OKLAHOMA AEROSPACE INTELLECTUAL CAPITAL/EDUCATIONAL RECOMMENDATIONS: AN INQUIRY OF OKLAHOMA AEROSPACE EXECUTIVES

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CHAPTER I

INTRODUCTION

The aerospace industry is one of three leading industries in the state of Oklahoma, employing over 143,000 jobs. One in ten Oklahomans derive their income from this thriving industry. Statewide direct and indirect gross output from Oklahoma's commercial aviation industry was estimated to be $12.4 billion in 2004, accounting for just over 10% of Oklahoma's industrial output according to the Oklahoma's Aerospace Industry Workforce Report (2007, p.5). Along with this growth comes a responsibility for development of talented and educated personnel to support the industry. Industry-academia collaborative efforts can help mold the future of aerospace in Oklahoma by partnering and addressing the needs of the aerospace industry for intellectual capital.

The Maintenance, Repair, and Overhaul (MRO) of aircraft is Oklahoma's primary role within the aerospace industry. Oklahoma is one of the six centers in the world for MRO work. The majority of these aerospace companies perform some type of MRO work. In 2007 it was reported that the commercial MRO industry was a $41 billion dollar worldwide market. By 2012, this value is said to be nearly $51 billion dollars and by 2017, nearly $63 billion dollars. Engine MRO work represents, by far, the largest portion of the MRO market, accounting roughly 42 percent, of the total spent in 2007 (Jackman, 2007, p. 47).

With companies such as American Airlines, in Tulsa, Oklahoma holding the title of the largest commercial MRO facility in the world and Tinker Air Force Base employing the state's largest number of Oklahomans, and not to mention the largest Department of Defense MRO facility, the state is positioned to be the leader in aircraft sustainment. Although the implications are that MRO companies require mostly touch labor, the administrative process requires a professional cadre of engineers, logisticians, safety and security experts, marketing analysts, consultants, and aerospace industry executives/managers.

This is particularly important since the industry is facing an aging aircraft problem along with the need to keep aircraft flying longer. Among the 400 plus companies in the state, Oklahoma has one of the highest concentrations of aviation maintenance workers and aircraft repair facilities in the world. "It is one of the six centers for aircraft sustainment." (Oklahoma's Aerospace Industry Workforce Report, 2007, p.5)

The economics and demographics of Oklahoma's aerospace workforce are experiencing major shifts due to aging and pending retirement of experienced personnel, increased diversity, changing technology, skill obsolescence, and an ever-increasing need for intellectual capital. Information, analysis, and trend identification will be essential for effective workforce development in this rapidly changing environment.

Aerospace companies in Oklahoma have expressed frustration with the shortage of intellectual capital necessary to maintain and grow the industry. These

companies have often been required to take on the role of the educational institution to adequately educate their own personnel; only to have them leave for greener pastures because of the highly competitive nature of the business.

To create a competitive advantage in a global economy, Oklahoma must have an aggressive and forward-thinking plan that integrates education and economic development efforts within the aerospace industry. Innovative thinking, increased collaboration, and more integrated processes and systems are required to position Oklahoma competitively for future growth and prosperity. This competitive advantage will enable Oklahoma to attract new business from within the aerospace industry and create quality career opportunities. By closely linking education, economic development, and professional systems, Oklahoma has the opportunity to be a leader in aerospace.

Statement of the Problem

A number of state agencies have conducted studies of Oklahoma aerospace workforce development needs (Governor's Aerospace Task Force Report, 2004, Oklahoma Aerospace Industry Workforce Report, 2007, Strategic Plan for the Growth of Oklahoma's Aerospace Industry, 2009). These studies are fragmented and generally confined to the development of touch labor rather than the identification of intellectual capital requirements for the professional personnel who support the field in such specialties as engineering, logistics, safety and security, marketing, consulting, and management. There has been limited research which

addresses the perspectives of aerospace industry executives in Oklahoma related to educational requirements.

Purpose of the Study

The purpose of this qualitative study was to conduct detailed personal interviews with aerospace industry executives/managers from both the private and military sectors from across Oklahoma to determine their perceptions of intellectual capital needs of the aerospace industry. Interviews with industry executives regarding intellectual capital needs of the aerospace industry could identify potential gaps in existing aerospace curriculum; and obtain recommendations for future curriculum as well as address issues related to academic-industry collaboration.

Research Questions

The following broad research questions were addressed this study.

1. What are the perceptions of current executives/managers regarding the educational needs, including intellectual capital needs, of the aerospace industry in Oklahoma?
2. What gaps exist in the current educational system between what is needed by the aerospace industry and what is being provided by higher educational institutions in Oklahoma?
3. What specific curriculum is recommended by aerospace industry executives to eliminate this gap?

4. How can industry, education, and government work together to address the educational needs of the industry and successfully feed the pipeline of intellectual capital (programs, partnerships, internships, etc.)?

Assumptions and Limitations

For the purpose of this study, the following assumptions and limitations were accepted:

1. Because the data was based on self-report, the honesty and accuracy of answers from the interviews must be taken into consideration when evaluating the results.
2. The study was conducted in Oklahoma only. The focus of this study was therefore limited to this state, particularly the knowledge and recommendations of aerospace companies.
3. Although the findings of the study should not be generalized to the population as a whole, the expertise of the participants provided a rich source of data from which this limitation could be minimized and a meaningful study could emerge.
4. The busy schedules and time constraints of the participants interviewed created access issues.
5. The study was limited to employer-focused educational programs, not employee-focused educational programs thus limiting the findings to the employer perspective.

Definition of Terms

The following definitions were applied in this study to provide, as nearly as possible, clear and concise meanings of terms:

Conceptual Definitions

Air Command and Staff College - provides the full spectrum of Air Force education, from pre-commissioning to all levels of professional military education, including degree granting and professional continuing education for officers, enlisted and civilian personnel throughout their careers. The Air University conducts research in air, space, and cyberspace power, education, leadership, and management; as well as providing citizenship programs and contributes to the development and testing of Air Force doctrine, concepts and strategy.

Air War College - prepares students to lead in a joint environment at the strategic level across the range of military operations; develop cross-domain mastery of joint air, space and cyberspace power and its strategic contributions to national security; and advance innovative thought on National Security, Department of Defense and Air Force issues.

A&P Mechanics (Airframe and Powerplant Mechanics) - individuals certificated by the Federal Aviation Administration (FAA) who adhere to the guidelines and Federal Aviation Regulations (FAR's) and are responsible for keeping aircraft airworthy.

Aircraft Sheet Metal - metal formed into thin, flat pieces which can be cut and bent into a variety of different shapes to be used on aircraft.

Computer Aided Draft & Design (CADD) – computer graphics software that is commonly used to make architectural and engineering drawings.

*Career*Tech (The Oklahoma Department of Career and Technology Education) - provides leadership, resources, and assures standards of excellence for a comprehensive statewide system of career and technology education and training.

CATIA (Computer Aided Three Dimensional Interactive Application) – the world's leading solution for product design excellence. It addresses all manufacturing organizations, from Original Equipment Manufacturers (OEMs) through their supply chains, to small independent producers. It is one of the most comprehensive, widely used engineering tools in the industry used by thousands of companies around the world.

Competitive Advantage – sustaining profits that exceed the average for the industry and create superior value to its customers.

FAA Certified – a product as certified by the Federal Aviation Administration, an agency in the Department of Transportation, that is responsible for the safety of civilian aviation.

Global Economy – the economy as viewed world-wide.

ISO (International Organization for Standardization) – it is a non-governmental organization that forms a bridge between the public and private sectors. It enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society**.**

Intellectual Capital – this is a term used interchangeably with Human Capital in the literature. Although the term human capital denotes the overall skills, talents, academic achievement of the human component, it is sometimes referred to as intellectual capital in that all levels of an organization require a certain level of knowledge, skill and ability. A more accurate definition that makes a clearer distinction between human capital and intellectual capital is the one used for this study. It denotes the professional level personnel in an organization who have the higher educational qualifications and skills to add value to the human capital of the industry (e.g. holders of Associate degrees or above).

Lean Manufacturing – which is often known simply as "Lean", is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. Working from the perspective of the customer who consumes a product or service, "value" is defined as any action or process that a customer would be willing to pay for. In short, lean is centered on creating more value with less work.

MBA – Masters of Business Administration from an accredited educational institution of higher education.

MRO – Maintenance, Repair, and Overhaul of aircraft or aircraft parts and components.

Original Equipment Manufacturer (OEM) – refers to the manufacturers of complete aircraft or aircraft parts, or heavy-duty engines, as contrasted with remanufacturers, converters, retrofitters, up-fitters, and repowering or rebuilding contractors who are overhauling engines, adapting or converting vehicles or engines obtained from the OEMs, or exchanging or rebuilding engines in existing aircraft and aircraft parts.

Workforce – workers employed in a specific project or activity. All the people working or available for work, as in a nation, company, industry, or on a project.

Operational Definitions (as defined by the researcher for purposes of this study)

Aerospace Industry - any aviation or space related business and/or organization.

Air Logistics Center – under the Department of Defense, a central operating center that can be considered as a tool for getting the products and services where they are needed and when they are desired. Within this study the air logistics center is referring exclusively to Tinker Air Force Base in Midwest City, Oklahoma.

Aircraft Repair Facilities – any facility used to repair, modify, or overhaul any type of aircraft including aircraft equipment.

Aircraft Sustainment – the act of keeping military, commercial, and private aircraft flying longer by repairing, maintaining, and overhauling.

Commercial MRO – the commercial sector of the maintenance, repair, and overhaul of aircraft.

Educational Institutions – any higher educational or *Career*Tech institution.

Facility – any facility built to serve the aerospace industry including companies and educational institutions.

Government – any military or state governmental agency within the state of Oklahoma.

Higher Education – any four-year university or college within the state of Oklahoma.

Logistics - the art and science of managing and controlling the flow of goods, energy, information and other resources with respect to the aerospace industry.

Military MRO - the military or Department of Defense sector of the maintenance, repair, and overhaul of aircraft.

Organization – any aerospace entity in the state of Oklahoma.

Pipeline – the function in which students start either in higher education or technical training and move through the education system.

Safety – the educational program in which safety concerns in aerospace are addressed.

Security – the educational program in which aerospace security issues are addressed.

Supply Chain Management – the management and coordination of a product's supply chain for the purpose of increasing efficiency and profitability in the aerospace industry.

Training Programs – programs in which aerospace and/or aviation related topics are taught.

Touch Labor **–** a term often used to distinguish lower level employees with vocational training who literally or figuratively touch the final product from employees in higher professional occupations who require college level work.

Scope and Significance of the Study

This study is significant in that it provides Oklahoma aerospace companies, educational institutions, and government organizations with a summary of industry educational requirements based on perceptions of its executives/managers. It offers specific coursework recommendations as well as suggestions regarding industry-academia collaborative efforts to aid in meeting educational requirements necessary to the growth and well-being of the aerospace industry in the State of Oklahoma. The findings could be used to implement changes that could keep Oklahoma competitive in the aerospace industry.

Although the scope of the study addressed was limited to the specific educational requirements of the Oklahoma aerospace industry, the participants selected for the study provided a rich source of data with respect to the aerospace industry. Their expertise and contributions did allow a meaningful study to emerge that could surface the need for and provide a foundation for subsequent research of a larger population.

CHAPTER II

REVIEW OF LITERATURE

A review of the literature on intellectual capital needs within the aerospace industry involved 1) establishing a better understanding of the science of Intellectual or Human Capital in general; 2) examining the findings of previous inquiry related to intellectual capital requirements in the aerospace industry at the international and/or national level; 3) reviewing findings of intellectual capital requirements of the industry in other states; and 4) examining previous research in the state of Oklahoma. Surprisingly, the literature at all levels seemed to be somewhat limited and appeared to frequently include touch labor, engineering, clerical, and administrative resources as well as professional level aerospace intellectual capital requirements.

The Science of Human/Intellectual Capital and Aerospace Requirements

As indicated in the definitions provided in Chapter I of this study, the term *human capital* usually denotes the combined talent or skill level of the human resources of an organization while *intellectual capital* is sometimes

used to describe the professional level of an organization requiring some level of academic achievement. Although this inquiry focused on the professional level or intellectual capital in Oklahoma aerospace organizations, a starting point for the study was to develop a basic understanding of the overall concept of both human and intellectual capital as described in the literature and the impact of current trends and issues affecting the ability to address the educational requirements of the aerospace industry.

The aerospace industry greatly enhances the vitality of the national economy by providing hundreds of thousands of high-skilled, well-compensated manufacturing jobs and by constantly developing sophisticated new technologies that benefit the entire economy, increase productivity, and enhance national security. Intellectual capital may be the most important factor determining the competitive success of aerospace and other industries. The intellectual preparation of the American workforce is the cornerstone for the aerospace industry's future and the nation's economic wellbeing. Keeping up with the trends and issues that affect the development of intellectual capital necessary to support the industry is imperative.

United States Aerospace Industry Educational Requirements

Current Industry Trends and Issues

The aerospace industry is a powerful force within the U.S. economy and one of the nation's most competitive sectors in the global marketplace.

> "Aerospace contributes over 15 percent to our Gross Domestic Product and supports over 15 million high quality American jobs. Aerospace products provide the largest trade surplus of any manufacturing sector. Last year, more than 600 million passengers relied on U.S. commercial air transportation and over 150 million people were transported on general aviation aircraft. Over 40 percent of the value of U.S. freight is transported by air. Aerospace capabilities have enabled e-commerce to flourish with overnight mail and parcel delivery, and just-in-time manufacturing" (America's Aerospace Industry: Identifying and Addressing Workforce Challenges, 2005, pg 1).

A review of the literature revealed the nation is at an end-pass with obtaining the educated workforce it needs to sustain growth. The need for qualified aerospace professionals is vast and will only continue to grow in the foreseeable future. The U.S. must ensure the nation's aerospace industry remains strong and viable by educating and developing a skilled workforce of scientists, technicians, engineers and executive level leaders. The aerospace industry is risking the loss of intellectual capital and could result in a failure to meet the forecasted needs for business. Lacking to produce enough qualified

aerospace professionals will endanger the ability of the nation to be the world's leader in innovation and new technologies, which could eventually jeopardize America's security.

There is an increasing need to identify and develop training for the skills necessary at all levels and to create strategies and opportunities that will keep the aerospace workforce pipeline filled. According to the Commission on the Future of the United States Aerospace Industry, November, 2002, our nation has lost over 600,000 scientific and technical aerospace jobs in the past decade. With fewer employers due to a fledgling economy, countless skilled aerospace experts and professionals have left the industry all together, resulting in a loss of aerospace intellectual capital. Many senior-level personnel have already retired or are near retirement, while the more entry to mid-level workers have been laid off and migrated to other more promising industries. A consequence of this environment has been an overall aging of the aerospace workforce, which risks the loss of intellectual capital (America's Aerospace Industry: Identifying and Addressing Workforce Challenges, 2005, pg 6).

