develop standards for work-ready/college ready requirements; and
  - Work closer with Common and Higher Education counselors and Colleges of Education.

7: Long-term Structure for Aerospace Workforce

- Develop certifications and/or licenses which might support or augment the existing A & P certification;
- Begin standardization of job categories/job titles/job descriptions;
- Develop career paths for ex-military (veterans) for quick insertion into the aerospace industry;
- Develop methods for aerospace industry representatives to network, share business capabilities and share work loads;
- Develop long term relationships with the Education sector through Summer Academies for teachers, principals, and counselors; and
- Develop academic aerospace-related camps for children during off-school days.
-

8: Improve Communications within workforce WIBs, Panels, the Aerospace Industry, CareerTech System, Community Colleges, Universities, Industry Training Operations, the Military, etc.

- Develop quarterly newsletters that highlights activities from entities;
- Establish working group with representatives from each organization to identify ways to leverage existing resources to aid shared training, equipment use and/or facility usage;

- Leverage established relationship s to eliminate duplication of effort among agencies and establish a complete inventory analysis of what programs/activities/entities have been established in Oklahoma to ensure they are being adequately marketed and utilized by their intended audience; and
- Develop regular meetings with existing panel members, provide joint meetings annually.

9: Identify needs that Could be Met with Existing Entities, e.g. OAC and its programs Oklahoma Aerospace Institute (OAI) and Center for Aerospace Supplier Quality (CASQ) as different from suppliers.

- Lead new certification efforts;
- Lead collaboration among the common state aerospace entities and industry organizations so that working groups can strategize as to how to best connect and network with aerospace companies in Oklahoma;
- Continue developing industry-led functionalities for the Aerospace Workforce Center website.

10: Preparing for the Exodus of a Retiring Workforce.

- Begin to develop ways to keep retiring workforce on staff a few hours a week for mentoring/training or to send to the classroom;
- Begin to educate our youth now on the type of jobs that are involved in the aerospace industry;
- Work with industry to investigate current processes that provide more on-the-job training where a young person can shadow a mentor (pre-retirement);
- Investigate Best Practices of Oklahoma aerospace companies as they plan and prepare for transitions as a result of a retiring workforce.

11.Continue the Workforce Database to Capture the Aerospace Workforce Data.

- Continue development of the website with guidance from industry;
- Continue to train Human Resources to input data into the database at least quarterly to gain information on the current workforce by job category, the number of people "on the bench," the number of employees expected to retire in the next three years, the estimated forecast in hiring during the next quarter, the estimates on cost of training;
- Develop training manuals for the aerospace companies as they learn to navigate the aerospace workforce database; and
- Continue developing networking capabilities among aerospace companies in Oklahoma.