Agenda Item #9

BROOKINGS

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Metropolitan Policy Program

Request for Proposals to Partner
Brookings Metropolitan Business Planning Initiative

Metropolitan Policy Program at Brookings
March 31, 2011

The Metropolitan Policy Program at Brookings (Brookings) is seeking—as part of the next phase of its Metropolitan Business Planning Initiative—to identify four to six metropolitan areas with which to work in continuing to pilot an innovative "bottom-up" approach to regional economic growth. With technical support from Brookings and RW Ventures, LLC (which will continue to help manage the project), teams will create and implement comprehensive metropolitan business plans (MBPs). (For more on the Metropolitan Business Planning Initiative, please see the Brookings concept paper by Bob Weissbourd and Mark Muro). Grounded in customized analysis of metropolitan economies, the initiative seeks to develop new levels of coordination, expertise, effectiveness and business discipline in the practice of regional economic development. The project, in brief, aims to achieve three complementary goals:

- Demonstrate the power of systematic, locally driven regional strategies to transform, reposition and demonstrably improve the economic performance of metropolitan regions

- Improve the field of regional and national economic development practice through the development and implementation of unique, intentional, market-based Metropolitan Business Plans

- Engage with federal, state, and regional policymakers and other "investors" to develop a new approach of integrated, performance-based investment in catalytic economic development ventures

Along those lines, the following sections outline the conceptual background of the project; the opportunity at hand, its scope, and associated deliverables; the preliminary work plan; criteria for participation, including necessary team capacities; and the process for responding to this Request for Proposals to Partner (RPP). Please note that this RPP is only being shared with a select group of potential partners that have already expressed interest and seem likely to meet the criteria described below, among others.

BACKGROUND AND CONCEPT

Three years after the Great Recession, it is increasingly clear that America needs to move toward a more productive "next economy" that will be increasingly export-oriented, lower-carbon, and innovation-driven—as well as opportunity rich. Leading U.S. metropolitan areas—which drive the national economy—are mounting increasingly strategic, locally developed, and sophisticated initiatives to move in these directions.

In this context, the nation and its regions need to take a new approach to economic development. Just as the best U.S. metropolitan areas are defining a new, more sophisticated and intentional approach to regional economic growth, so are federal, state, private and civic sector actors increasingly accepting that metropolitan regions are the critical geographic units in the U.S. economy. Stakeholders at all levels recognize that metros collectively house the vast majority of the assets and disproportionately generate the outputs that define national prosperity. Likewise, more sophisticated understandings are emerging of how regions are differentiating and of how regional prosperity emanates from unique concentrations and interactions of assets, market operations, and enabling environment to improve the efficiency and productivity of local economic activity. Given that, it is clear to Brookings and RW Ventures that the nation and its regions would be better served by the development of comprehensive, integrated, collaborative, and operable strategies tailored to the opportunities in particular regions. With such plans in hand, federal, state, and philanthropic actors will be able to approach metros not as problems requiring programmatic handouts but as compelling, individual investment opportunities for driving national prosperity.

Hence the metropolitan business planning concept: Given the needs of the moment, Brookings believes—and seeks to demonstrate—that the concept of metropolitan business planning offers a powerful new approach to regional economic development.

Metro business planning adapts the discipline of private-sector business planning to the task of regional development. Along these lines, the business planning process enables a region to undertake a deep analysis of its assets, marketplace, and economic performance; identify specific, measurable *goals*; formulate key *strategies* for achieving those goals; and create the *programs, policies, products and other interventions* required in order to carry out each strategy. This then gives rise to a series of *operational and financial implications*, identifying the institutional actors that will be responsible for carrying out each strategy, what they will need to do their job effectively and what kind of resources, including from the federal and state governments, are necessary for the plan to succeed. Finally, MBPs approach economic development as a disciplined business enterprise and specify *performance outcomes* and anticipated *return on investment*. The plans can then be used to restructure federal, state, and philanthropic engagement in ways that invert the current top-down, highly siloed, and often ineffective approach to cities and metropolitan areas while bringing new efficiency to development activity.

It was this approach to regional planning that Brookings and RW Ventures undertook to co-develop with a small number of U.S. metropolitan regions in winter 2009–2010. Three varied metropolitan areas—Northeast Ohio, Minneapolis Saint Paul, and Puget Sound (Seattle)—were chosen to co-develop and pilot the concept, and through the course of 2010 each of the pilot sites worked closely with Brookings and RW Ventures to craft an indigenous local plan and advance an initial concrete initiative for release at the Metro Program's December 2010 Chicago Global Metro Summit. All three metros have now produced major multi-dimensional plans and are currently working on the implementation of their initial strategic initiatives with substantial momentum in their home regions.

Overall, the three pilots have so far been highly successful and, as hoped, the pilot regions and Brookings team have refined and continued to co-invent the MBP approach. Now, Brookings and RW Ventures are seeking additional metropolitan partners to continue and expand this innovation by launching a second series of metropolitan business plans.

THE OPPORTUNITY: PROJECT SCOPE AND DELIVERABLES

In order to launch this next round of work Brookings seeks teams from four to six more U.S. metro regions with which to collaborate.

Project Scope

As with the first set of pilots, the aim is to demonstrate how this ground-up approach of strategic, integrated, metropolitan business planning and strategy implementation can work and, in parallel, to demonstrate a new relationship between governments, private and civic sector institutions and U.S. metropolitan areas. As before, Brookings seeks to facilitate regional strategy development that:

- Helps regions "change the game" in their economies by producing demonstrably improved economic outcomes
- Helps develop and highlight new and best practices for achieving productive, inclusive, and sustainable growth in U.S. metropolitan areas, and so the nation
- Helps accelerate the emergence of strong metropolitan leadership networks and institutional capacity
- Facilitates peer learning across pilot regions

At the same time, Brookings and RW Ventures seek to supplement the first round of pilots with additional ones that extend the approach to different geographies and types of regional economy, and that offer additional strategic opportunities to move toward the next economy (export-led, low-carbon, innovation-driven and opportunity rich).

Along these lines, Brookings and RW Ventures seek expressions of interest in partnering from metro-based teams interested in delivering a substantial draft MBP by late summer 2012.

Deliverables

Brookings and RW Ventures will work with partners to apply, improve, and adapt the general MBP template that was worked out in the first round of pilots and that will serve as a common starting point for work in the new pilot regions.

In addition to preparing a MBP, each region will prepare a Metropolitan Investment Prospectus, and later a policy implementation memo, based on its MBP.

1. Metropolitan Business Plan

The MBP itself is comprised of two distinct components. The first, the Strategic Overview, entails applying the business planning steps of market analysis, mission and goal determination, and strategy development comprehensively across all areas of the economy. The template organizes this analysis and strategy development around five "leverage points," further described in the concept paper. (The MBPs of the initial three pilot regions are also available.) The second component, the Lead Initiative, develops a full business plan—adding the steps of product development, operational and financial planning and output projections and monitoring—for a lead catalytic strategy (selected from among the strategies developed in the Strategic Overview).

(A) Strategic Overview: The planning process for each pilot region will begin with a review of existing regional strategy and project documents to extract and synthesize current work. It is anticipated that high-level mission, values, goals, elements of market analysis, and varied strategies and projects can be identified and organized in the context of the Metropolitan Business Plan template.

Brookings will provide key market data on metropolitan status and performance with respect to the leverage points, using a consistent set of nationally available indicators across all pilot regions. This will serve as a concise and general "baseline" assessment of the pilot region.

This high-level market analysis will serve as a starting point for finer-grained, more indigenous inquiry aimed at developing a profound, multi-dimensional understanding of the region's unique assets, challenges, and opportunities, enabling development of tailored goals and strategies across the linked areas of the economy.

(B) Lead Initiative: Local partners will also identify and justify with high-quality, detailed business analysis a specific, highly focused lead strategy in the region that responds to opportunities identified by the baseline analysis, and to drill

down through the rest of the elements of a full business plan—specifying the design of core initiatives, products, and policies and operational and financial characteristics for implementation. This deeper "dive" will exhibit regional, comprehensive, or integrated cross-sector thinking and advance a bold strategic initiative that is already underway or could in the project period become investment-ready. (For examples see the MBPs and prospectuses from the first three pilot sites.) Brookings and RW Ventures will help local teams choose one or more key initiatives to develop with a high level of detail, carrying it through the remainder of the business planning process.

Together, the Strategic Overview and the Lead Initiative will clearly articulate the elements of a business plan, including:

- ✓ the metro's development mission or vision
- ✓ a market scan to capture the reality of the regional economy, with additional narrowly focused analysis making the strategic and business case for undertaking key development initiatives
- ✓ overarching goals, highlighting, in particular, goals for key development initiatives
- ✓ strategies for achieving desired goals, with greatest detail for key development initiatives
- ✓ the products, services, policies, and programs to be implemented to pursue key development initiatives
- ✓ specific organizational and operational implications for key development initiatives, including performance metrics, institutional roles and accountability for implementation
- ✓ financial statements for key development initiatives showing project budget and resource needs (including the proposed use of investor funding)
- ✓ projected measurable outcomes suitable for achieving the overall goals and vision and demonstrating a return to investors

2. Metropolitan Investment Prospectus

MBPs articulate how a metropolitan area will increase outputs, revenues, and employment, providing returns to governmental and other investors (in the form of increased tax collections and reduced welfare costs, for example). For the Lead

Initiative, therefore, Brookings and RW Ventures will work with each pilot region to develop a short and concise Metropolitan Investment Prospectus that will present the investment opportunity, specific "asks" and returns, and form the basis for development of a new federal /state / metropolitan relationship.

3. Policy Implementation Memo

Drawing on and complementing the locally developed Metropolitan Business Plans and prospectuses, Brookings will work with the regions to draft a policy implementation memo that articulates the implications of the pilot regions' initiative for federal, state, or local policy response and reform. This memo will highlight the approach and synthesize the pilot projects' "asks" and implementation implications, in order to then propose a bold new policy direction, along with specific policy proposals, for federal and state investment in the MBP and particularly its Lead Initiative.

*

All of these deliverables will be published and released to key stakeholders and the public on the web, through published papers, and through local and Washington events.

WORK PLAN AND TEAM

To ensure successful development and execution of the business plans, careful attention must be paid to adherence to a clear work plan and the maintenance of a sound team and division of labor.

Work plan

Strong project management will be critical in developing the business plan. Brookings therefore proposes a broad "aspirational" work plan something like the following, though this outline should be adjusted to the degree of work and capacity available in each region. Note that a serious commitment of at least two years' duration is requested for development of the MBP and Lead Initiative, given that Brookings believes that sustained work is needed to assure successful on-going implementation.

Kick-off Meeting
Each MBP will begin with a kick-off meeting designed to introduce the Brookings and core local teams to each other and to develop a more detailed, agreed-upon project plan, including clarification of roles and responsibilities. The meeting will allow, as desired or needed, for further introduction of the Brookings "next economy" vision; more discussion of the MBP concept and methodology; and agreement on a work plan. A key outcome of the meeting will be the identification of a core pilot-region team (including convening organization, lead actors, and strong analytic team) as well as a plan for ensuring deep "buy-in" in the region among locally-based individuals/organizations whose involvement is critical to the ultimate success of the plan.

Phase 1: Strategic Overview

After the kick-off meeting, the next five months will be focused on assembly and completion of the comprehensive market analysis and development of the integrated strategies across the leverage points. This work on the Strategic Overview entails not just deep analytics but broad engagement to build institutional capacity both to undertake the necessary work and to develop and implement high quality MBPs. Brookings will be responsible for supplying basic market scan data for the region as situated among the largest 100 metros in the U.S. Each partner metro will be responsible for producing and organizing the full assessment by supplementing the Brookings data feed with local market intelligence and data. Brookings expects each region will conduct significant, multi-dimensional, in-depth, and rigorous empirical and qualitative research (in collaboration with the Brookings / RW Ventures management team) aimed at situating the opportunities and deficits of the regional economy as a context for developing strategic initiatives.