Today's aerospace industry demands a dynamic, results-oriented workforce with the talents, multidisciplinary knowledge, and up-to-date skills to enhance an organization's value to its customers. Yet it seems that Oklahoma is headed in the wrong direction insofar as the development of intellectual capital needed to support the industry as indicated by the trends reflected in the following research.

Shortage of Engineering and Science Majors

- In a recent survey of more than 270,000 college freshmen conducted by the UCLA Higher Education Research Institute, only 7.5 percent said they intend to major in engineering – the lowest level since the 1970s. (Industry's Response to the Workforce Challenge, 2008, pg 4)
- A report from the National Science Foundation indicated that overall graduate enrollments in science and engineering have increased over the past decade. This growth is largely attributable to an increase in foreign-born student enrollments. However, the aerospace industry continues to suffer as many of these students choose to return to their country of origin or cannot obtain appropriate security clearance for employment opportunities for which they otherwise qualify. (Oliver, 2007, pg 1)
- Five percent of U.S. bachelor's degrees are in science or engineering, compared to 20 percent in Asia, 63 percent in Japan, 59 percent in Singapore, and 56 percent in China. (Industry's Response to the Workforce Challenge, 2008, pg 4)
- In a survey conducted by the Massachusetts Institute of Technology (MIT) Lean Aerospace Research Initiative, of 500 U.S. aerospace workers, 80 percent said they would not recommend their children pursue aerospace careers due to workplace instability. (Report of the Interagency Aerospace Revitalization Task Force, 2008, pg 11)

An Aging Workforce

- The average age of the workforce is 45 years, only 22 percent of the workforce is 35 years or younger, meaning a smaller pool inadequate to replace the 45 year olds as they retire. 58 percent of the workforce over age 50, the majority of aerospace workers is heading to retirement. The rate of retirement for 2007 was 2 percent of workers eligible. (Launching the 21st Century American Aerospace Workforce, 2008, pg 6)
- The Commission on the Future of the United States Aerospace Industry reported in 2002 from a variety of sources that the aerospace workforce is "aging" and that approximately 26 percent of aerospace workers would be eligible to retire by 2008. (Commission on the Future of the U.S. Aerospace Industry, 2002, pg 154)
- Retention is a major problem with respect to aerospace graduates. The attrition rate in the 1–6 year range is approximately two times greater in the aerospace industry than in the overall new graduate population. (Maloney & Leon, 2007, pg 8)
- Industry surveys reveal that approximately half of the current workforce perceives a worsening outlook in the aerospace industry because of the continuing retirement of scientists and engineers, and also believes that the hiring outlook is getting worse or steadily declining. (Maloney & Leon, 2007, pg 8)

Global Competition

There is broad consensus that the long-term key to continued U.S. competitiveness in an increasingly global economic environment is the adequacy of supply and the quality of the workforce in the Science, Technology, Engineering and Mathematics fields. (The STEM Workforce Challenge, 2007, pg 2) The U.S. is losing global market share and its positive balance of trade in aerospace manufacturing is eroding. Jobs are going overseas. Retaining its existing workforce, attracting young people into the field and building its skills base are issues facing the aerospace industry today. There has to be a change if we are to remain globally competitive.

The Commission on the Future of the U.S. Aerospace Industry in 2002, reported that America's failure to produce enough qualified aerospace professionals will jeopardize the ability of the United States to be the world leader in innovation and eventually endanger the security of the nation. The aerospace community risks the loss of intellectual capital and will be unable to meet the forecasted needs for business.

> "Intellectual capital may be the most important factor determining the competitive success of aerospace and other industries. Tangible aspects of intellectual capital include a firm's investments, such as patents, proprietary processes, and training. Intellectual capital also includes knowledge created through collaborative work, relationships with suppliers, individual workers' expertise, and the firm's reputation. New employees may have the credentials to do the work, but the knowledge

> and relationships built through years of experience are difficult to replace. The pending retirements of so many aerospace scientists, engineers, and production workers pose a real threat to an industry already fraught with widespread layoffs and few new hires." (The Final Report of the Commission on the Future of the United States Aerospace Industry, 2002, pg 155)

Preparing the next-generation scientific and engineering workforce is critical to the future of the entire national economy. The President's Commission on the Future of the United States Aerospace Industry (pg 159) stated that "the education system must be prepared to deliver training and education to meet these changing skill requirements and meet labor market needs." It is imperative that academia keep up with those trends in development of intellectual capital for the aerospace industry.

State Aerospace Industry Educational Requirements

Besides Oklahoma, several other states around the nation have also taken corrective action to alleviate the shortage of a qualified workforce and bolster their intellectual capital as reflected in the following research.

Georgia

Georgia boasts an average $135,000 value-added output per employee in the aerospace industry – one of the highest among its surrounding states. It is home to more than 150 aerospace companies and employees more than 83,000

employees, ranking Georgia as a Top 10 state in terms of total aerospace employment.

The Middle Georgia Work-Ready Aerospace Partnership Solutions Summit in 2007 revealed Georgia's aerospace industry as a whole is projecting 3.8 percent annual compound growth through 2010. However aerospace workforce in Georgia may soon be insufficient to support this projected growth. Approximately 3,000 new workers will be needed in the next two years, based on current projections, within the Maintenance, Repair and Overhaul sector alone. (The Middle Georgia Work-Ready Aerospace Partnership Solutions-Post Summit Report, 2009, pg 1)

Georgia is already working towards lessening this shortfall of intellectual capital by cultivating aerospace networks like the Middle Georgia Work Ready Aerospace Partnership (mgWRAP). The desired outcome is to create partnerships between industry, education and community institutions to identify the workforce needs, communicate them to education and training facilities, and provide the workforce that industry requires and market the opportunities to the region. This joint venture is a coming together of two parallel aerospace workforce development initiatives, one led by Warner Robins Air Logistics Center (WR-ALC) and the other is led by Georgia's Aerospace Innovation Center (AIC) in partnership with the National Aerospace Development Center (NADC).

The WR-ALC initiated a workforce development strategy known as "Robins Workforce 21", with the purpose of making an in-depth assessment of their workforce needs. The idea is to develop public/private partnerships for

regional employment and training initiatives by creating a regional aerospace workforce committee to identify critical skills shortages. They also plan to draw more people into the aerospace workforce pipeline through education and public outreach/awareness, expanding youth apprentice programs and making area youth aware of employment opportunities on the base, as indicated in the 2007 post summit report (pg 2) of the The Middle Georgia Work-Ready Aerospace Partnership Summit.

In addition to the “Robins Workforce 21”, the AIC and NADC, has developed its own project called, Solutions Aerospace. It is funded through U.S. Department of Labor with the purpose of examining the condition of the aerospace industry workforce in Georgia with specific focus on the Middle Georgia region. The program brings together stakeholders in the state or the region to create strategies and a state/region-based Aerospace Workforce Solutions Plan. The plan is designed to provide a roadmap of implement and sustaining a series of projects and services that focus on understanding the characteristics and unique requirements of the aerospace community, identifying skills set requirements, enhancing the capacity and quality of education and training programs, improving worker retention, reducing the adverse effects of an aging workforce, and stemming the loss of scientific and technical talent.

In addition to partnerships, Georgia has invested in providing the industry with a one-stop-shop for aerospace solutions needs. In 2003 Georgia’s Governor Commission for a New Georgia formed the Center of Innovation for Aerospace, as supported by the Georgia Department of Economic Development, with a keen

focus on assisting in the federal procurement process, capitalizing on university research and centers of excellence in aerospace technology.

Arizona

According to the Arizona Aerospace, Defense, and Avionics Industry Study, the state is ranked 8th in the United States in aviation and aerospace industry employment, about 51,177 jobs and is 4th in the Nation in employment per 1,000 full-time workers. (Creating an Arizona Aerospace Institute, 2008, pg 4) Total wages attribute to roughly $3.8 billion a year, with an average industry wage of about $67,065, far greater than the average Arizona wage of $38,154.

Given that the availability of a qualified workforce and workforce development is a critical issue facing the aerospace and defense industry, Arizona too is partnering with state officials and business stakeholders to promote the retention and expansion of the in-state aerospace industry, as well as attracting into the state other aerospace industry-related economic activity. They are doing this with the creation of the Arizona Aerospace Institute, as recommended by the initial assessment report (Creating an Arizona Aerospace Institute, 2008).

The purpose of the institute is to facilitate workforce development by providing practical training and recruiting, by engaging engineering and other students, by attracting and engaging faculty, by making available educational certifications, and by conducting seminars and other industry-specific educational programs within its core competencies. (Creating an Arizona Aerospace Institute,

2008, pg 8) The report (pg 20) also indicates the institute provides a vehicle to upgrade the skills of engineering and non-engineering aerospace workers, the institute collaborates with government and with undergraduate and graduate degree-granting universities to develop curriculum and provide other workforce improvements to aerospace workers and their employees. The desired outcome of these initiatives is to protect Arizona's high wage jobs, attract additional jobs to the state, create business technologies, and increase the economic activity, which will in turn, increase the state and local tax revenue, as well as retain their intellectual capital.

Ohio

According to the Ohio Department of Development, the state ranks 7th among the 50 states based on the dollar value of aerospace products and parts produced and 8th based on total industry employment. Statewide, Ohio boasts more than 66,000 civilian employees at more than 600 private companies in the aerospace and defense industry, ranking Ohio first among the 12 comparable Midwestern states. (Aeropropulsion and Power Systems: Maximizing ROI in America's Leading State, 2009, pg 4)

Ohio has taken great steps to ensure its viability in the aerospace industry. Like other states, it too has formed a consortium of federal and state government and industry partnerships with the creation of the Ohio Aerospace Institute (OAI). Founded in 1989, the OAI is a joint initiative of the NASA Glenn Research Center, the Air Force Research Laboratory at Wright-Patterson Air Force Base, the State of Ohio, ten Ohio public and private universities granting doctoral

degrees in aerospace-related engineering disciplines, and numerous companies engaged in aerospace activities. Their mission is to build Ohio's aerospace economy through research and technology, education and training, and collaboration and information exchange. The OAI 2009 Annual Report (pg 1) list many opportunities for their state, including:

- Capitalizing on aerospace exports, the top U.S. manufacturing export, with projected growth in 2010 and beyond. Ohio can position itself by making investments now that support supply chain enhancements, workforce development, and the expansion and attraction of aerospace companies to Ohio.
- Repositioning some of Ohio's automotive industry assets to serve the growing aerospace industry.
- Leveraging Ohio's aerospace capabilities to address our nation's energy issues and target new and promising markets in advanced energy.
- Leading the way to the future of aerospace in quiet, clean and efficient aircraft; next generation access to space; and advanced space exploration systems.

Through student internships, scholarships, and fellowship opportunities for undergraduate and graduate students, OAI's goal is to sustain and build a strong aerospace workforce by using its network of universities, industries, and government laboratories to provide programs designed to develop and sustain critical skills. In addition to educational and training programs, the OAI conducts sponsored research in advanced materials and structures, communications,

propulsion systems, navigations and surveillance, and nanotechnology to name a few.

Oklahoma Aerospace Industry Educational Inquiry

The $41 billion worldwide market for the maintenance, repair and overhaul of commercially operated jet transports will expand at a compound annual growth rate of 4.8 percent over the next five years and then will taper off to 4.0 percent compound annual growth rate from 2012 to 2017, according to Overhaul and Maintenance Magazine's annual 2007 report. (MRO Market is Up and Down, 2007, pg 47) This market is a staple in Oklahoma, with the majority of its business in the Tulsa and Oklahoma City area. The state is one of the six global hubs for MRO services. According to the Oklahoma Department of Commerce, the aerospace industry in Oklahoma accounts for over 72,000 jobs with an average wage well above the state's average wage (Strategic Plan for the Growth of Oklahoma's Aerospace Industry, 2009, pg 5).

Just as the global and national markets are experiencing shifts in growth and educational requirements, the economics and demographics of Oklahoma's aerospace workforce are experiencing major shifts due to aging and pending retirement of experienced personnel, increased diversity, changing technology and skill obsolescence, and an ever-increasing need for intellectual capital. These statistics reflect a legitimate concern about the loss of intellectual capital in the aerospace industry. There is strong evidence that the aerospace industry is at the beginning stages of a skills shift that will significantly impact the basic skills

required within the industry. According to the 2007 Oklahoma's Aerospace Industry Workforce Report (pg 5) a series of surveys were conducted to evaluate Oklahoma's current and future workforce needs and identify patterns of supply and demand as it pertains to the aerospace industry.

> "Based on the analysis, it is estimated that Oklahoma will likely experience shortages of approximately 200 Aerospace Engineers and 400 Electrical Engineers by 2014, with shortages of additional engineering specialties possible in that same time frame. Currently not quantifiable but potentially more significant are pending skills gaps within Oklahoma's aerospace workforce." (Oklahoma's Aerospace Industry Workforce Report, 2007, pg 5)

Summary of Significant Literature

Finally, education and the workforce must be firmly entrenched as a high corporate and industry wide priority. Because the workforce challenge is enormous and requires sustained focus, commitment, energy and resources, it is easily set aside as something to be resolved another day. Throughout industry's remarkable history, aerospace professionals have been the foundation on which success has been built. The long-term ability to recruit and retain the right professional workforce, with the right skills, will determine the viability of the aerospace industry for the remainder of this century and beyond. The challenges are real and growing, and the future of the industry is at risk. Industry is

committed to taking the steps necessary to develop and strengthen the aerospace industry for the remainder of the 21st century workforce. (Industry's Response to the Workforce Challenge, 2008, pg7)

Oklahoma has its share of workforce shortfalls as well, and industry leaders are facing their own crisis with addressing intellectual capital needs. Government and industry should work together to develop and implement training and exchange programs that would educate and expose their workforces to their respective challenges and responsibilities. These programs should include internship and fellowship programs, cooperative training programs, and personnel exchanges to provide firsthand experience for both workforces in the others' day-to-day activities (Commission on the Future of Aerospace Industry, 2002, pg 147). Resolving the intellectual capital crisis will require government, industry, and academia to work together.

CHAPTER III

METHODOLOGY

Purpose

The purpose of this research was to conduct detailed personal interviews with aerospace industry executives/managers from both the private and military sectors from across Oklahoma. The purpose of the interviews was to determine perceptions of industry leaders regarding intellectual capital needs of the industry, determine potential gaps in existing aerospace curriculum, and obtain recommendations for future curriculum and academic-industry collaboration.