Based on the comprehensive market analysis, local teams will then identify strategies to address challenges and opportunities within and across each of the leverage points, as appropriate.

All of the work will necessarily be led and conducted by the local project team and stakeholders. Brookings and RW Ventures will provide data, analytic advice and ideas on best practices and strategies. Brookings in RW Ventures will also offer ideas on how best to develop community buy-in for the integrated set of strategies that will work best for each region.

Toward the end of this phase, we anticipate a cross-team meeting will take place to enable sites to share their analysis and strategies and provide each other feedback.

Phase 2: Lead Initiative

Meeting 2

Held about five months after the project kick-off meetings, a second on-site meeting will be held to accelerate development of the Lead Initiative. This meeting may include additional stakeholders as appropriate, including program providers, private-sector firms, and political leaders, as determined necessary to the needed work of identifying and designing the Lead Initiative by the local project team (with input and advice from Brookings).

The primary objective of this planning session is to further engage key stakeholders in identifying and developing the Lead Initiative.

Lead Initiative Design

After Meeting 2 the next four months will be focused on designing the Lead Initiative, including further institutional engagement and capacity development. Each partner metro will be responsible for designing—with its expert consultants and Brookings / RW Ventures advice—the full initiative. At this stage, Brookings expects each region will develop a detailed, well-argued, compelling business plan for a game-changing catalytic initiative aimed at seizing a key economic development opportunity. This work will be conducted by the local project team with guidance and comment from the Brookings / RW Ventures management team as well as top-quality consultants or outside experts.

The local project manager will assume responsibility for assembling and producing the Lead Initiative. Brookings / RW Ventures will continue to provide input and access to expert resources.

Phase 3: New Partnerships and Implementation

Once the draft MBP is developed, the prospectus and policy brief are prepared, as a prelude to further engaging stakeholders both locally and particularly in state and federal government. With those documents completed, the projects third phase turns toward raising the resources and building the institutions to deliver the Lead Initiative.

Meeting 3

The objective of Meeting 3 will be to provide final comments and move towards finalizing the MBP, engaging further stakeholders, and initiating implementation, including exploring federal, state, philanthropic, and private sector engagement and investment.

It is envisioned that the local project team will assume responsibility for writing the full business plan, including the Strategic Overview and Lead Initiative, as well as the prospectus and policy brief. Brookings / RW Ventures will help guide the process, provide extensive input and access to relevant experts, and offer quality control.

Implementation

Completion of the draft MBP is, we should stress, not the end of the process. In fact, it's only the beginning. These are not conventional, static, aspirational plans, but detailed business and operational plans for launching new programs and ventures. Implementation is the point of the exercise. Therefore, Metro Business Plan partners must make a serious, multi-year commitment to not only develop game-changing plans and initiatives but see that they are executed. Sites should therefore plan to dedicate serious staff time and resources to following up on their plan and initiative with key stakeholders; federal, state, and local policymakers and elected officials; and the philanthropic and private sectors. Demonstrable impact must be the key result of this work.

The plan and its initiatives belong to the local region and its project team and so the region will assume responsibility for their implementation. Brookings / RW Ventures will provide advice and support for at least a year after the initial plan has been completed.

We anticipate a major public event to showcase the next round of MBPs during the second half of 2012.

Team and Roles

A driving force behind this project is the belief that the best regional solutions must be highly tailored to the circumstances of particular regions and so must be developed locally through the leadership of deeply involved government, civic, and private-sector actors. The preferred team structure for the Metropolitan Business Planning project reflects this by placing local economic development actors at the center of the process, with Brookings and RW Ventures playing supportive project management, assistance, and coordinating roles as the plans are developed.

Identifying a robust team of local leaders in each region will be essential to the success of the project. Each team should be spearheaded by a well-established civic leader or institution with a regional perspective and the ability to convene a wide range of stakeholders throughout the course of the project. In addition, a lead author-analyst and a project manager/coordinator with strong technical expertise and access to analytic and other support staff will be necessary to execute the day-to-day work of developing the elements of the plan. The number of individual team members and division of roles and responsibilities among them is necessarily flexible, and will be determined locally in the context of each region's existing network of organizations and relationships.

In short, the local team's ability to develop and produce locally on a rigorous timeline a hard-hitting, well-analyzed Metropolitan Business Plan is of critical importance.

Adequate funding of a highly skilled local project team will be a critical requirement for participation in the project.

The regional team will, in this respect:

- Identify and engage the necessary stakeholders
- Select and organize the needed work team
- Conduct the necessary analyses
- Organize and manage development of the MBP and all aspects of the project
- Produce the documents described above

Brookings and RW Ventures will co-manage the overall project, providing:

- Project framing / context
- Standardized document templates (if needed)
- Facilitation (if needed) of collective kick-off meeting and local working sessions for each region
- Standardized market assessment data
- Ongoing technical assistance and content expertise
- Analytic support and writing guidance, particularly during Investment Prospectus development
- Facilitation of peer learning sessions
- Guidance on publication of project documents
- Support in interface with federal and state agencies and administration

While Brookings' intention is to help convene leadership and then co-develop each MBP, the primary orientation remains "bottom-up." Brookings believes strong strategy and change has to come from and be driven by differentiated regions acting in their own right, so we are looking for energetic, effective lead partners to drive plan creation in each region. The resulting plans will be "owned" by each metro.

TEAM SELECTION CRITERIA

As many as four to six metro-area teams will be selected to begin participation in spring 2011 and we hope that several will be far enough along in fall 2012 to go public with powerful new MBPs. Selections of partner-teams will be made based on the following criteria:

- Degree of existing regional planning and vision, around which substantial consensus has been built
- Critical mass of effective, regionally focused leadership who are already organized to effectively work together
- Significant data and analytic capacity, with proven ability to deliver results. Access to top-quality consultancy or other analytic advice, writing capacity, and project-management services is a major plus

- State of development of qualified specific key initiatives which can be tied to quantifiable plan outcomes
- Ability to raise significant funding from foundation or other resources to help support both Brookings / RW Ventures engagement and high-quality local project capacity
- Representation of varying types of regional economies and specific initiatives
- Orientation to one or more of Brookings' "next economy" directionals of exports, the low-carbon economy, innovation, or "opportunity"
- Familiarity and experience working with federal and state policymakers
- Long-term commitment to the partnership and MBP process, and likely achievement of concrete initiative implementation

Responding to this RPP: Proposal Elements and Next Steps

Team proposals should include the following key elements:

- ✓ Cover letter expressing interest in participation. The cover letter should review key local assets for project success, including existing relevant strategy documents and development activities; stakeholder engagement, institutional capacity, and proposed team structure; local and consultants' analytic capacity; community and philanthropic support

- ✓ Existing foundational analysis that identifies local assets and challenges

- ✓ Existing regional planning documents, studies and reports, evidencing relevant preexisting strategy work

- ✓ A document introducing a proposed local team structure, including roles outlined above in "Team Structure and Roles." This would include bios and/or organizational profiles

- ✓ A document anticipating budget needs and financial resources

Local teams interested in learning more about the Metropolitan Business Planning project are encouraged to attend the forum Brookings is hosting on the concept in Washington on April 11, which will be followed by an invitation-only afternoon meeting for teams

invited to respond to this RPP. Teams with specific questions as they begin to assemble their materials in response to this RPP are invited to contact Brookings or RW Ventures for assistance or to set up a phone conference (see "Contact Information" below).

Materials should be submitted **electronically** no later than **May 2, 2011** (see "Contact Information" below for recipients). Candidates will be notified of their selection by **May 30, 2011**.

Following a review of submissions, candidate regions may be contacted as necessary for a follow-up telephone or in-person interview to clarify any questions and supplement the electronic proposal materials.

Contact Information

For questions regarding this RPP, please call either of the contacts below:

Amy Liu, Metropolitan Policy Program at Brookings (aliu@brookings.edu)

Robert Weissbourd, RW Ventures (bob@weissbourd.com)

To respond to this RPP, please send materials electronically to *both* Brookings and RW Ventures:

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Gretchen Kosarko at RW Ventures at (Gretchen@rw-ventures.com)

ASU W. P. CAREY SCHOOL of BUSINESS

L. WILLIAM SEIDMAN RESEARCH INSTITUTE

Aerospace & Defense Industry in Arizona

An Intellectual Roadmap for Economic Development

March 29, 2011

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Executive Summary

Arizona's Aerospace & Defense (A&D) industry faces several challenges to its continued growth thanks to an increasingly competitive economic landscape and the changing technological needs of the military.

This current report, commissioned by Science Foundation Arizona (SFAz):

- summarizes the current state of the A&D industry within Arizona;
- identifies key players and developments that could yield additional growth to the industry;
- provides an overview of best practice in other states;
- evaluates the threats, opportunities, weaknesses and strengths of Arizona's A&D industry;
- identifies a range of strategic choices open to the A&D industry within Arizona today; and
- recommends a plan to enable the industry to maximize its opportunities while simultaneously minimizing the impact of any weaknesses and protecting itself against threats.

Drawing from a literature review and in-depth interviews with five industry stakeholders, the report examines the business environment, the supply chain, research competitiveness, workforce, educational policies, and the case for an Aerospace Institute, leading to the development of seven key messages:

- Arizona needs small businesses and entrepreneurs to support the operations of medium and large manufacturers, and to drive the innovation of new technologies or new applications of existing technologies;
- The optimal strategy for promoting growth within the A&D industry is to focus upon established operations and competencies;
- Arizona's congressional delegation needs to take a more proactive role within industry caucuses, and more aggressively champion investment by the Department of Defense within the State;
- An Arizona Aerospace & Defense Institute (ADI) is needed to align research and development with commercial and military needs;
- The provision of STEM education within Arizona should be advanced;
- Gaps within Arizona's A&D industry should be acknowledged, but not all of them need to be necessarily addressed;

- The industry needs to leverage local strengths in research and geography, complemented by targeted tax incentives, to foster future growth.

A comparison with three competitor states (Alabama, Florida and Virginia) is also made to provide further insight into best practice, highlighting both the importance of federal contracts and collaboration between stakeholders.

Collating these preliminary analyses within a point of intersection framework, the report recommends the following roadmap as a springboard to the future success of the Arizona A&D industry:

- Arizona's A&D industry is currently quite disparate and will benefit from greater collaboration between industry, research and the military;
- This collaboration is ideally best served by the establishment of an Aerospace Institute, facilitating the exchange of ideas and needs between all stakeholders;
- Current core competencies in areas such as national defense, cyber warfare, intelligence and surveillance, special operations, counter terrorism and border security have to become the main focus of future development;
- The Department of Defense is receptive to working outside the confines of Washington, DC. However, to take advantage of this opportunity, Arizona needs much greater support from its congressional delegation;
- Arizona's universities must work hand-in-hand with the business development teams at very large manufacturers such as Boeing and Raytheon to maximize share of the research dollars available, and produce work of value both commercially and militarily;
- Closely aligning the efforts of research and industry around established themes in A&D and through collaborative efforts, guided by the likes of an Aerospace Institute, will enable Arizona to offer the Department of Defense beginning-to-end solutions based on existing and solid competitive advantages;
- Further analysis is required to account for the lack of Second-Tier Suppliers within the State, the impact this has upon the industry, and the optimum strategy to remedy the situation.

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1. Introduction

Arizona's Aerospace & Defense (A&D) industry currently contributes $8.8 billion in gross state product to the local economy and is responsible for 93,800 jobs. (Seidman Research Institute, 2010a) The major contractors in the State include Raytheon Missile Systems, The Boeing Company, Honeywell Aerospace and General Dynamics C-4 Systems. These four companies alone contribute approximately 83% of private A&D jobs in Arizona based on a recent survey (Seidman Research Institute, 2010a). However, the industry faces numerous challenges as the economic landscape becomes more competitive and the technological requirements of the military continue to evolve.

The purpose of this report, commissioned by Science Foundation Arizona, is to meet these challenges head-on by outlining the necessary steps for the establishment of an Aerospace Institute within the State. Building upon current local strengths, and with some financial support from the Department of Defense, this Institute would enjoy a competitive advantage by crucially fostering the commercial developments needed to solidify A&D as perhaps the most important base industry component of the Arizona economy.

The objectives of this current report are to:

- summarize the current state of the A&D industry within Arizona;
- identify key industries and suppliers that could yield additional growth to the industry;
- describe key activities and best practice in other states;
- evaluate the threats and opportunities of the external environment, plus weaknesses and strengths of the industry's internal environment via a TOWS analysis[1];
- utilize this TOWS analysis to enhance understanding of the strategic choices faced by the A&D industry; and
- recommend a plan to enable the industry to maximize its opportunities while simultaneously minimizing the impact of any weaknesses and protecting itself against threats.

To meet these objectives, Section 2 draws from a literature review and in-depth, semi-structured interviews with five key stakeholders to describe the current economic landscape. Section 3 provides an overview of activities and best practice at three competitor States. Section 4 examines the linkages

[1] A TOWS matrix is a variant of a SWOT analysis used to evaluate the threats, opportunities, weaknesses and strengths involved in a project, business venture, industry or any situation requiring a decision.

between key players within the industry, focusing upon their points of intersection. In Section 5, a TOWS matrix is applied to the Arizonan A&D industry to highlight the strategic choices that need to be made to maximize the industry's strengths, circumvent weaknesses, capitalize on opportunities and manage threats. Our conclusions and recommendations are outlined in Section 6.

2. Literature Review and Analysis

2.1 Literature Review

The Arizonan A&D industry continues to attract significant interest within military, government and academic circles, resulting in a broad collection of reports, plans and studies. Table 1 lists the key existing literature reviewed for this report, primarily based upon Science Foundation Arizona recommendations and Arizona Commerce Authority commissioned reports:

Table 1: List of Literature Reviewed for This Report

AUTHOR	PUBLICATION
ANGLE Technology Group	• AZ Aerospace, Defense and Avionics Industries Study (2008)
Applied Economics	• Arizona Supply Chain Analysis (2005)
Arizona Aerospace & Defense Commission	• Progress Reports (2005) (2006) (2008) (2009) • Strategic Plans (2008) (2009) (2010) • Variety of Issue Forms submitted to the AADC
Arizona Arts, Sciences & Technology Academy	• Astronomy, Planetary Sciences, and Space Sciences Research Opportunities to Advance Arizona's Economic Growth (2007)
Arizona Commerce Authority	• Arizona Center of Excellence (2010)
Arizona Department of Commerce	• Arizona Military Regional Compatibility Project: Project Update #12 (2007)
Battelle Technology Partnership Practice	• Building from a Position of Strength: Arizona Advanced Communications and Information Technology Roadmap (2004)
The Gold Group	• Creating an Arizona Aerospace Institute (2008)
The Maguire Company	• Economic Impact of Arizona's Principal Military Operations (2008)
L William Seidman Research Institute (ASU)	• The Boeing Company – Economic Impact on Arizona (2006) (2010) • Economic Impact of the Boeing Led Ground-Based Midcourse Defense Program: Arizona Operations 2007 (2008) • Economic Impact of Raytheon Missile Systems (2009) • Economic Impact of Aerospace & Defense Firms on the State of Arizona (2010)

Several themes of relevance for the Arizonan A&D industry emerged from this literature review, namely:

a. The Business Environment
b. The Supply Chain
c. Research Competitiveness
d. Workforce/STEM Education
e. Aerospace Institute

The first four themes reflect the strategy adopted by the Arizona Aerospace & Defense Commission and outlined in their most recent annual report (Arizona Aerospace & Defense Commission, 2010).

2.1.1 The Business Environment

Improvements to the business environment are an essential pre-requisite for the development of a robust A&D industry within the State. This will initially require a clear and thorough understanding of both the scope and impact of A&D upon the Arizonan economy. In 2010, The Arizona Aerospace & Defense Commission (AADC) commissioned an economic impact study to quantify the direct, induced and indirect impacts of A&D firms within the State. This study estimated that the A&D industry in 2009 contributed $8.8 billion in gross state product and helped create 93,839 jobs (Seidman Research Institute, 2010a). It also concluded that Arizona was the eighth highest U.S. state in terms of A&D employment, with employees receiving salaries 52% higher than the average Arizonan wage (ANGLE Technology Group, 2008).

One important business environment factor often overlooked is the economic impact of the military installations upon the State. A recent study by The Maguire Company in collaboration with ESI, concluded that major military operations within Arizona created 96,328 jobs and generated $9.1 billion in economic output for the local economy (The Maguire Company, 2008). That's greater than the economic output of Arizona's largest private employers, Wal-Mart and Banner Health System.

The AADC has taken the lead in trying to improve the local business environment by collaborating with the Commerce Board's A&D Growth Sector Committee, and identifying key legislative incentives to help retain and foster growth within the industry (Arizona Aerospace & Defense Commission, 2010). Some of these programs include developing enterprise zones which incentivize investment through premium tax credits and property tax reductions, initiating a research and development tax credit, and reducing the corporate tax rate to below 5%.

2.1.2 The Supply Chain

In 2009, the direct impact of supplier purchases from A&D firms exceeded $1.4 billion, generating 17,059 jobs (Seidman Research Institute, 2010a). A recent report criticized the lack of interaction between large and medium manufacturers within the State and the host of suppliers that support their efforts (ANGLE Technology Group, 2008). Long-standing relationships with out-of-state suppliers, coupled with a lack of awareness about local ones, are highlighted as reasons for the lack of collaboration between suppliers and manufacturers; and this area is worthy of future study via a census or survey of A&D suppliers in Arizona.

Nevertheless, the AADC has taken steps to improve the linkage between manufacturers and suppliers via the formation of a subcommittee to actively engage with professional associations such as the ATC, NDIA, Arizona MEP, ACE, the Armed Forces Communications Electronics Association and the Southwest Defense Alliance. This subcommittee is also encouraging the creation of a Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Matching Fund Program similar to existing schemes in Kentucky, North Carolina, Oklahoma and Michigan (Arizona Aerospace & Defense Commission, 2010).

Local and regional tools are also being leveraged to enhance links between suppliers and buyers. For example, the City of Tucson operates AZBusinessLinc, an on-line supplier database that can be searched by potential buyers; and connectory.com, a Californian business-to-business, buyer-supplier marketing and communication tool providing a regional source for products, technologies and services (Applied Economics, 2005).

2.1.3 Research Competitiveness

The research output of Arizona's three major universities (ASU, University of Arizona and Northern Arizona University) plus the Embry Riddle Aeronautical University is also highlighted within the literature as a key competitive advantage. Collectively offering important technological research opportunities for the A&D industry, this topic will be discussed in more detail in Section 4.

2.1.4 Workforce/STEM Education

The literature review also highlighted the variety of technical schools within Arizona dedicated to the supply of skilled labor to large and medium sized A&D firms. Some reference was made to the lack of qualified graduate and post-graduate level workers in the areas of science, technology, engineering and

mathematics (STEM) - a national problem currently affecting a variety of industries (ACT, Inc., 2010). This has already prompted the State to invest in K-12 STEM education in accordance with the Governor's P20 Council recommendations and through merit-based scholarships. However, greater effort is required to raise STEM education to a level that allows Arizona to compete nationally and internationally.

2.1.5 Aerospace Institute

The literature also emphasizes the need for an Arizona Aerospace Institution, to serve as a focal point for meeting the critical needs of the industry. For example, a 2008 report produced by The Gold Group concluded that the establishment of an Aerospace Institute focusing on select high value services and meeting the needs of both in state and out of state aerospace industry stakeholders is essential to help protect and grow the A&D industry within Arizona. Positioning the Institute as a 'one stop shop' for industry expertise and knowledge, The Gold Group recommended a primary focus upon three core competencies:

1. Machine to machine and human to machine interactions and integration;
2. Information management and information assurance; and
3. Visioning, Simulation, and Modeling.

This report also suggested that an Institute could facilitate workforce development, accelerate the commercialization of advanced technologies and provide an environment for collaboration between business, government, the military and academia.

An advisory board, recruited by the Speaker of the Arizona House of Representatives, was also charged in 2009 with defining the mission of the Institute and securing a consortium of industry leaders committed to addressing the industry's most critical needs. Their initial vision is of a premier research and innovation center focusing on eight key areas:

1. Next Gen;
2. Human Performance Enhancement (Human-Interface Cognitive, Modeling, Simulation & Design);
3. Optical Imaging Sciences;
4. Aerospace Medicine;

5. Data & Information Intelligence/Security;
6. Sustainable Energies (Engines/Energy, Battery, Storage, etc);
7. UAV Development & Testing/Education & Training;
8. Space & Missile.

The advisory board argues that an Aerospace Institute is needed to not only maintain and grow existing A&D relationships within Arizona. It's needed to also aggressively pursue federal and private industry research and manufacturing opportunities.

The lack of progress within this area is probably due to a variety of reasons. Is the vision of sufficient appeal? Have the champions of an Aerospace Institute been bold enough in making this become a reality? Were the right people originally put in place? Nevertheless, the literature at least suggests that the desire for an Arizonan Institute exists.

2.2 Industry Leader Interviews

To build upon the 5 initial themes outlined in Section 2.1, and acquire further insight into the current state of the Arizonan A&D industry, five semi-structured, in-depth interviews were held with industry, government and research leaders, recommended by Science Foundation Arizona and ASU. The leaders interviewed were:

- Vicki Panhuise - Previous Vice President of Commercial & Military Helicopters at Honeywell and Chair of the Arizona Aerospace & Defense Commission;
- Werner Dahm – Director of the Security & Defense System Initiative (SDSI) at Arizona State University;
- Mitzi Montoya – Executive Dean of the College of Technology & Innovation at Arizona State University;
- Steven Kimmel – Senior Vice President, Corporate Development at Alion Science and Technology;
- Dee H. Andrews – Technical Director of the Warfighter Training Research Division of the Air Force Research Laboratory in Mesa, AZ.

Prior to interview commencement, a generic framework of twelve exploratory themes was prepared, illustrated in Table 2. However, a semi-structured approach was pursued to enable the interviewer to

tailor the order and expression of the questions to the interview context/situation, and ask additional questions in direct response to an interviewee's comments.

Table 2: Industry Stakeholder In-depth Interview Exploratory Framework of Questions

1	What are the linkages in the aerospace & defense system in AZ?
2	What role should government take in the economic development of the A&D industry?
3	What are the major challenges/roadblocks in developing an aerospace institute in AZ?
4	What role should tax incentives play in economic development?
5	What role should industry play?
6	What role should research entities play?
7	What role should the military play?
8	Where is the breakdown in communication between the major players in the industry?
9	What challenges does AZ face in terms of workforce development?
10	Which states do you see as leaders in collaborative initiatives?
11	What are the challenges/opportunities in AZ for commercializing new technologies?
12	What is being done to develop small businesses in the State (SBIR/STTR)?

Seven discernable, common themes emerged from these interviews:

1. **Small business support and entrepreneurial development**: Arizona needs small businesses and entrepreneurs to support the operations of medium and large manufacturers, and to drive the innovation of new technologies or new applications of those technologies. Too many businesses currently operate within small restrictive circles, and would therefore benefit from a forum in which they can engage and collaborate with research institutions, large manufacturers and military entities.