Theoretical Perspective

Epistemology

The epistemology of this research project was one of constructionism. By this, the research gathered was socially constructed and therefore, the reality was individually constructed (Crotty, 1998). In other words, the data

collected had several different voices, many truths, and multiple descriptions of personal meaning on what the interviewees believed were the intellectual capital requirement, as well as their recommendations on how to alleviate the shortage of intellectual capital in Oklahoma's aerospace industry.

Harre´ (1986) states within the epistemology of constructionism, the whole gamut of meaningful reality are embraced. The interviewees constructed their own personal meaning based on the list of open-ended questions facilitated by the researcher. The knowledge garnered from this research project was created through the detailed personal interviews with aerospace companies, educational institutions, and government organizations, from across Oklahoma with the purpose of identifying industry intellectual capital requirements. The result provided recommendations and best practices to better coordinate and grow the aerospace industry in Oklahoma.

The theoretical perspective informed the study through interpretivism. Schwandt (1994) further defines this theoretical perspective as using everyday concepts and typical situations to derive knowledge from the research. In this study, the research was interpreted and measured through participant observation and interviewee's personal experience within the aerospace industry. The reality of the study was that there is a shortage of qualified aerospace workers, leading to an intellectual capital gap in Oklahoma.

General Approach

The principles that guided the method of the study were through phenomenological research. The approach involved in-depth conversations based on personal knowledge and emphasized the importance of the participant's perspective and interpretation of the problem. This in turn, enabled the results of the data to be used for practical applications, as well as for informing and supporting efforts to implement the recommendations and for making changes to keep Oklahoma competitive in the aerospace industry.

The underlining goal was to make the participants voices heard and bring these issues and concerns to the surface. The data collected provided insight using a phenomenological approach by dividing the procedures into statements, then transforming them into meanings, and finally tying the results together, making a general description of the experience (Moustakas, 1994). Using this methodology, research questions were developed to specifically explore the meaning of their experiences (Creswell, 1998).

The general methodology used was that of a qualitative field study. A small sample of nine (9) executives from the Oklahoma aerospace industry was interviewed and asked a specific set of open-ended questions. This method of gathering data was appropriate due to the nature of the study and the precise documentation required for identifying industry intellectual capital requirements.

EPISTEMOLOGY

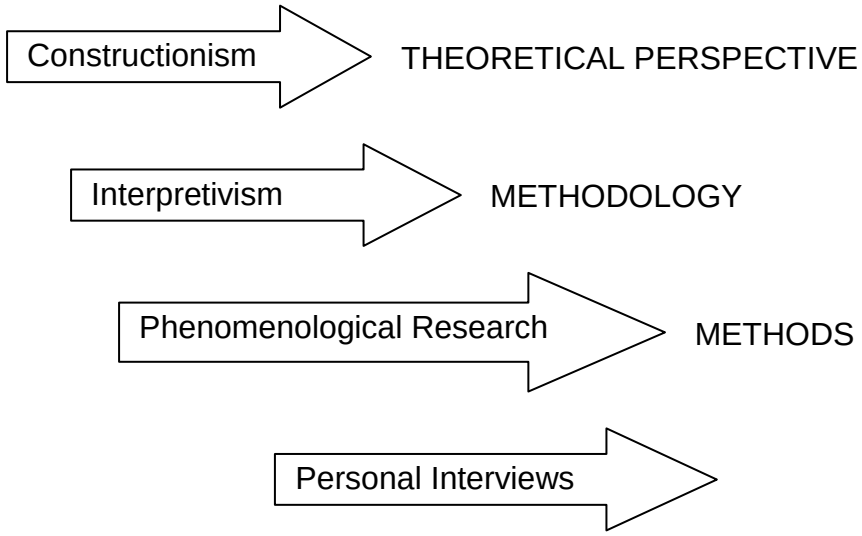

Figure #1. Research Perspective

Population and Sample

Participants for interview were selected from specific organizations within the Oklahoma aerospace population, to include approximately 400 aerospace companies. The selection of these participants was based on their expertise related to the needs of small, medium and large aerospace companies. The quality of participant background and experience is directly related to the ability to obtain meaningful data.

This sample consisted of nine participants who were purposively chosen from the 400 aerospace companies because they were believed to be a rich source of data for identifying educational requirements in the Oklahoma aerospace industry. In *Handbook of Qualitative Research*, Denzin and Lincoln (1994, pg 225) described the sample size of phenomenological research as

approximately six participants depending on saturation of data. Saturation occurs with repetition of the data from multiple sources of data becomes apparent with repetition in the information obtained and with confirmation of previously collected data. The nine participants interviewed provided the level of repetition and saturation necessary to adequately address the four broad research questions.

Instrumentation

An Interview Guide containing open-ended questions was used to gather information regarding Oklahoma's aerospace workforce and educational needs. Questions on the Interview Guide were validated by a panel of academic and aerospace industry experts prior to the interviews.

Procedures

Once the Interview Guide was completed and tested and the research proposal finalized, an IRB Request was submitted and approved along with a Consent Form to be signed by the participant prior to beginning the interviews. A letter was then sent to potential interviewees requesting their participation in the interviews and to notify them of the procedures and plans to respect confidentiality of the interviews. They were requested to give their permission to tape the interviews and advised that the tapes would be destroyed when the

study was completed. They were also notified that their confidentiality would be protected and they would not be identified by name in any publication. A follow-up phone call was made to finalize the date of the interviews.

The interview method consisted of eliciting and recording responses to the predetermined set of questions in the Interview Guide. This method was utilized to determine what aerospace executives and managers perceived as critical skills needed by industry professionals and their recommendations for academia-industry collaborative efforts. Once the interviews were completed they were transcribed and analyzed.

Data Analysis

The data analysis consisted of a detailed transcript of responses from aerospace executives and managers within the state of Oklahoma. Data was collected and coded using the Hyper-Transcribe software and qualitative research tools. From the data collected a set of recommendations and observations was compiled to determine the current and future intellectual capital requirements of the Oklahoma aerospace industry and the recommendations of executives and managers regarding how to address those requirements.

Timeline for Conducting the Study

The initial contact to aerospace companies, educational institutions, and government organizations with the intent of seeking approval to conduct an interview took one week and was completed by June 2008. The face to face interviews and transcriptions and analysis of the data were completed in 2009.

Validity and Reliability of the Study

It was important to insure the validity and reliability of this research related to Oklahoma aerospace education requirements because the findings may be used as a model of quality education in Oklahoma aerospace. That model must be based on valid and reliable research methods.

Validity in research addresses the issue of whether or not the research actually answers the question it was designed to answer. Reliability in research addresses consistency and repeatability. In qualitative research validity is especially important. The importance of reliability in qualitative research is somewhat controversial in research literature. L. R. Gay (1996) believes that both concepts are relevant in qualitative research but reliability is a consequence of validity and both concepts are correlated with the competence, experience, and dedication of the person conducting the interviews. According to Gay, validity can be attained by: (a) triangulation or use of multiple methods, data sources, or data collection strategies; (b) consistency across observations over time; (c) consistency of interview data among persons interviewed as well as

consistency of interview data for the same person(s); (d) consistency of researcher data and impressions; (e) use of multiple methods (triangulation) of data collection strategies and data sources; (f) or use of recording data (pg 242). In this study, triangulation of data involved obtaining the opinions of participants in a variety of aerospace organizations to assess the similarities and consistencies across the industry. Consistency of interview data among persons interviewed as well as consistency for the same person was considered.

Rubin and Rubin (1995, pg 85-92) suggested that validity and reliability do not fit qualitative research and that trying to fit the two quantitative indicators of validity and reliability to qualitative research distracts more than it clarifies. They viewed t*ransparency, consistency-coherence, and communicability* as the standard for qualitative interviewing.

From their perspective *transparency* allows the reader to assess the interviewer's biases, conscientiousness, and strengths and weaknesses, how they organized and analyzed the transcripts and how they maintained careful records. *Consistency-coherence involved* comparing themes in one interview with others, checking out inconsistencies and exploring contradictions. *Communicability* involves richness of detail, abundance of evidence, and vividness of the text with a description of how each major theme was tested and retested under different questions or conditions until you accepted it. The researcher should make sure those being interviewed talk about first-hand experiences; the experience of the interviewees gives legitimacy to the argument (Rubin & Rubin, 1995, pg 91)

Using the standards identified in Rubin & Rubin (1995), as the standard for quality of this research study, careful attention was given to *transparency* and how the interviews and data were organized and how the records were analyzed and maintained. *Consistency-coherence* involved comparing themes across all of the interviews and checking and cross-checking for potential discrepancies. *Communicability* was achieved by encouraging participants to talk about first-hand experiences within their organizations and how those experiences affected their analysis of the educational needs of the aerospace industry in Oklahoma.

CHAPTER IV

FINDINGS

Introduction

The purpose of this qualitative study was to explore the perceptions of aerospace industry executives in Oklahoma regarding intellectual capital needs of the aerospace industry and the potential gaps in existing aerospace curriculum. It was believed that the participants could provide valuable insight and make recommendations for future curriculum as well as explore issues related to industry/academia collaboration for improvement of aerospace education.

Detailed personal interviews were conducted with aerospace industry executives/managers from both the private and military sectors across Oklahoma. The nine participants interviewed for this study were selected from specific organizations within the Oklahoma aerospace population including federal; military; and corporate aviation in a variety of specialties ranging from manufacturing; repair & overhaul; engineering services; training; state

government; academia; and political leaders. Participants selected for interview were believed to be a rich source of data in determining educational requirements not only in the Oklahoma aerospace industry but potentially provide insight into aerospace educational requirements in general. The richness of the data in qualitative interviewing is directly related to the expertise of the participants in their field as represented in the demographic information in this Chapter.

Demographics

Participants interviewed for this study were executives and managers of aerospace organizations ranging in size from 300 to nearly 30,000 employees. Their combined education and experience provided valuable data in a variety of fields including engineering, executive management, finance, military, business administration, state government, and marketing. Although all of the participants had some corporate executive experience at the executive level, over half of the participants had been associated with organizations involving Maintenance Repair and Overhaul (MRO) activity which is the dominant aerospace industry in the state of Oklahoma. Of the nine participants, five had experience in the military which varied in length from five years of service to 34 years and included. The level of that military experience varied by participant; some of which rose to the level of a Major General or Brigadier General.

Educational levels ranged from bachelors to doctoral level. All nine participants had at least a baccalaureate degree, while five had a master's degree and one had a doctorate. All but two of the participants held a degree with either an engineering or math and science discipline.

Because aerospace is a wide-ranging industry, multi-national in scope, other pertinent demographic data was captured in that it was important to obtain possible variations of perception based on gender and ethnic issues. Of the nine participants interviewed in this study, one was a female and eight were male. One was a German national while the other eight were of American descent. Significant disparity of opinion was not noted among participants in any of the demographic categories.

Table 1. Participant Demographics

Participant	Gender	Education	Career Experience				Employees
Number	M/F	Degree/Major	Military Srvs/Yrs/Rank	Corporate	Government	Specialty	Number
#1	M	BS - Industrial Mgmt MS - Industrial Mgmt	U.S. Air Force 33 Yrs Brigadier General	Exec Lvl - Boeing Over 5 Yrs. in Aerospace		Def and Gov Srvs	900
#2	M	BS - History MS - Engineering Mgmt MS - National Resource Mgmt	U.S. Air Force 34 Yrs General	Exec Lvl - AAR Corp Over 3 Yrs. in Aerospace		MRO	2,500
#3	M	BS - Business Admin MS - Business Admin PhD - Intl Mgmt		Aerospace Consultant Exec Lvl - Lufthansa Technik Over 25 Yrs. in Aerospace		MRO	300
#4	M	BS - Natural Sciences		Exec Lvl - GAMI Exec Lvl - Tornado Alley Turbo Over 30 Yrs. in Aerosapce		Engine Modification	150
#5	M	BS - Mathematics & Physics MBA - Finance & Ops Rearch	U.S. Army	Exec Lvl- The NORDAM Group Over 35 Yrs. in Aerospace	Sec - Health of Human Svrs Exec Dir - Juvenile Affairs	OEM MRO State Government	1,500
#6	M	BS - Engineering MS - Material Logistics & Eng.	U.S. Navy 33 Yrs	Exec Lvl - American Airlines Over 5 Yrs. in Aerospace		MRO	7,000
#7	M	BS - Ocean Eng.	U.S. Navy 7 Yrs	Exec Lvl - ARINC Over 21 Yrs. in Aerospace		Comm & Eng Srvs	300
#8	F	BS - Merchandising & Mkt MS - Aviation & Space Science		Exec Lvl - FAA/MMAC Over 30 Yrs. in Aerospace		Exec. & Mgmt Training Logistics Financial Mgmt	6,500
#9	M	BS - Accounting BS - Science & Mgmt		Exec Lvl - Tinker Air Force Base Over 30 Yrs. in Aerospace		MRO Logistics	26,000

Interview Reports

The findings of the study were based on personal interviews transcribed and coded using Hyper-Transcribe software, which allowed for a detailed qualitative analysis of textual data collected during the interviews. After the data obtained from the nine participants was converted to code, a detailed report from each participant was generated focusing on the four broad research goals which addressed participant perceptions related to: 1) Aerospace Industry Educational Needs; 2) Educational Gaps; 3) Recommended Curriculum; and 4) Industry-Academia Partnerships. The following are detailed perceptions of each of the nine participants and those perceptions are summarized in Table 2, (pg 88 & 89)

Participant #1

Participant #1 holds a Bachelors and Masters of Science degree and has served as an aerospace corporate executive, a four-time commander in the United States Air Force, and a senior director of the air staff in the Pentagon. With over 33 years in the military, both in the United States Army and the United State Air Force, participant #1 has been a two-time commander of flying groups and a two-time wing commander.

Upon retirement from the Air Force, participant #1 held a senior-level leadership position for one of Oklahoma's aerospace companies. Job experiences have garnered opportunities for the participant in service schools and training primarily focused on leadership. It was noted that, the most valuable

training for the position as a corporate executive, was the leadership training within the military and a graduate degree. Participant #1 noted that obtaining a Master of Business Administration degree would have also added to a successful career in aerospace.

Aerospace Educational Needs

The query behind the educational needs identified in this study was focused on how you would develop the workforce needed to support the aerospace industry in Oklahoma for its growth and prosperity. In this instance, participant #1 believed an industrial management degree would have been beneficial to aerospace businesses, along with an understanding of organizational dynamics as well as business law and contracting.

Based on what this executive viewed as an educational need in the aerospace industry, a strong master's degree program in any university on executive level management was of particular note. This type degree is already appealing to managers as they desire to get a truly useful degree that focuses on building corporate strategies, understanding resource management as it relates to strategic development, fostering new business funds and business development, dealing with a decreasing customer base, and dealing with national issues that affect funding for programs.