2. **Focus upon existing State competencies:** The optimal strategy for promoting growth within the A&D industry is to focus upon established operations and competencies. State industries are heavily influenced by decisions made at the federal level and can take many decades to evolve (e.g. industry growth around the Tennessee Valley Authority was established by FDR in support of "The New Deal"). Successful regional economic development strategies usually focus upon the core competencies of a State, encouraging an industry's key stakeholders to collaborate around those core competencies. Arizona's A&D industry will therefore benefit most from collaboration between research, industry and the military working within established operations and competencies.

3. **Secure congressional support:** All interviewees called for Arizona's congressional delegation to take a more proactive role within industry caucuses, and encourage greater levels of investment by the Department of Defense within the State.

4. **Align research and development:** An Arizona Aerospace & Defense Institute (ADI) is needed to engage with, and function as, a link between, all of the players in the industry, thereby enabling the flow of information and aligning research and development efforts with the requirements of the military.

5. **Nurture STEM education:** Consistent with the literature review, the interviewees argued that STEM education is a national problem that merits immediate attention. However, the ADI could play a key role by coordinating the efforts of government and private industry in the advancement of STEM education within Arizona.

6. **Acknowledge existing gaps:** Arizona's A&D industry currently suffers from a number of gaps, due in no small part to a lack of coordination and collaboration between research, industry and the military. These include:

    a. a lack of second-tier suppliers supporting large manufacturers in the State;
    b. lost opportunities within value engineering, directed energy and optics;
    c. IP ownership issues which undermine collaboration between industry and universities;
    d. a failure to correlate the development of new technologies with the needs of both military and civilian consumers.

    Some, but not all, of these gaps should be addressed.

7. **Leverage strengths to foster growth:** Arizona has several strengths that provide a solid foundation for future industry growth. For example, Arizona's research and education entities (echoing the literature review) and its geographic location as a border state collectively offer the Department of Homeland Security some of the U.S.'s best research and testing capabilities. The AADC's efforts to improve the business environment through targeted tax incentives and

economic development programs is also highlighted for positioning Arizona as a prime location for A&D operations.

3. Competitor Strategies

Building upon the literature review and the five in-depth interviews, an analysis of best practice in competitor states also provides pointers for the continued development of the A&D industry in Arizona. In particular, Science Foundation Arizona requested a review of collaborative programs and best practice in Alabama, Florida and Virginia. Table 3 summarizes the publications reviewed for each of these States.

Table 3: Sources Consulted for Competitor States

STATE	PUBLICATIONS
Alabama	• The Alabama Development Guide (2010) • Best Practices in State Science & Technology Policies (Collaborative Economics Inc., 2009) • Aerospace & Defense White Paper (Alabama Aerospace & Defense Committee, 2009) • White Paper on Commercialization (Alabama Commercialization Committee, 2009) • Alabama Science & Technology Roadmap (Collaborative Economics, Inc., 2009)
Florida	• Modeling, Simulation & Training Overview (Metro Orlando Economic Development Commission, 2010) • Florida Defense Industry Economic Impact Analysis (Haas Center for Business Research and Economic Development, 2008)
Virginia	• The State of Virginia, U.S.A. (Virginia Economic Development Office, 2008) • National Institute of Aerospace 2009 Annual Report

All three States appear to focus on unique competitive advantages, leveraged by intermediary entities, to set their respective A&D research and economic development agendas. Some commonalities are also visible, including the establishment of each institute as a public-private or a private not-for-profit entity, affiliation programs between universities and industry partners, and Federally Funded Research and Development Centers (FFRDCs). The key strengths and characteristics of each state can be summarized as follows.

3.1 Alabama

The history of the A&D industry in Alabama can be traced back to the 1950s when the federal government located Wernher von Braun's rocket science team at the Redstone Arsenal in Huntsville.

Since that time, over 200 aerospace firms have clustered around Huntsville, illustrating the profound, long-term effects of federal decisions pertaining to the location of specific installations, projects or initiatives. This is why states need to focus solely upon things they can control and make sustained, long-term investment in existing core competencies.

Alabama's A&D industry can be explained in part with reference to five core strengths:

a. substantial SBIR investment (20% per $1,000 GDP compared to a national average of 8%);
b. per capita R&D expenditures within the State are 24% higher than for the U.S (although per capita R&D investment is only $3 compared to a national average of $11)
c. the State is home to military and government installations such as Fort Rucker, Maxwell Air Force Base, Marshall Space Flight Center and Redstone Arsenal;
d. over 330 aerospace companies currently operate within Alabama;
e. Cummings Research Park is the second largest research park in the nation.

3.2 Florida

The genesis of the A&D industry in Florida dates back to the transfer of a U.S. Navy training facility from Virginia to Florida in 1969. By 1995, all four military services had relocated their training facilities to Florida; and the State today specializes in modeling, simulation & training (MS&T), hosting over 200 companies within that area collectively accounting for 25,000 jobs. This again demonstrates how the inception of an industry within a State can depend upon external decisions about the relocation of a major program.

To encourage the growth of a robust and stable MS&T industry, Florida has also implemented long-term sustained programs that promote collaboration between stakeholders. The strength of the A&D industry within Florida today is attributed to a large extent to the following:

a. the State is home to the Naval Air Warfare Center Training Systems Division, plus the Army's Program Executive Office, Simulation Training and Instrumentation facilities;
b. the University of Central Florida offers leading graduate and postgraduate programs in simulation and training systems, as well as founding the Institute for Simulation and Training – a major source of internships, scholarships and grants for the MS&T industry;

c. significant support is received from The National Center for Simulation, a non-profit organization that promotes simulation technology both within the region and nationally;
d. Florida's Center of Excellence for MS&T promotes modeling and simulation technologies across commercial and military applications;
e. Research Park promotes collaboration through mere geographic proximity;
f. Florida Department of Commerce supports Research Park through building grants;
g. Florida's congressional delegation has joined the MS&T Caucus.

3.3 Virginia

Virginia's A&D industry secured $38.8 billion in US Department of Defense Prime in 2009, positioning the State second in terms of the total value of contracts awarded (Virginia Economic Development Partnership, 2011b). This phenomenal success can be attributed, at least in part, to the following:

a. proximity to major government agencies;
b. housing of important military installations;
c. 6% corporate income tax for the last 30 years;
d. some of the lowest worker's compensation and unemployment insurance payroll expenses within the U.S.;
e. availability of undergraduate and graduate aerospace engineering programs at Virginia Tech, University of Virginia, Old Dominion University and the National Institute of Aerospace;
f. major Research and Development assets such as NASA's Langley Research Center, Virginia Space Grant Consortium, Mid-Atlantic Regional Spaceport and the Commonwealth Center for Aerospace Propulsion Systems
g. ongoing financial commitments from the State of Virginia

Virginia's National Institute of Aerospace (NIA) Research, Education and Outreach activities is also a prime example of best practice. Conducting a broad range of research sponsored by government agencies and the aerospace industry (from space exploration to material science), this is frequently pursued in collaboration with other institutions worldwide, courtesy of the NIA's partnerships with industry and university partners, and the Institute's willingness to share intellectual property to meet research objectives.

The successful development of an A&D industry within Alabama, Florida and Virginia illustrates how competitive advantage can be attained outside DC. The high value of DOD contracts secured, for example, by Virginia in 2009 suggests that the Department of Defense is receptive to decentralization. Arizona needs to be more aggressive in its pursuit of these opportunities. The estimated $8.8 billion dollars that the A&D industry brings to the State is based solely upon companies receiving federal dollars from Department of Defense contracts (Seidman Research Institute, 2010a). The importance of aggressively pursuing large federal contracts therefore cannot be overstated.

Furthermore, it should also be noted that while stakeholders often compete for similar or even the same contracts, collaboration with other stakeholders does not necessarily lead to everyone receiving a smaller piece of the pie. Having the resources of universities and other suppliers at their disposal increases the competitive effectiveness of contractors, illustrated by this comment from Thomas L. Baptiste, President of the National Center for Simulation in Florida:

> "Orlando and Central Florida are the epicenter for Modeling and Simulation--when you combine the power of the Research Park, close ties between a World Class University, Industry and Team Orlando you produce a synergy found nowhere else in the world. Companies who want to be serious players in the Modeling and Simulation Industry need to consider focusing their efforts on Orlando and Central Florida." (National Center for Simulation, 2009)

4. Economic Landscape & Key Players - Points of Intersection

This section will attempt to match the major players within Arizona's A&D industry to corresponding themes in the Aerospace & Defense landscape[2], highlighting the points of intersection across industry, research institutions and the military that can be leveraged to aggressively pursue large government contracts and maximize the economic impact on the State.

4.1 Identifying Clusters

The first step in this process is the segmentation of Arizona's A&D industry into 5 segments or clusters:

a. Very Large Manufacturers (VLMs)

[2] The Points of Intersection framework uses the themes identified by the Security and Defense Systems Initiative at Arizona State University to provide a comprehensive "Security Research Space."

b. Second-Tier Suppliers

c. Research Entities

d. Workforce

e. Military Assets[3]

These clusters collectively develop nascent technologies into commercial applications used by the military. A description of each cluster and their role in Arizona's A&D industry follows to provide a macro picture of the economic landscape.

4.1.1 Very Large Manufacturers (VLMs)

VLMs represent the last step in the commercialization process of new technologies. Primarily interested in technologies with a Technology Readiness Level (TRL)[4] of 7, 8 or 9, VLMs generally do not have the capacity or expertise to develop technologies below a TRL of 5 or 6. Arizona currently has nine A&D VLMs, employing 500 to 12,000 staff respectively, listed in Table 4. VLMs receive the majority of Department of Defense dollars and rely on a network of second-tier suppliers within the State.

Table 4: Arizona's Aerospace & Defense VLMs

COMPANY	EMPLOYMENT
Raytheon Missile Systems	11,835
Honeywell Aerospace	9,716
The Boeing Company	4,853
General Dynamics C-4 System	4,000
Orbital Systems Corp.	1,317
L-3 Electro-Optical Systems	753
Goodrich Interiors	630
BAE Systems	607
Hamilton Sundstrand Aerospace	520

Source: Seidman Research Institute (2010a)

4.1.2 Second-Tier Suppliers

Second-Tier Suppliers support VLMs and display the most variance of all the clusters in terms of technology, needs and strategy. Usually specializing in a few key competencies, these are combined

[3] Clusters were identified by literature review and verified through industry leader interviews.

[4] Technology Readiness Levels range from 1 to 9 and correspond to the stages new technology passes through, from Basic principles observed and reported to actual system 'flight proven' through successful mission operations (Source: DOD (2006), Defense Acquisition Guidebook).

with relatively lower operating costs to remain competitive. The smaller size of Second-Tier Suppliers also enables them to more readily adjust their strategies to meet the changing requirements of the Department of Defense or VLMs.

Table 5 lists some of Arizona's Second-Tier Suppliers. These companies stand to benefit most from external support in the areas of training, networking and collaboration with other entities. A report by the Seidman Research Institute (2010) suggests that Arizona has a relatively small number of Second-Tier A&D Suppliers in comparison with other States, thus highlighting a potential opportunity for growing the entrepreneurial base. Further research is required to determine the relationship between suppliers and manufacturers, and the effect it has on the economic impact of the Aerospace & Defense industry in Arizona.

Table 5: Arizona's Second Tier Suppliers – Some Examples

COMPANY	EMPLOYMENT
Nammo Tally Inc.	275
Universal Avionics Systems Corp.	275
Alliant Techsystems Inc.	226
Paragon Space Development Corp.	74
Applied Energetics	49
Planetary Science Institute	38
Kutta Technologies	19
Qualtec Inc.	17
Engineering Science Analysis	10

Source: Seidman Research Institute (2010a)

4.1.3 Research Entities

Research Entities are one of Arizona's greatest resources and represent a major core competency for the State. Table 6 lists the four key players within this cluster and their core competencies. Further detail about each institution is available in the Appendix.

Table 6: Arizona's Four Lead Research Entities

INSTITUTION	CORE COMPETENCIES
Arizona State University (ASU)	• Aerodynamics and fluid mechanics, • Helicopter Electromagnetics • Nanofabrication • Control Systems • Combustion Dynamics • Planetary Sciences • Aeronautical Management Technology • ADRC • Security & Defense Systems Initiative (SDSI)
University of Arizona (UA)	• Optics • Spacecraft Design • Aerodynamics • Aircraft structures • Manufacturing • Sensors & Actuator Design • Propulsion Systems • Signal Processing • Telecommunications • Modeling & Simulation
Northern Arizona University (NAU)	• Environmental • Ecosystem • Sustainable Energy
Embry Riddle Aeronautical University (ERAU)	• Flight Engineering • Space Physics • Global Environment & Management • Global Security & Intelligence Studies • Computer Science • Aviation Business Administration • Meteorology • Safety Science • UAV • Autonomous Helicopters • Computational Fluid Dynamics • Airport Runways • Fatigue Analysis of Aircraft Structures

4.1.4 Workforce

The A&D industry requires a steady supply of Engineers and Scientists supplied by Arizona's four leading universities, alongside skilled technicians, machinists and other trades proficient in Science, Technology Engineering & Math (STEM) from Arizona's technical schools and community college system. Table 7 lists some of these institutions and the programs offered.

Table 7: Arizona's Schools & Technical Colleges

INSTITUTION	PROGRAMS OFFERED
Anthem College	Business Management, Business Networking & Security, Computer Science, Computer Aided-Drafting, Electronics Technology, Information Systems, Management, Master of Business Administration
Argosy University	Information Systems, Information Systems Management
Arizona Automotive Institute	Advanced HVAC and Basic Refrigeration, Automotive Service Technology, Diesel - Heavy Truck, HVAC and Basic Refrigeration, Combination Welding
Brookline College(Phoenix, Tempe or Tucson)	Business Technology Specialist (Diploma)
Brown Mackie College	Information Technology
College America Phoenix	Computer Science (BS), Computer Programming (Associates), Computer Technology & Networking (Associates)
DeVry University (Glendale, Mesa or Phoenix)	Engineering & Information Sciences, Electronics and Computer Technology (Associates), Network Systems Administration (Associates), Biomedical Engineering Technology (BS), Computer Engineering Technology (BS), Computer Information Systems (BS), Electronics Engineering Technology (BS), Electrical Engineering (Masters), Information Systems Management (Masters)
East Valley Institute of Technology	Marketing, Management, and Entrepreneurship; Automotive Technology, Collision Repair Technology, Diesel/Heavy Equipment Technology, Computer Service Technician/Networking, Electronics, Aviation Flight Training, Aviation Maintenance Training, Engineering Technology
Everest University (Online)	Computer Information Science (Associates), Computer Information Science (BA)
Fortis College	Biotechnology (Associates)
ITT Technical Institute (Central Phoenix, Tempe, Tucson or West)	Information Systems Security (BS), Information Technology - Computer Network Systems (Associates), Electronics and Communications Engineering Technology (BS), Computer and Electronics Engineering Technology (Associates)
Keller Graduate School of Management	Information Systems Management (Masters), Network & Communications Management (Masters), Biomedical Engineering Technology (BA), Computer Engineering Technology (BA), Computer Information Systems (BA), Electronics & Computer Technology (BA), Electronics Engineering Technology (BA), Game & Simulation Programming (BA), Multimedia Design & Development (BA), Network Systems Administration (BA), Technical Management (BA)
TechSkills (Mesa and Phoenix)	Information Technology - Cisco Certification, CompTIA Certification, Database Administration, IT Security, Microsoft Certification, Networking, Oracle
The Refrigeration School, Inc.	Refrigeration, AC, Heating, Electronic Technologies, Electro-Mechanical Technologies, Mechanical Maintenance
Universal Technical Institute Phoenix	Automotive Technology Training Program (51 week program), Diesel & Industrial Technology Training Program (45 week program),
University of Advancing Technology	BS: Advancing Computer Science, Enterprise Software Development, Network Engineering, Network Security, Robotics & Embedded Systems, Strategic Technology Development, Technology Forensics, Technology Product Design, Open Source Technologies; MS Advancing Computer Science, Emerging Technologies

Arizona Western College	Air Conditioning and Refrigeration, Automotive Technology, Biology, Chemistry, Computer Graphics, CIS, Computer Security, Environmental Sciences, Industrial Graphics, Logistics, Mathematics, Networking
Central Arizona College	Fire Science Technology, Manufacturing Engineering, Microcomputer Business Applications, Operating Engineer, Plumbing Trades
Eastern Arizona College	Biological Science, Chemistry, CNC Machining, CAD & Drafting Technology, CIS, Database Support, Electrical and Instrumentation Technology, engineering, Environmental Technology, Graphic Design, IT, Machine Shop Technology, Mathematics, Physics, Renewable Sustainable Energy, Welding Technology
Maricopa Community Colleges	Aircraft Maintenance Technology, Airline Operations, Airway Science Technology (Flight Emphasis), Architectural CAD Technology, Associate in Science, Automation Technology, Biotechnology, Broadband Telecommunications, CAD Technology, Civil Engineering Technology, Networking, Graphic Design, CIS, Programming, Electrical Technology, Electro/Mechanical Drafting, Electronics Engineering, Hydrologic Studies, Information Security, Manufacturing Engineering Technology, Military Leadership, Power Plant Technology, Systems Analysis, Surveying Technology, Web Development, Welding
Pima Community College	Computer Aided Drafting, Computer Information Systems, Computer Software Applications, Digital Arts, Associate of Science, Biotechnology, Engineering, Astronomy, Biology, Chemistry, Geography, Geology, Mathematics, Physics
Mohave Community College	Electrical Technology, Industrial Electrical Maintenance, Welding Technology, Chemistry, Geology, Mathematics, Science, Computer Information Systems Administration, CIS Foundation, Computer Graphics & Web Design, Computer Support Services, Essential Computer Technology, Network Support & Security, Professional Applications, Programming & Gaming Development, Systems Administration
Yavapai College	Computer Networking Technology, Computing Systems and Applications, Electrical Instrumentation Technician, Graphic Design, Gunsmithing, Industrial Plant Technician, Professional Pilot – Helicopter
Cochise College	Geography, Mathematics, Chemistry, Computer Science, Engineering, Physics, Manufacturing Engineering, Professional Pilot Technology, Avionics Technology, Computer Applications, Computer Information Systems, Computer Programming, Electronics Technology, Game Design and Creation, Information Security, Intelligence Operations Studies, Counterintelligence, Electronic Intelligence analyst, General Intelligence Operations, Ground Surveillance Systems Operator, Human Intelligence Collector, Intelligence Analyst, Linguist, Military Intelligence Systems Maintainer, Morse Interceptor/Communications Interceptor, Multi-Sensor Operator, Signal Collector Analyst, Signals Collection/ID Analyst, Signals Intelligence Analyst, Interpretation and Translation, Logistics Supply Chain Management, Manufacturing Engineering, Network Technology, Unmanned Aerial Vehicle Flight Operator, Unmanned Aircraft Systems Technician, Welding Technology

Arizona's public and private research institutions provide the industry with future technologies and usually operate at TRL 1-6. The biggest challenge facing this cluster is the alignment of ongoing research with the specified needs of commercial entities and more generally the larger A&D industry. This is due historically to a lack of intermediary entities interfacing between researchers, industry and the military. Efforts are already underway to correct this problem, but more assistance and guidance is needed.

4.1.5 Military

Arizona's principal military installations exert a significant impact upon the local economy, creating 96,328 jobs and generating $9.1 billion in economic output. Table 8 lists Arizona's principal military operations facilities.

Enjoying a unique competitive advantage due to the variety of testing and training capabilities available, this cluster is the final consumer of A&D products. Arizona's A&D industry needs to take advantage of the presence of a large military community within the State by proactively engaging with them to ascertain needs and wants. This information can then be leveraged to obtain larger Department of Defense research grants and contracts in areas that are closely aligned with the future missions of local military facilities (The Maguire Company, 2008).

4.2 Key A&D Themes

The in-depth interview with Werner Dahm identified four key themes within the A&D landscape, emanating from ASU's Security and Defense Systems Initiative. The current section therefore lists and summarizes these themes, before utilizing them within a point of intersection framework for the clusters in Section 4.3.

Dahm's four themes are traditional, irregular, emerging and underlying. Traditional refers to established activities the military engages in as part of its normal operations. Irregular activities do not occur consistently over time. Emerging activities have historically not played a major role in military operations but are now growing in importance for security and defense. The underlying refers to potential future sources of conflict around the world that are not directly related with military operations. Each theme can be further sub-divided into five mini-themes.

Table 8: Arizona's Principal Military Facilities

MILITARY BASE	PRIMARY MISSIONS
Davis-Monthan Air Force Base	Provide combat ready A/OA-10 aircraft to theater commanders worldwide and conduct initial qualification and reoccurring training for A/OA-1 pilots
Army Intelligence Center, Fort Huachuca	Military intelligence training, army network management, communications-electronics testing and training, and unmanned aerial systems training
Luke Air Force Base	Train the world's greatest F-16 pilots and maintainers while deploying mission ready war fighters
Marine Corps Air Station, Yuma	Provide aviation ranges, support facilities and services that enable the US Marine Corps and other military forces to enhance their mission capability and combat readiness
Army Proving Grounds, Yuma	Engineering, testing, developing, and supporting the development of military equipment including production testing of artillery, direct fire, automotive, aviation systems mines and countermines, unexploded ordnance, air delivery and soldier equipment
Air National Guard's 161st Air Refueling Wing	Provide trained combat forces to the USAF for the global war on terror and, under the command of the Governor of Arizona, work as a team to care for, serve and defend the citizens of local communities and the State
Air National Guard's 162nd Fighter Wing	Provide the finest fighter training programs in the world while partnering with the U.S. Air Force in the global war on terror and Air Sovereignty Alert
Army National Guard	Recruit, train, retain, sustain, and deploy the AZ ARNG forces
Western Army National Guard Aviation Training Site	Provide aviator, enlisted and specialty courses for the Army, and support regional simulation in the AH-64A, UH-60A, and AVCATT for US and allied pilots

Source: (The Maguire Company, 2008)

An overview of the four themes and their constituent parts, as discussed by Dahm, are as follows:

Theme A: Traditional

1. ***National Defense*** – Defending the homeland and its interests abroad by focusing primarily on direct military engagement.
2. ***Cyber Warfare*** – This is defined by government security expert Richard A. Clarke (2010) as "actions by a nation-state to penetrate another nation's computers or networks for the purposes of causing damage or disruption."
3. ***Homeland Security*** – This refers to security efforts to protect the homeland from terrorism.
4. ***Intel & Surveillance*** – Linking several battlefield functions to assist a combat force's employment of sensors and managing the information that they gather.

5. ***Special Operations*** – Operations to achieve a political or military objective that are performed either independently or in conjunction with conventional military activity, in situations where a conventional force requirement does not exist or might affect the overall strategic outcome.

Theme B: Irregular

1. ***Counter-Terrorism*** –Operations taken to prevent, deter, preempt, and respond to terrorism.
2. ***International Piracy*** – War-like acts committed by private parties not affiliated with any government, including robbery and/or criminal violence at sea.
3. ***Weapons Trafficking*** – Illegal trafficking or smuggling of contraband weapons or ammunition.
4. ***Counterfeiting*** – Producing currency imitations without the legal sanction of the state or government.
5. ***Internal Security*** – Maintaining peace within the national borders by upholding the national law and defending against internal security threats.