Educational Gaps

Participant #1's perceptions of the educational gaps between what is currently being offered and what is needed in Oklahoma educational institutions included a possible program management degree at the baccalaureate level. There is also a need for an adequate aerospace logistics degree as well as a master's degree in aerospace business administration.

According to participant #1, Oklahoma State University has already heard the needs of the aerospace community by creating an aerospace logistics degree at the bachelor's level; however industry is not yet aware of the degree and companies are not taking full advantage of the degree. Participant #1 believed this degree would also benefit the aerospace industry if offered at the master's level, but noted that not all logistics is focused on engineering, so a logistics degree centralized around aerospace business would be a better fit for not only Oklahoma's aerospace companies, but has the potential to be the greatest resource for program managers in the field. Participant #1 concluded that, as an aerospace executive leading a company of well over 900 employees, a logistics degree could lead to more success as a program manager in an aerospace organizations by specializing in aerospace business as opposed to just engineering.

Recommended Curriculum

When asked what specific curriculum could be recommended to meet the needs of the aerospace industry in Oklahoma, participant #1 recommended courses related to engineering and management. With an engineering track, any of the major programs would be applicable for the aerospace industry, but a special emphasis should be given for mechanical, chemical, industrial, electrical, and aerospace engineering. Chemical engineering in particular is needed due to issues of airframe corrosion and the introduction of new nano technologies Understanding lean manufacturing is also critical to the growth of most aerospace companies in Oklahoma, so industrial engineering is also very important.

In business management, participant #1 stated curriculum including program management, contracting, supply chain management, technical training, business strategies, manufacturing, lean processes, and accounting just to name a few would add value to any aerospace business degree. Ideally an aerospace professional with such a degree should also have some working knowledge of engineering systems given the high skill level within the aerospace industry.

Industry-Academia Partnerships

To better serve Oklahoma's aerospace industry, better collaboration is needed with the state's universities. Participant #1 supports an industry-academia partnership by stating, "…this industry cannot survive without the intellectual capital being generated by universities." It appears neither universities

nor industry fully understand what each one really contributes to the overall success of Oklahoma's workforce. Participant #1 poses the following questions to help industry recognize the value of Oklahoma's educational institutions: 1.) How do you run a university? 2.) What are the needs, strategies and objectives of a university? 3.) How does industry work towards a partnership with educational institutions to produce a better employee for Oklahoma's aerospace companies?

Participant #1 advocates establishing a solid relationship between industry and Oklahoma's providing universities by opening the doors for opportunities for industry-academia to better work together. Internships and capstones projects are good examples of this collaboration, "…these are all at no cost to the university but have a potentially high payoff."

Participant #2

Participant #2 has over 34 years in the United States military, with expertise in aircraft maintenance, logistics, demolition and bomb disposal. The participant holds both a Bachelor's of Science degree in history and a Master's of Science degree in engineering management; as well as, a Master's degree in National Resource Management from the National Defense University. Along with holding a senior-level position at an Oklahoma maintenance repair and overhaul company, participant #2 was also a two-time commander in the United States Air Force.

Aerospace Educational Needs

With respect to educational needs of the aerospace industry in Oklahoma, participant #2 suggested more finance and accounting. The Air Force provided many facets of technical leadership, technical management, and process improvement, but would benefit from a strong working knowledge in finance and accounting procedures.

Participant #2 would like to see future employees with experience in strategic communications and business development. Technical centers in Oklahoma do a good job offering degrees in commercial aviation maintenance or some type of technical management degree, but universities or higher education institutions should offer degrees that teach principles of business strategies, not just marketing and sales. This does not necessarily mean an MBA or an airframe

& power plant mechanic, but possibly someone with a technical management degree highlighted by business experience.

Educational Gaps

Participant #2 reported within their organization there is not much need for engineering backgrounds, but more along the lines of technical education and vocational education. With that being said, there is a need for institutions of higher education to produce and generate the quality of senior to mid-level managers for aerospace companies. Examples of these gaps are a strong need for leadership. In general, academia does not do a particularly good job of teaching leadership. To be more specific, students entering the workforce lack the skills needed to understand how to motivate and organize large organizations.

Recommended Curriculum

Again, participant #2 regarded leadership skills as a tremendous asset to an organization and should be part of an aerospace business curriculum offered by the universities. Oklahoma educational institutions should also present courses on supply chain management, lean manufacturing, six sigma, pre-engineering, process improvement, application and business processes, and organizational strategies. Business curriculum should of course focus on business, but more importantly the development of core processes. Participant

#2 emphasizes that the future workforce in Oklahoma's aerospace industry should have more business skills, not just engineering based, but a heavy emphasis on the foundations of how an aerospace business is run.

Industry-Academia Partnerships

To grow industry-academia partnership, participant #2 advocates for a better alliance between the two. Internships are a way to do just this, but more importantly base them on areas of focus to the student, which in turn would benefit the organization. To better serve the student and potential employees, universities should benchmark their program against companies and or locations that are supporting these industry-academia partnerships. Questions to be asked could be: 1.) Where are they seeing significant improvement and growth in the industry? 2.) Do they have similar issues with their educational system? 3.) From where do they draw their people? 4.) Do they have the same challenges that we have in terms of drawing and retaining people? 5.) Are they drawing from internally in the state or are they pulling from other places, and if so, where?

Participant #3

Participant #3 is a corporate executive for an Oklahoma maintenance, repair, and overhaul aerospace company. Upon joining the company, participant #3 was a consultant and expert for the aerospace industry and holds a bachelors degree and masters degree in business administration and mechanical engineering degree focused on bridging the industry requirements from a business perspective with the technical requirements of the industry. Participant #3 also holds a PhD specializing in strategic alliances and international management.

Aerospace Educational Needs

Across the board participant #3 believes American students are currently not being exposed to international studies like universities in Europe. He asserts that, “the aerospace business is a global market and requires global leadership.” Oklahoma aerospace companies compete at the international level for contract and business; however some mid to senior-level positions at these very companies do not require their managers to travel international. Most students that attend major universities in Oklahoma are never even exposed to international business unless they are taking international studies specifically. Participant #3 believes this is placing students at a competitive disadvantage with their international counterparts.

A Master's of Business Administration is just not enough in this industry, "the classic MBA program does not really make you a good leader or a good manager." Universities need to distinguish their MBA degree with specifics on aerospace international studies. Participant #3 spoke of the International Master and Practicing Management program which was offered at the vice president and chief executive officer level. This should be embraced in Oklahoma universities, making for a more well-diverse employee. As part of the program, six different international universities partner together to present effective leadership skills to leaders from multi-million dollar companies to small entrepreneurs who have just founded their own enterprises. Students job shadow leaders in the industry, which according to participant #3, is one of the best ways to learn about the aerospace business.

In addition to the need to bring forward more international management programs, participant #3 believed universities should do a better job offering internships with Oklahoma's aerospace companies. Most of the larger aerospace businesses in Oklahoma, such as NORDAM, Boeing, Tinker, and Lufthansa Technik to name a few, do indeed have such programs but educational institutions are not taking full advantage of this resource for its students. Internships are one of the very best ways to determine a future employee's success.

Educational Gaps

Good leadership skills are the foundation of success in the aerospace industry said participant #3, “if you want to really change a system or change the way an organization does something, you have to have, in the very least, leadership skills to gain the support from your people.” Aerospace companies that hire employees with a basic understanding of what it takes to be a leader could boost production rates within their organization. Educational institutions could help bridge the gap of this shrinking skill set if they would take a cue from industry professionals on its importance to the aerospace industry as a whole. Students should be more proficient on international affairs. The industry is running in a global economy and Oklahoma touts itself as being the “Global Aerospace Destination,” yet most of the students coming out of the universities have never even left the state.

Recommended Curriculum

Participant #3 would like to see universities offer courses in international finance and investments, logistics, lean management, leadership, and communication skills all related to the aerospace industry. Students versed on aerospace business specifically, instead of a broad scope like an MBA offers, would be very helpful to this industry. Curriculum like international aerospace marketing, project management, and supply chain management, taught by an aerospace professional in the field would not only give the student “real life” experience, but it would only add value to the degree. Ideally, if the educational

institutions could combine a technical degree with an aerospace business administration degree you would have skill set unmatched by most universities in the United States.

Industry-Academia Partnerships

Participant #3 advocates that industry and academia can foster better partnerships by establishing personal relationships with university faculty members. In turn, this allows the educational institutions a clear picture of curriculum needed by Oklahoma's aerospace industry and provide a source from which they could draw from those specifically trained students. These partnerships could also benefit future internships with aerospace businesses. "Universities need to take a more aggressive approach to working with industry in order to obtain valuable internships."

Another suggestion is for companies to collaborate more effectively with the universities on job placement. Participant #3 recalls a time when it was necessary to pay top dollar for a head hunter to find a person with certain skill. "It would be better to have direct access to these potential employees." Oklahoma educational institutions could provide this linkage to the aerospace industry.

Participant #4

Participant #4 is an executive and founder of an aerospace company that develops supplemental type certificates for engine modifications on piston engines and holds a bachelors degree in natural sciences. With well over 30 years experience in aviation business, participant #4 has extensive knowledge on engineering, management training, purchasing, and manufacturing of aircraft parts.

Aerospace Educational Needs

Participant #4 believed an ideal aerospace educational background would include an engineering degree with exposure to a high level of business education. An MBA degree followed by an engineering degree is an excellent path to obtain maximum success in the aerospace industry. Participant #4 said writing and leadership skills are a must for any senior to mid-level manager in this kind of business, “We deal a lot with Federal Aviation Administration (FAA) certification matters, so documentation is key for being able to develop our types of products.”

Participant #4 reported, as part of a formal education, a working knowledge of engineering, management, accounting, and executive development would all be helpful towards running and managing an aerospace business. This could be achieved at the bachelor’s in engineering and at the master’s level in aerospace business administration, “for particularly high disciplines we would occasionally make use of a doctoral degree.”When referring to educational

needs, participant #4 believed there is an immediate need at the university level for entrepreneurship, innovative design, and new technology focus, “There is a lot more opportunity out there to design your own parts and modifications than people recognize.” There is a shortage of qualified personnel not a shortage of ideas that would all make for a great business. When this trend happens the company is limited to one specific idea, as opposed to pursuing multi ventures for business growth, “but it takes knowledge of the industry, recognition of the needs, and the desire to be innovative in designing new products and then the ability to certify it when you're done.”

Educational Gaps

In terms of aerospace engineering, there are a number of disciplines participant #4 believes are not currently being met by educational institutions in Oklahoma. In a business highly specialized; individuals with intellectual capital towards FAA certification requirements and how to meet those requirement, both in terms of test, verification, and documentation, could help tremendously. It is very challenging right now to find people familiar with generating the kind of documentation the FAA requires to certify a part. The company struggles with the broad requirements for documenting the development of the software for the FAA certification. “If this particular knowledge base were offered at the university level, it would be very advantageous for company prosperity.”

"Another insufficient concentration from our universities is in Computer Aided Design (CAD)," said participant #4. Most new engineers coming out of school who have only been exposed to the use of 3-D CAD modeling software typically need almost a year of additional training before they can design and develop the parts needed in participant #4's company. It would be most useful for a recent graduate to be trained on current engineering software being used today by the major Original Manufacturing Equipment (OEM) companies. This would lead to high levels of productivity and would reduce the cost of training these new hires.

Recommended Curriculum

Overall, participant #4 recommended curriculum focused around the FAA certification process, engineering software such as CATIA, aerospace financing, business development, supply chain management, quality assurance programs, government contacting and procurement processes. These are all skills needed for a quality manufacturing position in the aerospace industry.

Industry-Academia Partnerships

The aerospace industry and our state educational institutions need to communicate more effectively to better address the needs of our aerospace companies. "Academia should reach out and stay in touch in with industry and see whether or not industry feels they are meeting those needs." Development of an evaluation process for Oklahoma's educational institutions could assure

course work is appropriate for the intellectual capital requirements of the industry. Facility visits by university faculty could provide the opportunity to see the Oklahoma's aerospace businesses products and services for the benefit of offering applicable curriculum.

Participant #5

Participant #5 is an executive for a privately owned aerospace company in Oklahoma, operating within the Original Equipment Manufacturer (OEM) and after markets for commercial, business, and military aircraft. The aerospace executive holds a bachelors degree in mathematics, with a minor in physics and an MBA, with a major in finance and a minor in operations research. After a stent with the United States Army teaching quantitative analysis, participant #5 began a professional career, which has spanned over 35 years, ranging from vice president of finance and president for a major aerospace company, secretary of health and human services, and executive director of juvenile affairs.

Aerospace Educational Needs

When asked about the educational needs of students today, participant #5 suggested a strong technical and financial background, coupled with diverse experience in the aerospace industry as an important foundation for any successful professional in this business. Future aerospace leaders should also have a solid background in sales and marketing, engineering, supply chain, information technology, financial analysis, project management, and organizational performance, to name a few.

The executive's company has always been willing to help support the educational fortitude of its employees by insuring they have the best opportunity for growth with programs in leadership and mentorship. This includes technical

training, like six sigma, lean technology, and CATIA, as well as, computer system analysis and engineering software design. In addition to providing on the job training, the company offers tuition reimbursement, with the purpose of encouraging its workforce to pursue advanced degrees.

Participant #5 believes our educational institutions are not producing a well-rounded employee. A blend of engineering, finance, mathematical simulation, and a specific skill-set in quantitative and analytical design could help alleviate the educational shortfall students experience when they graduate from college and begin looking for job opportunities with our aerospace companies. The jobs of tomorrow will require professionals that know how to work with their mind. For example, decisions made by company leadership should be data driven. Universities need to set higher standards for the professors that currently teach physics and mathematics curriculum. Like so many courses within these fields, they are a bit daunting to the average student, but if they were to make it applicable to everyday life or even teach principles of how it makes you a better manager this could encourage students to pursue degrees in math and science.

Educational Gaps

Participant #5 does indeed agree there are educational gaps universities must address in order to produce the most qualified workforce for the aerospace industry in Oklahoma. We live in a knowledge-based economy, to be competitive in this arena students need to start early by focusing on specialized training like

accounting, finance, and engineering. They should also have research capability to conceptualize, design, innovate, engineer and manufacture services and products.

"Students should have a high level of expertise in engineering, or equivalent curriculum. General business courses are nice to have, but they lack the difficulty and wherewithal to generate the level of expertise needed by Oklahoma's top aerospace companies. The courses are naturally harder, but in the end the potential employee makes more money because they have more skills. The capital investment of this skill-set is costly, but in the end it is needed."