Theme C: Emerging

1. ***Border Security*** – Methods used to prevent the smuggling of drugs, weapons, endangered species and other illegal or hazardous material.
2. ***Cargo Inspection*** – Efficient use of technologies to detect illegal materials and threats to national security in or among transported freight.
3. ***Immigration & Control*** – Technologies used for legal and illegal immigration, monitoring the movement of citizens across borders.
4. ***Narcotics Interdiction*** – Technologies used to discourage the production, distribution, and consumption of illegal drugs.
5. ***Cyber Crime*** –Any crime that involves a computer and a network, where the computers may or may not have played an instrumental part in the commission of that crime.

Theme D: Underlying

1. ***Energy and Security*** – Threats to energy security including the political instability of energy producing countries, manipulation of energy supplies, competition over energy sources, attacks on supply infrastructure, plus accidents and natural disasters.
2. ***Religious Extremism*** – Monitoring and responding to religious ideologies far outside the perceived political center of a society, which could potentially become a cause of conflict.

3. ***Legal & Policy Issues*** – Any issues faced during armed conflict that requires expert consultation to avoid violating treaties and other international agreements.
4. ***Global Disparities*** – Differences in culture and ideologies that lead to an innate mistrust of different nations or political views.
5. ***Root Social Causes*** – Broad political, economic and social issues which, if left unchecked, can lead to internal and external conflicts.

4.3 Points of Intersection

Building upon the clusters identified within Section 4.1 and the key themes outlined in Section 4.2, a point of intersection framework can be developed to provide a comprehensive 'Security Research Space', illustrated in Table 9. The color code represents the number of clusters affected by a theme.

Table 9: Arizona's A&D Points of Intersection

Type	Themes	VLM	2nd Tier Suppliers	Research Entities	Unique Facilities	Workforce	Military Bases
TRADITIONAL	National Defense	X		X	X	X	X
	Cyber Warfare	X		X		X	X
	Homeland Security			X	X	X	X
	Intel & Surveillance	X		X	X	X	X
	Special Operations	X	X	X	X	X	X
IRREGULAR	Counter Terrorism		X	X	X	X	X
	International Piracy	X		X	X	X	
	Weapons Trafficking	X		X	X	X	
	Counterfeiting			X	X	X	
	Internal Security			X	X	X	X
EMERGING	Border Security		X	X	X	X	X
	Cargo Inspection			X	X	X	
	Immigration & Control			X	X	X	
	Narcotics Interdiction			X	X	X	
	Cyber Crime	X		X	X	X	
UNDERLYING	Energy and Security			X			
	Religious Extremism			X			
	Legal & Policy Issues			X			
	Global Disparities			X			
	Root Social Causes			X			

KEY	
Number of Clusters	Color Code
1	
2	
3	
4	
5	

Table 9 suggests that Special Operations affects every Arizona cluster. It also highlights six areas well represented within the State that can be leveraged as a competitive advantage. These are:

- national defense;
- cyber warfare;
- intelligence & surveillance;
- special operations;
- counter terrorism; and
- border security.

Representing Arizona's core competencies, these six areas should serve as a focal point around which collaboration between industry, research and the military entities is encouraged to maximize the economic impact of Aerospace & Defense statewide. This collaboration is ideally best served by the establishment of an Aerospace Institute, facilitating the exchange of ideas and needs between all stakeholders. If the Institute is to be effective, it must establish key links with the business development teams at VLMs such as Boeing or Raytheon. If the Institute fails to connect and interact with the 'big ideas' personnel and long term planners at VLMs, it will be unable to maximize its share of the research dollars available.

Table 9 also identifies several gaps or weaknesses in Arizona's A&D industry, such as counterfeiting, cargo inspection, immigration and control, and narcotics interdiction. Arizona could try to address or fix these areas to increase its competitiveness. However, the TOWS analysis presented in Section 5 concludes that the most effective strategy for the economic development of the A&D industry within the State is to focus all efforts around established clusters and core competencies.

5. TOWS Analysis

The implementation of a TOWS analysis provides a clear strategic direction for the economic development of the A&D industry within Arizona. Similar in its constituent parts to the more traditional SWOT analysis, TOWS initially focuses upon the threats (T) and opportunities (O) of the external environment to formulate a strategy for success within the applicable landscape, rather than starting from the weaknesses (W) and strengths (S) of the industry's internal environment.

Identifying a range of strategies from offensive to defensive, a TOWS matrix is therefore an effective framework for identifying the optimal strategy to manage threats, capitalize on opportunities, circumvent weaknesses and maximize strengths.

5.1 The Four Strategies of a TOWS Matrix

A TOWS Matrix offers four conceptually distinct alternative strategies, ranging from the offensive to the defensive. These are:

- The WT Strategy (Mini-Mini)
- The WO Strategy (Mini-Maxi)
- The ST Strategy (Maxi-Mini)
- The SO Strategy (Maxi-Maxi)

The general aim of the WT Strategy is to minimize both weaknesses and threats. It is, in effect, a mere survival position that a firm or industry would usually try to avoid. A WO Strategy attempts to minimize weaknesses and maximize opportunities. An ST Strategy recommends the use of strengths to meet and therefore minimize threats. The SO Strategy is one in which strengths are used to maximize opportunities. Weihrich (1982) argues:

> "Successful enterprises, even if they temporarily use one of the three previously mentioned strategies, will attempt to get into a situation where they can work from strengths to take advantage of opportunities. If they have weaknesses, they will strive to overcome them, making them strengths. If they face threats, they will cope with them so that they can focus on opportunities." (Weihrich, 1982, p. 62)

Although conceptually different, in reality overlap is possible between these strategies.

5.2 Developing a TOWS Matrix for Arizona's A&D Industry

The first stage in the development of a TOWS Matrix is to identify the threats and opportunities of the external environment, plus the weaknesses and strengths of the internal environment. Drawing from the literature review, in-depth interviews and best practice elsewhere, these can be listed as follows:

(A) Threats

1. Lack of communication between researchers, industry and the military.

   This could result in lost opportunities within value engineering or undermine an ability to win large federal contracts by offering the military a "cradle-to-grave" solution (ANGLE Technology Group, 2008).

2. Difficulty transitioning from TRL 6 to TRL 7.

   Without a statewide coordination of efforts by research and industry, it's difficult to advance from prototype to operational technologies.

3. Classified domain.

   Due to the unique nature of the A&D industry, the inability of some players to operate in the classified domain makes it difficult to coordinate statewide efforts.

4. Lack of integration between the Legal and Policy domain and other research.

   The legal and policy domain plays an important role in certain missions. The inability to integrate this expertise with current research may present a missed opportunity when coordinating the efforts of research and industry.

5. Competition from other states.

   The competitor states outlined in this report among others are structuring and positioning themselves well in order to compete for scarce federal and private investments. For example, Alabama has developed a science and technology roadmap that "has assembled the information, developed the strategies, and engaged the key public and private sector decision-makers necessary to enable the State to compete in this challenging environment" (Collaborative Economics, Inc., 2010).

(B) Opportunities

1. Build synergies with a statewide focus between disengaged firms.

   Break down the silo mentality and build collaborations with a State-wide focus by leveraging the expertise of large and small firms to pursue larger military and security contracts.

2. Border security technology research and testing.

   This is an area where Arizona enjoys a competitive advantage due to its geographic location. Border security represents a largely untapped source of federal contracts for the State (ANGLE Technology Group, 2008).

3. Increase in UAV research and testing.

   Arizona has some of the best research and testing resources in the country which make UAV technologies a natural fit (The Maguire Company, 2008).

4. Value Engineering.

   By coordinating the efforts of research and industry, both could benefit from the opportunities that lie in improving existing technologies through the US Department of Defense VE program (Wade, 1986).

5. Technology Horizons recommendations for new technologies.

   Align the efforts of research and industry with the military's Technology Horizons recommendations to offer the best solutions for large contracts in a competitive economic landscape.

6. Greater role of Legal and Policy experts in warfare.

   Arizona has excellent Legal and Policy resources that can be leveraged to provide a more comprehensive solution to the military's future needs.

(C) Weaknesses

1. Low Number of Second-Tier Suppliers.

   A lack of second-tier suppliers allows federal dollars to potentially leak out of the State. For example, a recent report suggested that one manufacturer working on a federal contract assigned 95% of subcontractor expenditure to work performed by firms outside the State (Seidman Research Institute, 2008). Potential reasons for this could include smaller firms' reluctance or inability to bid for federal contracts, or a general lack of awareness of local suppliers (Applied Economics, 2005).

2. Weak commitment from congressional delegation.

   The lack of support from Arizona's congressional delegation is a major disadvantage compared to other states. For example, Florida has benefited greatly from having two members of its congressional delegation (Suzanne Kosmas and Jeff Miller) join the Modeling & Simulation Caucus formed by Congressman Forbes of Virginia. Their

congressional delegation has also sponsored and co-sponsored large appropriation bills benefitting the Aerospace & Defense industry in Florida. (US Library of Congress, 2011)

3. External perceptions of the State.

   Controversial issues such as gun laws and immigration have potentially tarnished the image of Arizona, prompting at least some out-of-state firms in a variety of industries to hesitate before doing business in the State (Thomason, 2011).

4. Poor development of STEM education.

   A national problem, the State is currently trying to rectify the situation locally with several programs such as those being promoted by the Arizona Aerospace & Defense Commission, but there is still much to be done (ACT, Inc., 2010).

5. Unwillingness to share ideas.

   An insular, silo mentality prevalent amongst A&D firms in the State is demonstrated by a general unwillingness to share ideas. The lack of an intermediary entity to facilitate communication and collaboration between firms and research in the A&D industry has contributed to this weakness (ANGLE Technology Group, 2008).

6. Lack of organized thrust for research.

   Until recently, research in the State has not been closely aligned with industry needs. Significant progress has been made on this front through entities such as the SDSI and the ADRC, but more needs to be done to promote collaboration between research and industry.

7. Weak national marketing of advantageous state policies.

   The State has advantageous policies that, if marketed at the national level, could result in greater procurement of DOD contracts. For example, the aggressive marketing of State policies in Texas has secured a "disproportionate share of DOD prime contracts" (ANGLE Technology Group, 2008, p. 157)

(D) Strengths

1. Availability of Restricted Airspace.

   A large amount of restricted airspace sets Arizona apart from other parts of the US. Local development near the likes of Fort Huachuca has raised occasional concern, but the State's airspace remains an invaluable asset that must be protected (The Maguire Company, 2008, p. 13).

2. Military Bases and Testing & Training Ranges.

   Arizona's principal military installations exert a significant impact upon the local economy, creating 96,328 jobs and generating $9.1 billion in economic output. Arizona's A&D industry needs to take advantage of the presence of a large military community within the State by proactively engaging with them to ascertain needs and wants (The Maguire Company, 2008).

3. Active and retired military population in the State.

   Arizona receives substantial stimulus from spending by active and retired military personnel which can be directly linked to the presence of the various military installations in the State (The Maguire Company, 2008, p. 7).

4. Sufficient number of Very Large Manufacturers (VLMs).

   Arizona houses several VLMs, who collectively attract the majority of defense contract dollars to the State (Seidman Research Institute, 2010a).

5. Strong civilian aerospace facilities.

   Greater Phoenix's Civil Aviation facilities, including Sky Harbor, Goodyear and Deer Valley airports, exert a total economic impact of $33 billion for Arizona (W. P. Carey School of Business, 2008)

6. Excellent Research Entities.

   Arizona's three research universities (ASU, UA and NAU) and Embry Riddle Aeronautical University (ERAU) are a key asset. Primarily responsible for the vast majority of university-based R&D within the State, they also help to meet the increasing demand for a skilled workforce in the A&D industry (ANGLE Technology Group, 2008).