Recommended Curriculum

Financing, statistical research, operational management, and information technology are all curriculum participant #5 recommends that future aerospace leaders must possess. Also a good grasp on project management with the ability to organize, conceptualize, and solve a problem is paramount in preserving and maintaining intellectual capital. Our educational institutions should focus on curriculum that develops and promotes the advancement of our market and not just necessarily what professors are good at teaching, instead more should focus on what is needed by the industry as a whole.

Industry-Academia Partnerships

Participant #5 recommended industry and academia should partner by thinking of themselves as customers of one another. In the aerospace field companies offer services their customers need. This should be no different in the academia world. The university is a customer of industry whose service is to provide an educated workforce. The industry is a customer of the university which provides expertise and desired intellectual capital needs. Educational institutions should survey local aerospace businesses before offering programs to match the needs of the market. There is a disconnect between what is needed in the industry and what universities are currently marketing to its students. Higher education is lacking in selling careers primarily because they are not focusing on the market or the specific skill set needed in order to obtain a higher-level position with an aerospace company. Industry and academia should establish a customer-based partnership to alleviate these educational gaps.

Participant #6

Participant #6 spent 33 years serving the United States Navy before joining a major airline as a senior executive. Holding an engineering degree from the United States Naval Academy, and a master's degree in material logistics and systems engineering; most of this executive's training and expertise stems from a series of technical assignments involving highly complex industrial repair and engineering of major systems in a wide variety of different types of aircrafts.

Aerospace Educational Needs

In today's aerospace business the more marketable you make yourself the better. Case in point, Participant #6 believes an ideal workforce would consist of people with technical skills and management skills, "it is taken for granted that as you mature you obtain automatically executive skills, which is not always the case." Many executives these days survive through the maturing of their hard skills, but lack the soft skills, specifically management and executive development skills needed to grow a business. A better balance in the academic system with respect to hard and soft skills would allow for a more diverse employee and would be quite appealing to most aerospace companies looking for a qualified workforce.

Many Oklahoma companies require specific technical background, such as systems engineers, design engineers, and sustainment engineers. These are the hard disciplines aerospace companies expect to get when they come in the

door regardless of where they want to go in the organization, “People with that level of academic training seem to fare very well in this highly technical line of work.” That being said, Participant #6 believes balance between technical skills and administrative and practical skills, such as managing stations or in support of an aircraft as a mechanic or as a supervisor or a manager, are ingredients that weave into the fabric of a successful aerospace company. “Many people who are specialists in certain areas, but may have only one view, team up with another person who has come from the hard science corner, like structural engineering. Together they can probably write the equation to what the solution is, but either one of them on their own would probably have a lopsided approach, so it would be great if there were a way to balance people individually so they could come at it from a lot of different angles.”

Educational Gaps

When asked about the educational gaps currently existing in Oklahoma’s universities, Participant #6 again goes back to having a balanced set of skills which ultimately makes for a more qualified and diverse workforce. “There was a time when employees could be just an engineer, or just a production line person or, just be a soft skill administrative type, but because of the economies that every company is searching for, you need an engineer who can also lead people. You need an administrative person who has technical skills. You need a production person who knows something about engineering.”

The executive's organization consists of two main types of employees. One consists of the labor force, which is predominantly made up of people that have a specific skill, like performing maintenance on an aircraft, and the other is at the executive level. He feels the technical force is at a disadvantage given their educational background is not always the most robust. It would be favorable for these individuals to continue their education in some kind of executive development program.

Recommended Curriculum

Participant #6's company is one of Oklahoma's flagship aerospace companies and the world's largest commercial MRO facility. It needs people with expertise in production, chemical, and structural engineering, finance, avionics, hydraulics, operations analysis, electrical engineering, and aerodynamics. All of those are individual disciplines and people could spend a whole career just getting one. Those are the highly skilled, highly educated disciplines. The challenge is finding someone with those skills, but who also has experience in production management. Participant #6 also recommends curriculum focused around project, program, and/or operational management, as well as material logistics all of which would make for a well educated workforce in the aerospace industry.

Industry-Academia Partnerships

Oklahoma educational institutions should provide better placement of students in mentorship or internship programs. This could be accomplished by assigning students to companies and areas they are not familiar with the end goal of producing a more diverse future employee. Participant #6 also suggests Oklahoma's educational institutions need more aggressive recruiting programs highlighting industry and academic partnerships. Academia and the aerospace industry should collaborate and encourage universities to provide corporate development programs to Oklahoma aerospace companies. Most of Oklahoma's educational institutions have resources, such as business centers that could aid in the process of professional and organizational development. Universities should promote these continuing education programs to businesses for better partnerships.

Participant #7

Participant #7 has served for over 21 years as an executive for an aerospace company that provides communications services to the airline industry and engineering services to the United States government through the Department of Defense. Over 300 employees call this $1 billion company home in Oklahoma City. The facility offers a variety of services within the aerospace industry, such as modifications of aircraft and integration of new systems, to providing industrial support to Tinker Air Force Base and other major aircraft modification facilities.

Prior to joining the aerospace business, Participant #6 obtained a bachelors of science degree in ocean engineering from the United States Naval Academy. The degree is the equivalent of a mechanical engineering degree; the only difference is all the coursework is applied to an ocean environment. After college, Participant #6 continued to serve in the United States Navy for seven years before joining the Oklahoma aerospace company.

Aerospace Educational Needs

When asked about the educational needs of the aerospace industry in Oklahoma, participant #7 believed courses offering strategic thinking and executive development are among the top desired skills for managerial positions. On the technical side of the house, a bachelor's of electrical or mechanical engineering is the preferred skill-set. The company typically employs engineers,

logisticians, business analysts, program managers, and technicians, all of which require advanced degrees. The technical personnel are logisticians and engineers, chief engineers or technical directors that require at least a bachelors and masters degree in electrical or mechanical engineering. Participant #7 stated most of their management level positions have not reached their optimum level of education. Innate leadership skills are desired, along with specialized classes in executive development and program management. More include critical path thinking, budget and finance management, strategic and tactical thinking, and business planning development.

Educational Gaps

Participant #7 believes Oklahoma educational institutions excel in producing engineering degrees, but lack in preparing those engineers with specific skill-sets like situational application. It appears the engineers fall short on how to apply those skills to particular situations. Universities offer a wide-range of engineering tools to their students; however, most do not always know how to use the software applicable to the task at hand when entering the job market. Therefore, additional on the job training is needed; which leads to lower productivity towards the beginning of their employment.

Recommended Curriculum

While mechanical and electrical engineering courses are ideal for obtaining the desired skills, participant #7 notes the high drop-out rate of these students due to the difficult nature of the curriculum. He recommends institutions research ideas on how to convince students to stay in engineering. Although the state does offer incentives for engineering degree seeking students, those incentives will not necessarily encourage high school graduates to pursue engineering but rather retain current engineers.

Along with this research, participant #7 encourages universities to train students using the industries latest software applications, like AutoCAD, Solid Works, and Abacus. If pursing a managerial position in the participant's organization, it would be prudent for potential employees to have an advanced knowledge of industry used software such as Microsoft Project for scheduling and timeline management, along with Microsoft Excel for spreadsheet and calculation application.

Industry-Academia Partnerships

Participant #7 believes industry and academia could foster partnerships to better serve students and potential aviation professionals by collaborating on a regular basis. Aerospace industry leaders should start by visiting Oklahoma's local educational institutions, talking to students about the importance of pursuing advanced degrees such as engineering. Academia could further this effort by

helping students garner relationships and job opportunities with industry professionals through work study programs or internships. With that in mind, universities should strive towards hiring professors with industry experience, as opposed to just an academic background. Hiring aerospace experts to instruct courses not only adds value and credibility to the program, but more importantly, allows students to apply real world application to the curriculum.

Participant #8

Participant #8 is an executive for a federal aerospace agency and holds a bachelor's of science degree in merchandising and marketing and a master's of science degree in aviation and space science. The organization serves other government agencies by providing technical training, as well as executive and management training, logistics and financial management. There are over two hundred different job series, so the agency is quite diverse.

Aerospace Educational Needs

Participant #8 believes students and working professionals need more experience in different development and training programs. For example, more and more executive management leadership courses are being offered and the organization's executives and managers are expected to participate in these symposiums and seminars. An ideal professional would be someone with a good balance of practical experience and academia. "It really is all about obtaining a balanced employee."

In Participant #8's organization alone, there is much more emphasis on not only four-year degrees, but advanced degrees for management, "you are starting to see more master's and doctoral degrees at senior executive levels, but they also possess real world work experience which in turn, makes them a much more well-rounded." Participant #8 voiced a concern about the lack of proficiency in soft skills, such as the ability to work with customers and other employees

which has been very detrimental. Academia should work towards better preparing the future workforce in the aerospace industry with these basic competencies. “It's about selling ideas and building coalitions to get things done.”

Educational Gaps

Overall participant #8 believes academia is falling short on instructing the state’s future company leaders about the basic business of aerospace. Most of their executives below the age of fifty have not reached their optimum educational level. On the other side, most of the younger employees being hired by the participant’s organization do indeed have a much higher degree of education. This is needed given the sheer competitive nature of the aerospace industry. Again, this educational gap comes from a lack of clear understanding about running a government entity like a business. If employees had a basic understanding of ISO and Lean, the better they are able to find ways to improve processes.

Recommended Curriculum

Exposure to a diverse level of curriculum and experience is not only beneficial to the success of the student, but as an organization is favored among potential executives and managers. Participant #8 suggested courses such as supply chain management, logistics, acquisition, and federal regulations would all

be useful curriculum when it comes to a leadership team's ability to run their organization like a business. Ideally the participant's organization would benefit greatly from a person with a background in aerospace business development, aerospace financing, aerospace globalization, and aerospace quality. Course work including cost effective quality when running an aerospace business and leadership would be of great value to many of the state's aerospace companies.

Industry-Academia Partnerships

Participant #8 understands the importance of quality internships programs and recommends the educational institutions push for greater participation in this arena. This is one of the more cost effective ways for an aerospace company to influence the quality of workforce coming into the pipeline, as well as, garnering exposure in the aerospace industry and to the leading companies in the state if you are a student. Participant #8 suggests better placement of internships comes from a working knowledge and understanding from academia of what the state's aerospace companies capabilities are and how do they align with them.

Participant #9

For over 30 years, Participant #9 has served as a civilian within an air force base and holds a bachelor's degree in accounting and a master’s degree in science and management. The division is in charge of all the long-range and mid-range workload planning, as well as developing the strategic plan for the base.

Aerospace Educational Needs

Participant #9 said the organization is looking for individuals with experience with government contracting, such as rules and laws and Air Force contracting policies, program management, logisticians, financing, and supply chain management. Future leaders seeking positions with the base should in the very least hold a master’s degree in business. However if they are more the technical type, like say an engineer, it would beneficial to pursue a bachelors degree in engineering and adding to it an MBA or some other kind of business degree. Participant #9 admits to discouraging students, when asked, from pursing only engineering degrees if they are interested in any level of management as a non-military civilian.

> “Do you want to be a director? Do you want to be a senior manager at this center? If you do, get your degree in business. Do not get it in engineering, unless you want to be a professional engineer the rest of

your career. If you want to make that transition from engineering into management, you have to have a business degree."

Participant #9 recommended adding professional military education (PME) from institutions such as the Air Command and Staff College and the Air War College. Combined with a bachelors and masters, in the right discipline, and at least two levels of PME, participant #9 feels they have successfully accomplished an ideal academic career for the U.S. Air Force. In order to be best suited for a senior-level leader and achieving the strongest skill set from an academic perspective, that person needs to have a good understanding of technical disciplines, such as engineering, and a flavor of aerospace business and the challenges that come with the industry.

Educational Gaps

When discussing the educational gaps within the aerospace industry, participant #9 believes three areas educational institutions could improve on would be under the heading of logistics. Those are program management, supply chain management, and contracting. Understanding those three areas would be extremely valuable help to develop stronger educational understanding in logistics.

Another gap participant #9 addresses are that of diversity. This is not to be confused with diversity within the educational system, but predominately diversity within the individual themselves, i.e. broaden yourself. If you only understand the

technical aspects of the aerospace industry, you are shortchanging yourself a bit if you have a desire to move into management. At some point as that person grows in their career and they want to make that next step into management and ultimately to senior leadership positions, having an education in business and business principals will serve you well.

Recommended Curriculum

Participant #9 suggests when determining curriculum for logistics, which is a very appropriate and a much needed skill-set, it is important to pursue a deep understanding of supply chain management, program management, and contracting all of which would greatly benefit organizations in a positive way. Educational institutions should offer courses and curriculum to their students within this discipline to better serve the aerospace community.

Even though qualified engineers are critical to the success of the aerospace industry in Oklahoma and the Nation, Participant #9 believes universities are doing an excellent job in producing quality engineers. Oklahoma has good engineering diversity in terms of different kinds of engineering curriculum; however keeping those engineers in Oklahoma once they are educated and trained is a growing problem, which is fortunately being addressed in the state through state tax incentives.

Industry-Academia Partnerships

In order to create partnerships between the aerospace industry and universities, participant #9 believes communication is the one critical element in forming these valuable relationships. Holding an aerospace education/industry forum to discuss issues addressing the aerospace industry and how Oklahoma's educational institutions are working toward producing an educated workforce to aid industry in achieving success and staying competitive The event would create a link of communication between industry and academia. Participant #9 suggests this forum could serve as a catalyst for educational institutions understanding the significant intellectual capital needs of the industry and create a dialogue with a detailed set of objectives and goals in mind.

Summary of Findings

Table 2 supports the previous narrative of participant comments. It also provides a summary of the significant findings of the study related to each of the four broad research objectives.