7. Unique facilities.

   Unique facilities such as the Air Force Research Laboratory in Mesa, AZ offer an opportunity to perform sensitive research at a "high-level security facility" (The Gold Group, 2008, p. 24).

8. Intermediary Entities.

   Existing intermediary entities in the State like the Security & Defense Systems Initiative (SDSI) and the Aerospace and Defense Research Collaborative (ADRC) strengthen research and industry's ability to collaborate and align their efforts with the military's future needs.

9. Economic Incentives.

   The State has created a more appealing economic environment for businesses by introducing tax incentives such as the Angel Investment Tax Credit and lowering corporate tax to below 5 percent.

10. Arizona Commerce Authority and affiliated statewide entities.

    The Arizona Commerce Authority and its affiliated statewide entities such as Science Foundation Arizona "promote Arizona as a premier location for business expansion" (Arizona Commerce Authority, 2010), and provide key resources that support business growth.

11. Favorable weather conditions.

    Arizona has some of the best and most sought-after flying environments in the world thanks to its optimal weather conditions (The Maguire Company, 2008, p. 23).

This list of threats, opportunities, weaknesses and strengths is then applied to the four distinct strategic alternatives (WT, WO, ST, SO) to provide a snapshot of the range of actions open to a firm or industry at any one time.

Table 10 illustrates the results of a TOWS matrix for Arizona's A&D industry, and the range of strategies available. Priority should be placed upon developing current core competencies and seeding intermediary entities that interact directly with research and industry. This will offer Arizona's A&D industry the greatest return. Implementation of some defensive strategies is also recommended to help protect the industry from a combination of external threats and internal weaknesses. However, the focus should be on the more aggressive, offensive tasks. Maintaining strategies should only be pursued after offensive strategies.

Table 10: TOWS Matrix Analysis of Arizona's A&D Industry

	EXTERNAL OPPORTUNITIES (O)	EXTERNAL THREATS (T)
	1. Building synergies 2. Border Security research 3. Increase in UAV research 4. Value Engineering 5. Technology Horizons recommendations for new technologies 6. Greater role of Legal and Policy experts in warfare	1. Lack of communication between researchers and military 2. Difficulty transitioning from TRL 6 to TRL 7 3. Classified domain 4. Legal and Policy domain not integrated with other research 5. Competing states
INTERNAL STRENGTHS (S) 1. Restricted Airspace 2. Military bases & testing 3. Military population in State 4. Number of VLMs 5. Civilian aviation facilities Excellent Research Entities 6. Unique facilities 7. Intermediary Entities 8. AZ Economic Incentives 9. AZ Commerce Authority 10. Favorable weather	**OFFENSIVE STRATEGIES (SO)** • Focus on core competencies beginning with National Defense, Intelligence & Surveillance and Special Operations, to maintain competitive advantage. • Leverage airspace and testing ranges to obtain new federal contracts in areas like UAV research and testing. • Seed Intermediary Entities to assist in collaboration between research and industry.	**MAINTAINING STRATEGIES (ST)** • Strengthen current assets such as military bases, VLMs and unique facilities via collaboration facilitated by intermediaries to prevent threat from lack of communication between entities. • Facilitate transition from TRL 6 to TRL 7 through collaborative partnerships and intermediary entities.
INTERNAL WEAKNESSES (W) 1. Low number of Second-Tier Suppliers 2. Weak commitment from congressional delegation 3. Tarnished Image of State 4. Poor STEM education 5. Silo mentality of firms 6. Lack of organized thrust for research 7. Weak national marketing of advantageous policy	**MAINTAINING STRATEGIES (WO)** • Promote value engineering opportunities through VLMs and Second-Tier Suppliers. • Mediate between industry and research to remove key roadblocks to collaboration such as IP ownership. • Facilitate engagement between firms and suppliers to build synergy in the industry.	**DEFENSIVE STRATEGIES (WT)** • Protect current assets by supporting unique facilities within the State. • Communicate the importance of the A&D industry to the congressional delegation and encourage participation in industry caucuses (i.e., Modeling & Simulation Caucus).

6. Conclusions & Recommendations for Future Research

Several key conclusions can be drawn from this report.

1. The Aerospace & Defense industry is a complex cluster of systems that relies on a variety of different entities with differing needs and goals. Historically, the A&D industry has been heavily focused on aerospace and neglected other core competencies such as Arizona's unique facilities (e.g. AFRL in Mesa), federally funded research facilities (e.g. NOAO) and Second-Tier Suppliers in new technologies (e.g. directed energy, security and optics). Arizona's A&D industry will benefit to a considerable extent from greater connections and collaborations between these key players. The overarching goal of these collaborative efforts is to obtain larger, more lucrative contracts and grants, thereby enabling the production of cutting-edge, commercially-viable solutions of significant value to the military. This will also benefit Arizona's economy as a whole through the direct, indirect and induced spending of all key stakeholders.

2. The points of intersection analysis identified core competencies in areas such as national defense, cyber warfare, intelligence and surveillance, special operations, counter terrorism and border security. These areas should be leveraged to encourage other entities to focus on them and further enhance the State's reputation.

3. A TOWS analysis suggests several strategies for success, ranging from the offensive to the defensive. Offensive Strategies include focusing on core competencies to maintain competitive advantage, leveraging restricted airspace and testing ranges in the State to obtain large federal contracts, and seeding intermediaries to maximize collaboration between research and industry. Defensive strategies currently available to Arizona's A&D industry include protecting current assets via greater support for the State's unique facilities and attaining greater support from the congressional delegation. Maintaining strategies include a greater emphasis upon collaboration, pursuing opportunities within homeland security and narcotics intervention, promoting value engineering opportunities, building synergies between firms, and removing roadblocks to collaboration such as IP ownership.

4. Offensive strategies will offer Arizona's A&D industry the greatest return because they take advantage of both strengths and opportunities and hence should be the main priority. Defensive strategies are also important to the extent that they will protect the industry from external threats and internal weaknesses – that is, areas where the industry is most vulnerable. The implementation of maintaining strategies would support offensive and defensive strategies, and hence provide a sustained and long-term investment within the industry. However, this latter type of strategy should only be pursued once the offensive strategies have been secured.

5. Securing greater support from the congressional delegation is of particular importance for the Arizona A&D industry to more aggressively pursue Department of Defense contracts.

6. The report recommends the establishment of an Aerospace Institute to seed intermediary entities such as the Aerospace and Defense Research Collaborative and coordinate research efforts through a virtual network of outposts at Arizona's leading research facilities. The co-ordination and enhancement of links between research, industry and the military by an Aerospace Institute will remove key hurdles such as potential disputes over intellectual property rights, and therefore offer a robust foundation for the continued development of the industry within Arizona.

7. Closely aligning the efforts of research and industry around established themes in A&D and through collaborative efforts, guided by the likes of an Aerospace Institute, will enable Arizona to offer the Department of Defense beginning-to-end solutions based on existing and solid competitive advantages.

8. This report has also identified a lack of Second-Tier Suppliers supporting both Arizona's VLMs and other missions outside the State. Further study is recommended within this area to address the following questions:

    a. Which suppliers do Arizona's VLMs currently use the most and why?
    b. Do Second-Tier Suppliers in other States enjoy competitive advantages currently unavailable within Arizona?
    c. Does the lack of local Second-Tier Suppliers impact the ability of VLMs to win new contracts from the federal government?

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Appendix

A.1 Arizona's Research Programs and Centers

ARIZONA STATE UNIVERSITY (ASU)	
Adaptive Intelligent Materials and Systems (AIMS) Center	Integrates a variety of interdisciplinary areas spanning mechanical, material, electrical and computational engineering, and developing a solid foundation in the area of integrated intelligent system design. Research in this area will solve large-scale problems that have direct benefit to the economy and society as well as a significant impact on aerospace and mechanical systems and civil infrastructures. Such problems are of interest to both industry and government.
Flexible Display Center	A university, industry, government collaborative venture designed to advance full color flexible display technology and flexible display manufacturing to the brink of commercialization. The principal goal of the FDC is to develop high performance, commercially-viable, conformal and flexible displays that are lightweight, rugged, low power, and low cost.
Information Assurance Center	A multi-disciplinary center focus on both the research and educational activities to address the broad issues of developing trustworthy information systems (TIS) and ensuring the quality of information being stored, processed and transmitted by information systems and networks. The Center has been certified as a National Center of Academic Excellence in Information Assurance Education (CAEIAE) by the National Security Agency & the Department of Homeland Security.
ASU / NASA Space Grant	Supports graduate and undergraduate students in a variety of disciplines to further their educational experiences in science, engineering research, and informal education programs.
Sensor, Signal & Information Processing Center	Develops signal and information processing foundations for next-generation integrated multidisciplinary sensing applications in biomedicine, defense, homeland security, sustainability, environmental technologies, interactive media, wireless communications, and vehicular systems.
Wireless Integrated Nano Technology	Wireless systems are a budding technology that will go beyond the current cellular telephone application. This young technology will play a dominant role in a variety of fields including information processing, remote sensing, autonomous monitoring, homeland security, bio-medical sensors, and bio-telemetry.
Cognitive Engineering Research Institute (CERI)	An independent, not for profit 501c3 research institute located in Mesa, AZ, adjacent to ASU's Polytechnic campus. Though not a part of ASU, CERI has a close relationship with ASU through a Memorandum of Understanding that allows mutual sharing of faculty, students, and facilities. In addition, CERI collaborates closely with the Air Force Research Laboratory's Human Effectiveness Directorate. CERI's research focuses on human factors consideration and human systems integration of large scale cognitive and socio-technical systems, particularly the ground control stations for Unmanned Aerial Systems (UASs). CERI specializes in the development of assessment methods and metrics in these environments and the use of synthetic task environments for team experimentation. In addition to UAS research, CERI also conducts research in emergency response, strategic planning, cyber security and healthcare domains.
Unmanned Aerial System Training and Simulation Center	Currently in the planning stages, this would fill a national need for UAS training and training research, while at the same time addressing a variety of other UAS human systems integration concerns. The plan is for this center to be an arm of the AZ Aerospace Institute and managed by CERI. It will leverage the secure facility currently occupied by AFRL, as well as a sizeable portion of the AFRL skilled workforce that will remain behind in AZ after the USAF BRAC (Base Re-alignment and Closure) which will be complete in 2011. These resources combined with local science and technology strength in the UAS and training and simulation areas, as well as the growing need for UAS training and training research, ideally position the center to succeed and flourish.