Table 2. Summary of Executive Participant Perceptions of Aerospace Education

Participant	Aerospace Educational Needs	Educational Gaps	Recommended Curriculum	Industry-Academic Partnerships
#1	Industrial Management Contracting Executive Level Management	Program Management Aviation Logistics Aerospace Business Administration	Airframe Corrosions New Nano Technologies Lean Manufacturing Management Contracting Supply Chain Management Technical Training Business Strategies Manufacturing Lean Processes Accounting Engineering Systems	Internships Capstones Projects
#2	Financing Accounting Proceedures Technical Leadership Technical Management Process Improvement Strategic Communications Business Development Principles of Business Strategies	Technical Education Vocational Education Leadership	Leadership Supply Chain Management Lean Manufacturing Six Sigma Pre-Engineering Process Improvement Application & Business Processes Organizational Strategies	Better Alliances Benchmarking Educational Programs
#3	Aerospace International Studies	Leadership Skills International Affairs	International Finance International Investments Logistics Lean Management Leadership Communication International Aerospace Marketing Project Management Supply Chain Management	Personal Relationships Internships Job Placement
#4	Engineering Management Accounting Executive Development Aerospace Business Administration	FAA certification requirements Computer Aided Design Current Engineering Software	FAA Certification Process Engineering Software-CATIA Aerospace Financing Business Development Supply Chain Management Quality Assurance Programs Government Contacting Procurement Processes	Communication Facility Visits
#5	Technical and Financial Background Marketing Engineering Supply Chain Management Information Technology Financial Analysis Project Management Organizational Performance Engineering Mathematical Simulation Quantitative and Analytical Design	Accounting Finance Engineering	Six Sigma Lean Technology Engineering Software-CATIA Computer System Analysis Financing Statistical Research Operational Management Information Technology Project Management	Customer Based Partnership Survey Businesses Market Programs

Table 2. Summary of Executive Participant Perceptions of Aerospace Education (continued)

Participant	Aerospace Educational Needs	Educational Gaps	Recommended Curriculum	Industry-Academic Partnerships
#6	Technical and Management Skills Soft Skills-Executive Development	Diverse Skill-Sets Executive Development	Production Engineering Chemical Engineering Structural Engineering Electrical Engineering Financing Avionics Hydraulics Operations Analysis Aerodynamics Operational Management Material Logistics	Mentorship & Internship Programs Corporate Development Programs
#7	Strategic Thinking Executive Development Electrical Engineering Mechanical Engineering Logistics Business Analysis Program Management	Critical Path Thinking Budget and Finance Management Strategic and Tactical Thinking Business Planning Development Situational Application Software Application	AutoCAD Solid Works Abacus Microsoft Project & Excel	Site Visits Industry Lead Events Hire Aerospace Experts
#8	Development & Training Programs Executive Management Leadership Balance-Practical & Academia Soft Skills	Business of Aerospace Diverse Skill-Set Process Improvement	Supply Chain Management Logistics Acquisition Federal Regulations Aerospace Business Development Aerospace Financing Aerospace Globalization Aerospace Quality	Internships
#9	Government Contracting & Policies Program Management Logistics Finance Supply Chain Management Professional Military Education	Program Management Supply Chain Management Contracting Diverse Skill-Set	Program Management Supply Chain Management Contracting Engineering	Communication Educational Forums

Findings and Recommendations by Academic Category

Perceptions of Oklahoma executives in each of the broad research categories were analyzed across possible academic degree categories to highlight significant findings related to most frequently recommended curriculum. Table 3. (pg 91 & 92) Summary of Findings by Academic Category provides some significant insight in that regard. The most frequently identified need was in the area of Executive Development and Technical Management, followed by Government Policies and Logistics/Supply Chain, business and finance.

The educational gaps were broad and growing trends and requirements in such areas as executive development, leadership and program and project management. Recommended curriculum was heavily concentrated in the area of engineering, logistics, and business and business related coursework and in the narrative several of the executives recommended aerospace MBA's and Executive Development degree programs.

Table 3. Summary of Findings by Academic Category

The following table summarizes the executive perceptions of educational requirements and curriculum recommendations by academic category.

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Management	Executive Development - # 1, 4, 6, 7, 8 Industrial Management - #1 Technical Management - #2, 5, 6 General Management - #4	Executive Development - #6	Management - #1 Operational Management - #5, 6
Logistics/Supply Chain	Logistics - #7, 9 Supply Chain - #5, 9	Logistics - #1 Supply Chain - #9	Logistics - #3, 8 Supply Chain Management- #1, 2, 3, 4, 8, 9 Lean Manufacturing - #1, 2, 3 Lean Technology - #5 Material Logistics - #6 Lean Processes - #1 Six Sigma - #2, 5
Business	Business Development - #2 Business Strategies - #2 Strategic Thinking - #7 Business Administration - #4 Orangizational Performance - #5 Business Analysis - #7	Process Improvement - #8 Business Administration - #1 Aerospace Business - #8 Critical Path Thinking - #7 Business Planning Development - #7 Situational Application - #7 Strategic & Tactical Thinking - #7	Business Strategies - #1 Organizational Strategies - #2 Application & Business Processes - #2 Aerospace Business Development - #4, 8 Operations Analysis - #6 Quality Assurance - #4, 8
Contracting	Government Contracting & Policies - #1, 9	Contracting - #9	Contracting - #1, 9 Government Contracting - #4 Procurment Process - #4 Acquistions - #8 Federal Regulations - #9
Finance	Finance - #2, 9 Accounting - #2, 4 Financial Analysis - #5 Mathematical Simulation - #5 Quantitative & Analytical Design - #5	Finance - #5 Accounting - #5 Budget & Finance Management - #7	Accounting - #1 Aerospace Finance - #4, 5, 6, 8 Statistical Research - #5

Table 3. Summary of Findings by Academic Category (continued)

The following table summarizes the executive perceptions of educational requirements and curriculum recommendations by academic category.

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Program/Project Management	Program Management - #7, 9 Project Management - #5	Program Management - #1, 9	Program Management - #9 Project Management - #3, 5
Leadership/Communication	Soft Skills - #6, 8 Strategic Communciations - #2 Leadership - #8	Leadership - #2, 3 Diverse Skill Set - #6, 8, 9	Leadership - #2, 3 Communications - #3
International Studies	Aerospace International Studies - #3	International Affairs - #3	International Finance - #3 International Investments - #3 International Aerospace Marketing - #3 Aerospace Globalization - #8
Information Technology	Information Technology - #5	Software Application - #7 Engineering Software - #4 Computer Aided Design - #4	Engineering Software - CATIA - #4, 5 Computer System Analysis - #5 AutoCAD - #7 Solid Works - #7 Abacus - #7 Microsoft Project & Excel - #7 Information Technology - #5
Engineering	Engineering - #4, 5 Mechanical Engineering - #7 Electrical Engineering - #7	Engineering - #5	Engineering Systems - #1 Pre-Engineering - #2 Production Engineering - #6 Chemical Engineering - #6 Structural Engineering - #6 Electrical Engineering - #6 General Engineering - #9
Other Specific Technical Curriculum Recommended			Airframe Corrosions - #1 New Nano Technologies - #1 Technical Training - #1 Avionics - #6 Hydraulics - #6 Aerodynamics - #6

Analysis of Management Findings

Table 3 provided an overall summary of the findings of the study by academic category. The following tables will address the implications of each of those categories in more detail.

The most frequently identified need with five out of nine, (over 50 percent) of the participants, acknowledged Executive Development as an aerospace need in Oklahoma. Only one participant indicated it was a gap. None identified specific executive development curriculum they would like to see produced. Technical Management was identified by one-third of the participants as a need but did not identify it as a gap. Curriculum recommended by participants was general management and operational management.

Table 4. Analysis of Executive Perceptions Related to Management Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Management	Executive Development - # 1, 4, 6, 7, 8 Industrial Management - #1 Technical Management - #2, 5, 6 General Management - #4	Executive Development - #6	Management - #1 Operational Management - #5, 6

Analysis of Logistics/Supply Chain Findings

Although only identified as a need by two of the participants and only one participant indentified it as a gap six out of nine, (over 60 percent) of the participants recommended supply chain management as curriculum for future students. Two participants identified Logistics as a need and recommended curriculum and one participant identified it as a gap. Three out of nine indicated Lean Manufacturing as recommended curriculum; along with one participant recommended each of the following categories: Lean Technology, Material Logistics, and Lean Processes curriculum. Lastly, two out of nine participants identified Six Sigma as recommended curriculum.

Table 5. Analysis of Executive Perceptions Related to Logistics/Supply Chain Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Logistics/Supply Chain	Logistics - #7, 9 Supply Chain - #5, 9	Logistics - #1 Supply Chain - #9	Logistics - #3, 8 Supply Chain Management- #1, 2, 3, 4, 8, 9 Lean Manufacturing - #1, 2, 3 Lean Technology - #5 Material Logistics - #6 Lean Processes - #1 Six Sigma - #2, 5

Analysis of Business Findings

Four out of the nine participants identified business skills as needed by aerospace companies. Three of the participants identified seven gaps in aerospace business skills related to process improvement, strategic and tactical thinking, business planning and administration, critical path thinking, and situational application. More business development curriculum was recommended than any other category including business and organizational strategies, operations analysis, application and business processes, and quality assurance.

Table 6. Analysis of Executive Perceptions Related to Business Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Business	Business Development - #2 Business Strategies - #2 Strategic Thinking - #7 Business Administration - #4 Orangizational Performance - #5 Business Analysis - #7	Process Improvement - #8 Business Administration - #1 Aerospace Business - #8 Critical Path Thinking - #7 Business Planning Development - #7 Situational Application - #7 Strategic & Tactical Thinking - #7	Business Strategies - #1 Organizational Strategies - #2 Application & Business Processes - #2 Aerospace Business Development - #4, 8 Operations Analysis - #6 Quality Assurance - #4, 8

Analysis of Contracting Findings

Contracting was identified as a need by two participants but was designated as a gap by only one participant. Three out of nine participants indentified contracting as recommended aerospace curriculum in higher educational institutions.

In addition to contracting, participants indentified some specific recommendations in the areas of government contracting, the procurement process, acquisitions, and federal regulations. There was considerable discussion in the narrative pertaining to coursework in government related curriculum needs that cross almost all of the academic specialties. Because government regulations and policies significantly impact much of the activities of aerospace in the areas of flight safety, certification, and procurement, curriculum related to some of those specialties surfaced frequently throughout the interviews.

Table 7. Analysis of Executive Perceptions Related to Contracting Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Contracting	Government Contracting & Policies - #1, 9	Contracting - #9	Contracting - #1, 9 Government Contracting - #4 Procurment Process - #4 Acquistions - #8 Federal Regulations - #9

Analysis of Finance and Accounting Findings

Finance and accounting were both identified as aerospace educational needs by four out of nine participants. Others acknowledged financial analysis, mathematical simulation, and quantitative and analytical design as needs.

Two participants identified finance as an educational gap. Accounting, budget and financial management were also identified as gaps in the Oklahoma educational pipeline.

Four of the nine participants identified aerospace finance as recommended curriculum for Oklahoma universities. Accounting and statistical research were also recommended future curriculum.

Table 8. Analysis of Executive Perceptions Related to Finance and Accounting Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Finance	Finance - #2, 9 Accounting - #2, 4 Financial Analysis - #5 Mathematical Simulation - #5 Quantitative & Analytical Design - #5	Finance - #5 Accounting - #5 Budget & Finance Management - #7	Accounting - #1 Aerospace Finance - #4, 5, 6, 8 Statistical Research - #5

Analysis of Program and Project Management Findings

Program/project management needs were identified by three of the participants. Two participants identified Program Management as an educational gap in Oklahoma. Two participants recommended project management curriculum and one recommended program management curriculum for future aerospace education in Oklahoma.

As reflected in the narrative Program Management and Project Management support a variety of aerospace organizational functions. This is a growing specialty that crosses both hard and soft skills and is increasingly indentified in business and the aerospace industry to support many organizational and team activities. Many organizations are now requiring certification credentials for employees responsible for those activities.

Table 9. Analysis of Executive Perceptions Related to Program and Project Management Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Program/Project Management	Program Management - #7, 9 Project Management - #5	Program Management - #1, 9	Program Management - #9 Project Management - #3, 5

Analysis of Executive Perceptions Related to Leadership/Communications

Findings

Soft skills were recognized as an aerospace educational need by two participants. One participant indentified strategic communications and another stressed repeatedly the importance of leadership skills.

Three of the nine participants identified diverse skill sets as an educational gap. Two of the nine participants identified leadership as a gap in today's Oklahoma higher educational institutions.

In keeping with their perceptions of this skill set, two of the participants strongly emphasized leadership curriculum. Although only one leader recommended Communications curriculum, several stressed the importance of both of those skills in relation to technical fields such as engineering where additional emphasis in the area of soft skills is needed.

Table 10. Analysis of Executive Perceptions Related to Leadership/Communication Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Leadership/Communication	Soft Skills - #6, 8 Strategic Communciations - #2 Leadership - #8	Leadership - #2, 3 Diverse Skill Set - #6, 8, 9	Leadership - #2, 3 Communications - #3

Analysis of Executive Perceptions Related to International Studies Findings

By nature, the aerospace industry is an international business. Surprisingly, only one participant indentified international studies and affairs as an educational need and an educational gap.

The same participant recommended curriculum in international finance, investments and aerospace marketing, while one other participant identified aerospace globalization to be offered to students entering the workforce.

One of the participants offered a rather strong rebuke of aerospace organizations and academia in suggesting that the aerospace industry is a global economy and Oklahoma touts itself as being the ”Global Aerospace Destination” yet most of the students coming out of the universities have never even left the state.

Table 11. Analysis of Executive Perceptions Related to International Studies Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
International Studies	Aerospace International Studies - #3	International Affairs - #3	International Finance - #3 International Investments - #3 International Aerospace Marketing - #3 Aerospace Globalization - #8

Analysis of Executive Perceptions Related to Information Technology Findings

It goes without saying in today's environment that in a business and technical field such as aviation, it is critical to acquire at minimum some understanding of basic system analysis and software application.

Only one participant indentified information technology as a need. One identified current engineering software systems as a gap in the Oklahoma educational pipeline and two included it in recommended curriculum. Three of the participants identified specific software curriculum including CATIA, AutoCAD, Solid Works, Microsoft Project and Excel, and Abacus.

Table 12. Analysis of Executive Perceptions Related to Information Technology Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Information Technology	Information Technology - #5	Software Application - #7 Engineering Software - #4 Computer Aided Design - #4	Engineering Software - CATIA - #4, 5 Computer System Analysis - #5 AutoCAD - #7 Solid Works - #7 Abacus - #7 Microsoft Project & Excel - #7 Information Technology - #5

Analysis of Executive Perceptions Related to Engineering Findings

The aerospace industry is closely tied to both the field of business and engineering so it comes as no surprise that aerospace professionals would identify engineering as an educational need. Four of the nine participants recommended some form of engineering with respect to curriculum offered in Oklahoma's higher educational institutions.

Only one participant identified engineering as an educational gap. This is somewhat inconsistent with most of the research done in Oklahoma, especially since engineering shortages prompted recent legislation changes to attract more engineers to the state aerospace industry. Even though only one participant addressed engineering in terms of a gap, four of the nine participants identified specific recommended engineering curriculum.

Table 13. Analysis of Executive Perceptions Related to Engineering Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Engineering	Engineering - #4, 5 Mechanical Engineering - #7 Electrical Engineering - #7	Engineering - #5	Engineering Systems - #1 Pre-Engineering - #2 Production Engineering - #6 Chemical Engineering - #6 Structural Engineering - #6 Electrical Engineering - #6 General Engineering - #9

Analysis of Executive Perceptions Related to Other Technical Courses Findings

In addition to the specified engineering degree program participants indentified a number of other specific technical courses including airframe corrosions, nano technologies, avionics, hydraulics, and aerodynamics.

Table 14. Analysis of Executive Perceptions Related to Other Technical Courses Curriculum

Category	Aerospace Educational Needs & Participant Number	Educational Gaps & Participant Number	Recommended Curriculum & Participant Number
Other Specific Technical Curriculum Recommended			Airframe Corrosions - #1 New Nano Technologies - #1 Technical Training - #1 Avionics - #6 Hydraulics - #6 Aerodynamics - #6

Summary of Participant Recommendations Related to Industry-Academic Partnerships

Participant recommendations related to industry-academic partnerships can be found in Table 2, pg 88 & 89 which listed numerous suggestions for improvement of collaborative efforts to benefit students, industry, and academic institutions. The range of ideas included mentorships, internships, capstone projects, corporate development programs, site visits, industry led events, expert hiring, communication, and joint educational forums. More important than the range of activities suggested were some of the significant comments found in previous narrative worthy of re-emphasis here.

1. Use of the concept of benchmarking with other industry and academic organizations and locations to see what is working in other partnerships.
2. Improved collaboration with on job placement with Oklahoma institutions taking the lead to serve as a kind of “head-hunter” link with industry on creative ways for industry access to potential employees and student access to opportunities for employment upon graduation.
3. Development of an evaluation process for Oklahoma’s educational institutions to ensure course work is appropriate for intellectual requirements of the industry.
4. A continual communication process between educational institutions including site visits, joint research projects and forums, as well as other

opportunities to better address the needs of the aerospace industry.

5. Improved customer relationships to eliminate the disconnect between what is needed in the industry and what universities perceive is needed.
6. Improved focus on the needs of the actual market rather than academic perceptions of those needs to include surveys, site visits, etc.
7. Engage in a more aggressive recruiting agenda through programs related to corporate development such as business centers to aid in professional and organizational development and promote continued education programs to businesses for better partnerships.
8. Industry visits to educational institutions to talk to students about the importance of advanced degrees.
9. Promotion of work study programs, internships, mentoring, shadowing and other assignments to develop real-world experience.
10. University emphasis on hiring professors with industry experience as opposed to just academic background. “Hiring aerospace experts to instruct courses not only adds value and credibility to the program, but more importantly, allows students to apply real world applications to the curriculum.”

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

Consistent with the purpose of the study, the findings in this research provided a snapshot of the perceptions of Oklahoma aerospace executives and managers related to their assessment of the intellectual capital needs within aerospace industry, the gaps in the educational system between what is needed and what is currently being provided, their recommendations for specific curriculum to address those gaps; as well as how industry and academia can work together to address those needs and feed the pipeline of intellectual capital in the state.

Conclusions

Educational Needs

Executive Development Needs: Development of Oklahoma aerospace intellectual capital centers around some predominant needs identified by its aerospace executives and managers. An unexpected finding of this study

indicated that the largest number of participating executives (five of the nine participants or over 50 percent) identified executive development as an aerospace educational need in Oklahoma. In addition to executive development, technical, industrial and general management educational needs were also identified.

Business Development Needs: Four of the participants identified business educational needs including business development, strategies, analysis and administration particularly targeted toward the logistics and supply-chain environment. Other business related hard skills included contracting, finance, and accounting; as well as soft skills in leadership and communications. Program and project management and international studies were also identified as educational specialties that utilize both hard and soft skills to address a growing need in the aerospace industry.

Technical Needs: A variety of educational needs in the fields of engineering and information technology were identified. The most significant of those fields was indeed engineering, with three participants identifying such engineering specialties as electrical and mechanical to be important to the development of aerospace intellectual capital. This is consistent with the findings of several previous Oklahoma research projects that prompted legislation designed to encourage retention of engineering graduates in the state.

In 2008, Oklahoma House Bill 3239, the Engineering Workforce Bill passed, which provides incentives for attracting and retaining engineers for the state's aerospace industry by providing tax credits to companies that hire them.

An even larger tax credit is offered for graduates of Oklahoma educational institutions. The tax credit is given to engineering graduates who agree to work for an Oklahoma aerospace company, and is not to exceed $5,000 per year for the first 1-5 years of employment. In addition, a tax credit is offered to employers that provide a fifty percent reimbursement of tuition to new engineer graduates, based on the average tuition of an Oklahoma public college or university, for the first through fourth years of employment.

Gaps in the Aerospace Educational System

Gaps in the aerospace educational system were identified by participants in all of the major categories of previously identified educational needs including executive development and management, business, logistics, contracting, finance, accounting, program and project management, international affairs, engineering, and engineering software system. The most frequently identified educational gaps were in the areas of leadership, program management, and lacking diverse skill-sets. Educational gaps within the category of business included process improvement, business administration, critical path thinking, planning development, situational application, and strategic and tactical thinking.

Curriculum Recommendations

Supply-Chain Management/Logistics: Specific curriculum was recommended by aerospace industry executives in each category of educational needs. The most significant finding related to recommendations was that six out

of nine or sixty percent of the executives specifically recommended supply-chain management coursework. It was followed closely by specific logistics and lean coursework as identified in Table 5.

Business: A wide variety of specific business courses including eight in business development and administrative areas as well as four in contracting, three in finance and accounting, four in international studies, two in management specialties, program and project management, two in the soft skills area of leadership, communications and marketing for a total recommended courses of thirty-two courses in management and business related fields including the logistics and supply-chain area.

Technical: There were six information technology curriculum recommendations including engineering software CATIA, computer systems analysis, information technology, AutoCAD, Microsoft Project and Excel. There were seven engineering curriculum recommendations including engineering systems, pre-engineering, production engineering, chemical engineering, structural engineering, electrical engineering and general engineering. Other more specific technology curriculum recommended included airframe corrosion, nano technologies, technical training, avionics, hydraulics, aerodynamics. There were approximately twenty recommendations in technical curriculum.

Suggested Programs or Partnerships between Academia and Industry

Programs: To better serve the student and potential employees, universities should benchmark their aerospace programs against companies and or locations that are supportive of an industry-academia partnership. Questions universities could ask aerospace industry leaders:

1.) Where do they see significant improvement and growth within the aerospace industry?

2.) From where do their employees predominately come from?

3.) Do they have the same challenges that educational institutions have in terms of drawing and retaining people?

4.) Are they obtaining individuals from within the state or are they recruiting them from other places, and if so, where?

Another suggestion is for companies to collaborate more effectively with the universities on job placement. This direct access to potential employees would be most advantageous to the aerospace companies themselves. Oklahoma educational institutions could provide this linkage to the aerospace industry.

Oklahoma's educational institutions need more aggressive recruiting programs highlighting industry and academic partnerships. Academia and the aerospace industry should collaborate and encourage universities to provide corporate development programs to Oklahoma aerospace companies. Many of

Oklahoma's educational institutions have resources, such as business centers that could aid in the process of professional and organizational development. Universities should promote these continuing education programs to businesses for better partnerships.

Based on participant recommendations, universities should also strive towards hiring professors with aerospace industry experience, as opposed to just an academic background. Hiring aerospace experts to instruct courses not only adds value and credibility to the program, but more importantly, allows students to apply real world application to the curriculum.

Internships: Oklahoma educational institutions should provide better placement of students in mentorship or internship programs. This could be accomplished by assigning students to companies and areas they are not familiar with the end goal of producing a more diverse future employee. Academia should strive towards helping students garner relationships and job opportunities with industry professionals through work study programs. Better placement of internships comes from a working knowledge and understanding from academia of what the state's aerospace companies capabilities are and how do they align with them. Internships are one of the more cost effective ways for an aerospace company to influence the quality of workforce coming into the pipeline, as well as, garnering exposure in the aerospace industry and to the leading companies in the state if you are a student.

Partnerships: Industry and academia could foster partnerships to better serve students and potential aviation professionals by collaborating on a regular

basis. Establishing personal relationships with university faculty members would allow the educational institutions to obtain a clear picture of curriculum needed by Oklahoma's aerospace industry and provide a source from which they could draw from those specifically trained students.

In order to create this partnership, communication is the one critical element in forming these valuable relationships. Facility visits by university professors could provide the opportunity to see the Oklahoma's aerospace businesses products and services for the benefit of offering applicable curriculum. Aerospace industry leaders should also take this same approach by visiting Oklahoma's local educational institutions and talking to students about the importance of pursuing advanced degrees.

Another way industry and academia can partner is by thinking of themselves as customers of one another. In the aerospace field, companies offer services their customers need. This should be no different in the academic world. The university is a customer of industry whose service is to provide an educated workforce. The industry is a customer of the university which provides expertise and desired intellectual capital needs. Educational institutions should survey local aerospace businesses before offering programs to match the needs of the market. There is a clear disconnect between what is needed in the industry and what universities are currently marketing to its students. Higher education is lacking in selling careers primarily because they are not focusing on the market or the specific skill set needed in order to obtain a higher-level position with an

aerospace company. Industry and academia should establish a customer-based partnership to alleviate these educational gaps.

An additional suggestion for successful partnerships would be to hold an aerospace education/industry forum to discuss issues addressing the aerospace industry and how Oklahoma's educational institutions are working toward producing an educated workforce to aid industry in achieving success and staying competitive. The event would create a link of communication between industry and academia. This forum could serve as a catalyst for educational institutions understanding the significant intellectual capital needs of the industry and create a dialogue with a detailed set of goals and outcomes.

The aerospace industry cannot survive without the intellectual capital being generated by universities. It appears neither universities nor industry fully understand what each one really contributes to the overall success of Oklahoma's workforce. Universities should focus more on partnerships that will lead to a vested stake in the outcome and success of one another. If a particular college is producing a certain kind of graduate, but the industry is not hiring that particular kind of graduate, who loses? The student loses. The aerospace industry loses. And eventually the university will lose too. Ultimately, the educational institutions will end up producing a product the industry is not buying. This is Oklahoma's future pipeline of workers, but if the skill set is not right, the student graduates with a greater bill to pay than student loans; they pay the price of unemployment.

Recommendations

1. Executive Development: Executive Development was a strongly identified need in that over 50 percent of the aerospace executives and managers in this study spontaneously identified it as an educational need. Specific curriculum was not identified by this group of participants. Further research is recommended to determine interest from a broader sample of aerospace industry executives. Perhaps a survey could be designed and distributed at the annual Oklahoma Aerospace Summit and Expo to determine interest level, potential curriculum, format (e.g. hybrid, online, classroom) and other potential instructional strategies. The Oklahoma Aerospace Institute, the Oklahoma Executive Institute and its partnership with FAA, along with other aerospace organizations should be considered as a potential partner in marketing the program locally and nationally.
2. Supply-Chain Management/Logistics: Because supply chain management and logistics curriculum were recommended by over 60 percent of the participants, it should be a significant part of a specialized aerospace degree program in that field. Program and planning for future coursework in the field of aviation and aerospace education should keep the findings of this study and place aerospace supply chain and logistics in the forefront of the degree programs at both the bachelors and masters level. Although Oklahoma State

University implemented a bachelors degree in Aerospace Logistics in Oklahoma City in 2007, the number of participants who identified this curriculum as an educational need in Oklahoma and were still unaware of its availability, indicates that the degree may need extensive marketing. For broader appeal, it could also use some modifications in the area of more advanced procurement and acquisition topics as well as additional finance and marketing. With those minor additions, the degree should be heavily marketed to all areas of the state with a variety of options for delivery (online, classroom, and hybrid). The Oklahoma Aerospace Alliance, Oklahoma Aerospace Institute, Oklahoma Aeronautics Commission, Greater Oklahoma City and Tulsa Chambers, as well as the Department of Commerce and Workforce Development organizations could be a viable source for marketing that program all across the state.

3. Aerospace Masters of Business Administration (MBA): Participant #3 commented that the classical MBA is just not enough in this industry; it does not make you a good leader or a good manager. Universities need to distinguish their MBA degree with specifics on aerospace international studies. Because of the level of need for supply chain and logistics courses in the aerospace industry, as well as unique aerospace business planning and management courses, consideration should be given to an Aerospace MBA with a Logistics or Supply-Chain track, a Business track and an International and Practicing

Management track, all of which include both hard and soft skills as shown on Table 3, pg 91 & 92.

4. Industry Academic Partnerships: Participants stressed the importance of industry academic collaboration on a regular basis through a variety of structures and programs such as visitation of industry leaders to Oklahoma's educational institutions to stress the importance of pursuing advanced degrees in engineering and aerospace business. Academia could further the effort by helping students garner relationships and job opportunities with industry professionals with work study programs and internships.
5. Faculty Hiring Standards: Participants were emphatic about the "importance of hiring instructors with industry experience as opposed to just an academic background." Hiring aerospace experts to instruct courses not only adds value and credibility to the program because instructors can teach outside the textbook, but it also allows students to foster relationships with industry leaders and apply real world application to the curriculum. Oklahoma universities should include industry representatives on curriculum planning and faculty selection panels and develop a set of rigorous academic and experience qualifications for hiring faculty in the field of aerospace.

6. Significant New Curriculum Recommendations – Nelson Model:

Management

Management

Operational Management

Logistics/Supply Chain

Logistics

Supply Chain Management

Lean Manufacturing

Lean Technology

Material Logistics

Lean Processes

Six Sigma

Business

Business Strategies

Organizational Strategies

Application & Business Processes

Aerospace Business Development

Operations Analysis

Quality Assurance

Contracting

Contracting

Government Contracting

Procurement Process

Acquisitions

Federal Regulations

Finance

Accounting

Aerospace Finance

Statistical Research

Program/Project Management

Program Management

Project Management

Leadership/Communication

Leadership

Communications

International Studies

International Finance

International Investments

International Aerospace Marketing

Aerospace Globalization

Information Technology

Engineering Software - CATIA

Computer System Analysis

AutoCAD

Solid Works

Abacus

Microsoft Project & Excel

Information Technology

Engineering

Engineering Systems

Pre-Engineering

Production Engineering

Chemical Engineering

Structural Engineering

Electrical Engineering

General Engineering

Other Specific Technical Curriculum Recommended

Airframe Corrosions

New Nano Technologies

Technical Training

Avionics

Hydraulics

Aerodynamics

Summary Comments

The long-term ability to recruit and retain a professional workforce with the needed skills will determine the viability of the industry for the remainder of this century and beyond. The challenges are real and they are growing. Continued research on the growing challenges is imperative to the aerospace industry.

REFERENCES

Aerospace State's Association. (2008). *Industry's response to the Workforce Challenge*, 4.

Aerospace State's Association. (2008). *Launching the 21st century American aerospace workforce*, 6.

Arizona State University. (2008, October). *An initial assessment: creating an Arizona Aerospace Institute*. 4.

Commission on the Future of the United States Aerospace Industry. (2002, November). *Final report of the commission the future of the united states aerospace industry*. Arlington, VA.154.

Creswell, J. (1998). *Qualitative inquiry and research design: choosing among five traditions.* Thousand Oaks, CA: Sage Publication.

Crotty, M. (1998). *The foundations of social research: meaning and perspective in the research process.* Thousand Oaks, CA: Sage Publication.

Denzin, N.K. & Lincoln, Y.S. (1994). *Handbook of qualitative research.* Thousand Oaks, CA: Sage Publications.

Gay, L.R. (1996). *Educational Research*. (5th Edition). New Jersey: Prentice Hall Inc.

Georgia Work Ready. (2009, February). *Middle Georgia work ready aerospace partnership strategy work ready region strategy overview*. 1.

Governor's Aerospace Taskforce. (2004). *Report of the Governor's aerospace taskforce: 2004 report.* Oklahoma City, OK: Author.

Governor's Council for Workforce and Economic Development. (2007). *Oklahoma's aerospace industry workforce: 2007 report.* Oklahoma Department of Commerce Research and Economic Analysis Division: Author.

Harre´, R. (1986). *The social construction of emotions*, Basil Blackwell, Oxford.

Interagency Aerospace Revitalization Task Force. (2008). Report of the Interagency Aerospace Revitalization Task Force, 11.

Jackman, Frank. (2007, April). MRO market is up and down. *Overhaul & Maintenance*, 47.

Maloney, P., & Leon, M. (2007). The state of national security space workforce. *The Aerospace Corporation, Vol.8, No.1*, 8.

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA: Sage Publications.

Ohio Aerospace Institute. (2009, November). *Aeropropulsion and power systems: maximizing ROI in America's leading state*.4.

Ohio Aerospace Institute. (2009, October). 2009 annual report. 1.

Oklahoma Aerospace Industry Partners. (2009, September). *Strategic plan for the growth of Oklahoma's aerospace industry*. Oklahoma City, OK: Author

Oliver, Julia. (2007, December). *First-time graduate student enrollment in science and engineering increases in 2006, especially among foreign students*. (Directorate for Social, Behavioral, and Economic Sciences. NSF 08-302). Arlington, VA: National Science Foundation.

Rubin, J. R., & Rubin, I. S. (1995). *Qualitative interviewing: The art of hearing data*. Thousand Oaks, CA.: Sage Publications.

Schwandt, T.A. (1994). *Handbook of qualitative research.* Thousand Oaks, CA: Sage Publication.

The President's High Growth Job Training Initiative in the Aerospace Industry. (2005, May). *America's aerospace industry: identifying and addressing workforce challenges*, 1.

U.S. Department of Labor, Employment and Training Administration by Jobs for the Future. (2007, April).*The STEM workforce challenge: the role of the public workforce system in a national solution for a competitive science, technology, engineering, and mathematics (STEM) workforce*. 2.

APPENDICES

APPENDIX A

IRB APPROVAL FORM

Oklahoma State University Institutional Review Board

Date	Monday, November 10, 2008	**Protocol Expires:**	**11/9/2009**
IRB Application No:	ED07108		
Proposal Title:	Intellectual Capital in the Aerospace Industry: An Inquiry of Oklahoma Aerospace Executives and Educational Recommendations		
Reviewed and Processed as:	Exempt **Continuation**		

Status Recommended by Reviewer(s): **Approved**

Principal Investigator(s) :

Erin M. Wright
303 Station Ave.
Glenside, PA 19028

Timm Bliss
317 Willard Hall
Stillwater, OK 74078

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt project may be reviewed by the full Institutional Review Board.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

Signature:

Sheila Kennison, Chair, Institutional Review Board

Monday, November 10, 2008
Date

APPENDIX B

PARTICIPANT LETTER

Dear Mr./Ms. _____

As you are aware, a number of state agencies have conducted studies of Oklahoma aerospace work force development needs. These studies are fragmented and generally confined to the development of touch labor and engineering only rather than the identification of all branches of intellectual capital requirements for the professional personnel who support the field in such specialties as logistics, safety and security, marketing, consulting, and management.

Aerospace companies in Oklahoma have expressed frustration with the shortage of intellectual capital necessary to maintain and grow the industry. Along with this growth comes a responsibility for development of talented and educated personnel to support the industry. Industry-academia collaborative efforts can help mold the future of aerospace in Oklahoma by partnering and addressing the needs of the industry for intellectual capital.

As a leader in the aerospace industry in Oklahoma your role is critical to its growth. I am conducting a research study as part of my dissertation for the doctoral program at Oklahoma State University and would respectfully ask for your participation in the form of an interview with the purpose of establishing your intellectual capital needs within your company. Your input and contribution to this study will provide educational institutions with a detailed list of industry needs based on skill set requirements, education and training programs, and future qualified workers with the intent on providing recommendations and best practices to better coordinate and grow the aerospace industry in Oklahoma. The interviews will take place during _____. I will of course work around your schedule to determine the most convenient time for you.

To create a competitive advantage in a global economy, Oklahoma must have an aggressive and forward-thinking plan that integrates education and economic development efforts within the aerospace industry. Innovative thinking, increased collaboration, and more integrated processes and systems are required to position Oklahoma competitively for future growth and prosperity. This competitive advantage will enable Oklahoma to attract new business from within the aerospace industry and create quality career opportunities. By closely linking education, economic development, and professional systems, Oklahoma can and will become the global leader and destination for aerospace.

Please review the enclosed Informed Consent Document. It details the purpose and procedures of the study, as well as providing you with important information regarding confidentiality. If you would be willing to participate in my study, **please sign and date the document and return to me**. Should you have any questions about the study or the interview process, please do not hesitate to contact me. I may be reached at (405) 255-9182 or by email at emw1107@yahoo.com. Thank you in advance for your wiliness to participate in this study. I look forward to hearing from you.

Regards,

Erin M. Nelson

APPENDIX C

CONSENT FORM

INFORMED CONSENT DOCUMENT

Project Title:

OKLAHOMA AEROSPACE INTELLECTUAL CAPITAL/EDUCATIONAL RECOMMENDATIONS: AN INQUIRY OF OKLAHOMA AEROSPACE EXECUTIVES

Investigators:

Erin Nelson

BS & MS – Oklahoma State University, Aviation & Space Sciences

Purpose:

The purpose of this study is to conduct a qualitative research study consisting of detailed personal interviews with aerospace companies, both from the private and military sectors from across Oklahoma with the purpose of compiling a list of industry needs based on skill set requirements, education and training programs, and future qualified workers with the intent on providing recommendations and best practices to better coordinate and grow the aerospace industry in Oklahoma. The aerospace industry in Oklahoma is currently facing a shortage of qualified workers. This is due to the high demand of work companies are obtaining. Our State's aerospace industry is encountering a surge and with that comes the need for a larger labor pool. In order for these companies to success they must have a skilled, competent workforce. Aerospace companies in Oklahoma have expressed frustration with a lack of a qualified workforce, a need for new education and training programs, and the shortage of potential hires coming out of the pipeline system. Education has experienced their own frustrations with facility shortage, low student enrollment, and funding concerns. How can we better prepare our future generation of aerospace workers in Oklahoma by providing recommendations today?

Procedures:

Subjects for the interview will be selected from 9 predetermined companies within the Oklahoma aerospace population. The selection of these subjects is based on obtaining information related to the needs of small, medium and large aerospace companies. This sample is purposively chosen because it is believed to be a rich source of data for identifying workforce and educational needs in the Oklahoma aerospace industry.
The interview method, consisting of seeking responses to a predetermined set of questions, will remain constant in all groups interviewed. This method will be utilized to determine what aerospace companies think are the critical skills needed for an educated and qualified workforce and the reasons for the shortage within the aerospace industry in Oklahoma. In order to compile a list of aerospace industry needs within the state of Oklahoma, open-ended questions were developed as a guide for the interviews.

The interview is anticipated to take no longer than one hour. The initial contact to aerospace companies, educational institutions, and government organizations with the intent of seeking approval to conducting an interview will take one week and should be completed by June 2007. The face-to-face interviews with the specific selected aerospace companies will take one month and should be completed by the end of July 2008.

Risks of Participation:

There are no known risks associated with this project which are greater than those ordinarily encountered in daily life.

Benefits:

This study will be significant because it will provide Oklahoma aerospace companies, educational institutions, and government organizations with a detailed list of industry needs based on skill set requirements, education and training programs, and future qualified workers with the intent on providing recommendations and best practices to better coordinate and grow the aerospace industry in Oklahoma.

Confidentiality:

The records of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you. Research records will be stored securely and only researchers and individuals responsible for research oversight will have access to the records. It is possible that the consent process and data collection will be observed by research oversight staff responsible for safeguarding the rights and wellbeing of people who participate in research.

Compensation:

There will be no compensation given for participation in this research project.

Contacts:

Primary Investigator:

Erin Nelson
405-255-9182
Emw1107@yahoo.com

If you have questions about your rights as a research volunteer, you may contact Dr. Sue C. Jacobs, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-1676 or irb@okstate.edu.

Participant Rights:

Participation in this research project is voluntary and subjects can discontinue the research activity at any time without reprisal or penalty. There will be no risk to any subjects due to withdrawal from research project.

Signatures:

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy of this form has been given to me.

_____ _____

Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

_____ _____

Signature of Researcher Date

APPENDIX D

INTERVIEW GUIDE

INTERVIEW GUIDE

PARTICIPANT CAREER & DEMOGRAPHIC DATA

1. Describe your career history highlighting those areas that pertain to education, training applicable to your current position and what have been most valuable in this position.
2. Describe your educational history.
3. What would you have done differently to prepare for your current position?
4. As an executive/manager in the field, do you believe that you could have used more academic curriculum in the field of executive development?
5. Describe in general terms the professional level positions of your organization. (Example: aerospace engineers, logisticians, accountants, marketing supervisory, mid-management, executive-level management).

PARTICIPANT RECOMMENDATIONS

6. If you could describe the ideal professional in your organization, what would be their optimum academic specialty and level of achievement? (Ex. logistics, engineering, management, marketing, human resource management, accounting, management, executive development, etc. with an associate bachelors, masters, or doctoral degree)
7. In general, would you describe the majority of your professional level personnel as having reached their optimum level of achievement in education? If not, what would be the area that needs improvement?
8. In your opinion, what are the educational needs currently not being met by the academic community in the aerospace industry in Oklahoma?
9. What specific curriculum would you recommend to meet the needs of the aerospace industry in Oklahoma (for your organization and/or the industry as a whole)?
10. How can industry and academia work together to better address the academic needs of the industry?

11. Are there short-term educational recommendations that could be developed to help alleviate the shortages in qualified personnel when they occur?
12. Are there long-term educational recommendations that could be developed to help alleviate the shortages in qualified personnel when they occur?
13. Describe your perception of the next generation of Oklahoma aerospace professionals and your prediction of their academic requirements for success?
14. What if any, research to your knowledge has been conducted in the State of Oklahoma that addresses educational requirements of the aerospace industry?
15. What additional research would you recommend to obtain a clear picture of future requirements of the industry?
16. As a potential employer of aerospace students, what coursework would you consider to be of the greatest practical value?
17. What graduate degree programs would be beneficial to students in the aerospace industry as a whole?

VITA

Erin Mandy Nelson

Candidate for the Degree of

Doctor of Education

Thesis: OKLAHOMA AEROSPACE INTELLECTUAL CAPITAL/EDUCATIONAL RECOMMENDATIONS: AN INQUIRY OF OKLAHOMA AEROSPACE EXECUTIVES

Major Field: Applied Educational Studies with an Emphasis on Aviation and Space Science

Biographical:

Education: Graduated from Putnam City North High School, Oklahoma City, Oklahoma in May 1996; received Bachelors of Science degree in Aviation Management from Oklahoma State University, Stillwater, Oklahoma in May 2000; received Master of Science degree in Aviation Management from Oklahoma State University, Stillwater, Oklahoma in May 2002. Completed the requirements for the Doctor of Education in Applied Educational Studies with an Emphasis on Aviation and Space Science at Oklahoma State University, Stillwater, Oklahoma, in May 2010.

Experience: Employed as the aviation and government affairs liaison for the Oklahoma Aeronautics Commission; employed as the eastern regional representative for the Aircraft Owners and Pilots Association; employed as the director of policy development for Oklahoma Lieutenant Governor Jari Askins; employed as the vice president for the aerospace division for SpiritBank; employed as the associate director for the Oklahoma Aerospace Alliance; adjunct professor for Oklahoma State University's Aviation Department; employed as a business developer for the Boeing Company in Oklahoma City, 2009-present.

Professional Membership: Founder and President of the Winnie Mae Oklahoma Chapter for Women in Aviation International, member of the Aircraft Owners and Pilots Association, Governor's Council for Workforce and Economic Development, Central Oklahoma Workforce Investment Board, Boeing Women in Leadership, and the Steering Committee for the Oklahoma Aerospace Summit & Expo

Name: Erin Mandy Nelson Date of Degree: May, 2010

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: OKLAHOMA AEROSPACE INTELLECTUAL CAPITAL/EDUCATIONAL RECOMMENDATIONS: AN INQUIRY OF OKLAHOMA AEROSPACE EXECUTIVES

Pages in Study: 126 Candidate for the Degree of Doctor of Education

Major Field: Applied Educational Studies with an Emphasis on Aviation and Space Science

Scope and Method of Study: The purpose of this qualitative study was to conduct detailed personal interviews with aerospace industry executives/managers from both the private and military sectors from across Oklahoma to determine their perceptions of intellectual capital needs of the industry. Interviews with industry executives regarding intellectual capital needs of the aerospace industry could identify potential gaps in existing aerospace curriculum; and obtain recommendations for future curriculum as well as address issues related to academic-industry collaboration. The general methodology used was that of a qualitative field study. A small sample of nine executives from the Oklahoma aerospace industry was interviewed and asked a specific set of open-ended questions. This method of gathering data was appropriate due to the nature of the study and the precise documentation required for identifying industry intellectual capital requirements.

Findings and Conclusions: Consistent with the purpose of the study, the findings in this research provided a snapshot of the perceptions of Oklahoma aerospace executives and managers related to their assessment of the intellectual capital needs within aerospace industry, the gaps in the educational system between what is needed and what is currently being provided, their recommendations for specific curriculum to address those gaps; as well as how industry and academia can work together to address those needs and feed the pipeline of intellectual capital in the state. The long-term ability to recruit and retain a professional workforce with the needed skills will determine the viability of the industry for the remainder of this century and beyond. The challenges are real and they are growing. Continued research on the growing challenges is imperative to the aerospace industry.

ADVISER'S APPROVAL: Dr. Timm Bliss