THE UNIVERSITY OF ARIZONA (UA)	
Center for Astronomical Adaptive Optics	Focused primarily on the development of adaptive optics techniques for enhancing the resolving power of both imaging and spectrographic instruments at large ground-based telescopes.
Department of Planetary Sciences and Lunar and Planetary Laboratory	Dedicated to the common goal of understanding and teaching about the formation and evolution of the planetary system.
Funding	NASA, JPL, NSF, Southwest Research Institute (SWRI), Space Telescope Institute (STSCI).
Research Groups	Planetary atmospheres, surface composition, climate change, and global warming. Mercury studies, studies of small objects (asteroids & comets), astrophysics, and ultraviolet spectroscopy & imaging.
Projects	Projects 2007/2008 – Phoenix Mars Lander Mission first mission to Mars led by an academic institution.
Current Special Projects	• Cassini Visual Infrared Mapping Spectrometer • High Resolution Imaging Science Experiment – Planetary Image Research Laboratory • Space Imagery Center – Research collection of NASA planetary photography, cartographic products & technical documentation.
Department of Astronomy/Steward Observatory	Currently has 47 Ph.D. students, making it the largest astronomy graduate program in the country. The program is extremely high quality, with admission of approximately 8-10 students per year from among 120-130 applicants. Incoming astronomy graduate students have the highest mean GRE scores among over 100 graduate programs on campus.
Aerospace & Mechanical Engineering Department	Aerodynamics, active flow control, fluid mechanics, hydrodynamic stability & transition, aero acoustics, design and testing of UAVs and MAVs, CDF, aerospace structures & materials, structural design optimization & combustion.
Research & Test Facilities & Capabilities	Low speed wind tunnel (50 m/s), low turbulence closed loop wind tunnel (up to 40 m/s), two open-loop wind tunnels, unsteady water tunnel & water jet, anechoic chamber associated with a jet noise lab. Two water channels, a large high-speed water tunnel and two shock tubes.
Space Engineering Laboratory	Space Engineering Laboratory pursues innovative and challenging concepts through a first engineering demonstration of feasibility, so that future missions can use the product for economical and reliable enhancements of (and enabling) newer spacecraft and unique Rockets and Robots.
Department of Homeland Security Center of Excellence	Focuses on eight major research areas: • Detection: Humans, Vehicles and Decision Supports • Networks: Interoperability, Reliability and C3 • Fusion: Tools and Approaches • Risk: Mitigation, Assessment and Alignment • Population: Methods, Metrics and Estimates • Immigration: Economics, Policies and Alternatives • Governance: Law Enforcement and International Cooperation

EMBRY RIDDLE AERONAUTICAL UNIVERSITY (ERAU)	
Research & Test Facilities & Capabilities	• Aerospace Experimentation and Fabrication Building - Completed in the Fall of 2006, the Aerospace Experimentation and Fabrication Building houses design and testing suites that are used by Aerospace Engineering students in capstone projects and component design courses. • Embry-Riddle faculty have also participated in NASA-Dryden Flight Research Center (DFRC) (via the AERO Institute) research focusing on Unmanned Aviations Systems.
Aerospace Laboratories & Testing Capabilities	• Mechanical Testing Lab • MTS Hydraulic Load Frame/Actuator Suite • Propulsion Lab • Structural Dynamics Lab • Microscopy Lab • Materials Lab • Structural Testing Lab • Aeronautical Fabrication (AXFAB) Lab and Machine Shop • Rapid Prototyping Lab • Space Lab • Wind Tunnel Facilities
LIGO Optics Lab	Explores high index layer coatings in order to reduce the optical noise in the next-generation LIGO experiment. The current LIGO experiment is comprised of two 4-km long interferometers that are sensitive to gravity waves produced black hole and neutron star collisions in nearby galaxies. These interferometers can measure shifts in space down to 1/1000th the size of a proton. The implementation of this new optical technology will improve the sensitivity of the interferometers to search for collisions of massive objects in hundreds of nearby galaxies in the Virgo super-cluster.
Particle Physics Lab	A teaching and research facility set up to explore the properties of elementary particles using liquid scintillators and quantum photomultiplier tubes. As a teaching lab, students learn the basic principles of particle detectors and particle accelerators. As a research lab, students and professors are constructing particle physics detectors with sub-nanosecond timing resolution to track atmospheric cosmic rays as well as byproducts of radioactive decays.
Hydrophone Lab	A research laboratory developing hydrophone arrays to search for artifacts buried under centuries of silt and mud. This lab investigates the use of high-powered transducers that scan through a large bandwidth of frequencies to produce evanescent sound waves that can travel sideways through the silt and mud to detect ancient artifacts. The use of evanescent sound waves reduces the number of scans required to identify objects, and thus, reduces the time required to complete a search. This new sensor array will soon be used by our professors and students to scan the Venice lagoon for Roman artifacts.

NORTHERN ARIZONA UNIVERSITY (NAU)	
Physics and Astronomy	Part of the College of Engineering, Forestry and Natural Sciences, it is housed in two stories of the Physical Sciences building and is home to 13 faculty members and approximately 165 students. Faculty currently engages in two primary areas of research; materials science and astrophysics.
Materials Research Laboratories	Currently used for work in chemical sensors and solar storage. The chemical sensor work is based primarily on micro cantilevers, and the solar storage work is centered on thin-film capacitors. The labs house a variety of analytical tools, such as Scanning Tunneling Microscopy (STM), X-ray Photoelectron Spectroscopy (XPS), Scanning Probe Microscopy (SPM), and a full suite of deposition and vacuum systems.
Astrophysics	Includes the following projects: • Cratering in the Solar System • Studies of Near-Earth Asteroids • Spectroscopy of Kuiper Belt Objects • Transits of Extra-solar Planets • High-Mass Binary Stars • Dust-Disks around Nearby Stars • Astrobiology • Laboratory studies of astrophysical ices
Mechanical Engineering Aerospace and Defense Research	Part of the College of Engineering, Forestry and Natural Sciences, housed in a newly renovated 90,000 sq. ft. engineering building, the Department has 7 full-time faculty and 400 students. Faculty actively engages in research activities in thermal/fluid sciences, renewable energy, and solid mechanics. An additional 8,500 sq ft of mechanical engineering laboratory space is contained in a separate building, within walking distance from the main engineering building. The following research activities related to aerospace and defense are currently ongoing in the department:
Adaptive Materials and Systems	This research focuses on modeling, characterization and implementation in practical applications of adaptive/smart materials with a particular focus on magnetic shape memory alloys, magneto-rheological fluids and piezoelectric materials. Micro actuators/sensors, power harvesters, micro pumps and active/semi active vibration isolators are some of the applications under development. Other adaptive materials applications, such as morphing structures and health monitoring, are in the early stages of investigation, with the intent to develop them into another research thrust in the near future.
Advanced Composites and Optomechanics	Focuses on the characterization and improved design and analysis of advanced composite materials including optomechanical and fracture mechanics applications. For example, models have been developed to predict fracture near singularities at biomaterial anisotropic interfaces in bonded joints. Optomechanics applications include the design, analysis and characterization of an all-composite telescope for the Naval Research Lab.
Improved Models for Plastic Deformation	Currently researching the development of improved models for plastic deformation in metals that include distortional hardening with applications to manufacturing processes and plastic analysis of structures. Future work includes the extension to large elasto-plastic deformations and implementation of the new models into finite element programs; application of directional distortional hardening to stability problems (e.g. plastic buckling); and predicting elastic spring-back during manufacturing.

Source: Arizona Aerospace and Defense Commission

A.2 Number of 2000 – 2010 Graduates by Most Recent Degree and University[5]

Arizona State University (ASU)	11,006
Bachelor	6,845
Electrical Engineering	981
Mechanical Engineering	799
Computer Science	790
Computer Systems Engineering	514
Bioengineering	491
Microbiology	365
Chemical Engineering	349
Biochemistry	335
Mathematics	331
Industrial Engineering (includes Systems Engineering)	301
Molecular Bio Science/Technology	261
Aerospace Engineering	259
Chemistry	195
Physics	119
Materials Science & Engineering	108
Industrial Technology (Information Technology)	103
Applied Sciences (Fire Service Management)	65
Electrical Engineering Technology (Electrical Sys)	61
Manufacturing Engineering Technology	42
Applied Sciences (Computer Systems Administration)	42
Mechanical Engineering Technology	35
Sustainability	45
Manufacturing Engineering Technology (Mechanical)	24
Industrial Technology (Environmental Technology Management)	23
Mechanical Engineering Technology (Aerospace)	23
Applied Computer Science	20
Industrial Technology (Industrial Technology Management)	14
Environmental Technology Management	14
Electrical Engineering Technology (Telecommunication Systems)	12
Applied Sciences (Software Technology Applications)	10
Applied Sciences (Microcomputer Systems)	10
Applied Sciences (Manufacturing Technology & Management)	10
Electrical Engineering Technology (Microelectronics)	10
Applied Sciences (Semiconductor Technology)	9
Electrical Engineering Technology (Computer Systems)	9
Operations Management Technology	8
Computer Engineering Technology (Software Technology)	7
Industrial Technology (Graphic Information Technology)	7
Applied Sciences (Emergency Management)	7
Computer Engineering Technology	6

[5] University of Arizona data reflects number of graduates from 2000 to 2009.

Mechanical Engineering (Automation)	5
Computer Systems (Embedded Systems)	5
Mechanical Engineering Technology (Automotive)	5
Computer Engineering Technology (Software Engineering Tech)	4
Computer Engineering Technology (Embedded Systems Tech)	4
Electrical Engineering Technology (Alternate Energy Tech)	3
Computer Engineering Technology (Hardware Tech)	3
Computer Systems (Hardware Tech)	2
Master	**3,300**
Electrical Engineering	1,224
Computer Science	638
Industrial Engineering (includes Systems Engineering)	407
Mechanical Engineering	149
Bioengineering	104
Technology (Computer Systems)	89
Mathematics	84
Tech (Environmental Technology Management)	69
Technology	62
Materials Engineering	57
Chemical Engineering	45
Chemistry	44
Technology (Electrical Systems Engineering Technology)	42
Physics	42
Technology (Management of Technology)	38
Aerospace Engineering	36
Computing Studies	29
Technology (Information Technology)	29
Molecular & Cellular Biology	19
Technology (Fire Science Administration)	17
Technology (Microelectronics)	16
Microbiology	13
Sustainability	12
Technology(Computer Systems)	11
Biochemistry	9
Energy Systems Engineering	8
Technology (Integrated Electronic Systems)	6
Civil/Environmental Engineering	1
Doctorate	**861**
Electrical Engineering	240
Chemistry	124
Computer Science	100
Industrial Engineering (includes Systems Engineering)	66
Mathematics	64
Bioengineering	59
Mechanical Engineering	55
Physics	48

Molecular & Cellular Biology	34
Chemical Engineering	33
Microbiology	19
Biochemistry	11
Aerospace Engineering	7
Sustainability	1
University of Arizona (UA)	**10,160**
Bachelor	**7,139**
Molecular & Cellular Biology	1,350
Mechanical Engineering	768
Computer Science	753
Electrical Engineering	652
Mathematics	504
Microbiology	483
Computer Engineering	440
Chemistry	291
Chemical Engineering	286
Bioscience & Molecular Biophysics	281
Physics	262
Aerospace Engineering	226
Biochemistry	191
Optical Sciences & Engineering	174
Environmental Sciences	147
Materials Science & Engineering	138
Industrial Engineering (includes Systems Engineering)	125
Optical Engineering	45
Environmental Hydrology & Water Reserves	18
Optics	4
Biochemical & Molecular & Cellular Biology	1
Master	**1,493**
Electrical & Computer Engineering	334
Optical Sciences	287
Computer Science	232
Mechanical Engineering	164
Industrial Engineering (includes Systems Engineering)	107
Chemistry	101
Physics	59
Environmental Engineering	48
Aerospace Engineering	41
Mathematics	41
Materials Science & Engineering	29
Chemical Engineering	21
Microbiology & Immunology	12
Molecular & Cellular Biology	8
Biochemistry	3
Bioscience & Molecular Biophysics	3

Microbiology	1
Electrical Engineering	1
Computer Engineering	1
Doctorate	**1,528**
Medicine	528
Pharmacy	495
Chemistry	165
Electrical & Computer Engineering	65
Molecular & Cellular Biology	49
Microbiology & Immunology	41
Chemical Engineering	30
Mathematics	25
Physics	23
Materials Science & Engineering	23
Mechanical Engineering	20
Biochemistry	13
Environmental Engineering	12
Computer Science	11
Biochemistry & Molecular & Cellular Biology	10
Optical Sciences	8
Aerospace Engineering	8
Microbiology	2
Northern Arizona University (NAU)	**1,838**
Bachelor	**1,699**
Computer Information Systems	482
Mechanical Engineering	271
Electrical Engineering	179
Chemistry	125
Mathematics	96
Environmental Science - Biology	88
Microbiology	85
Computer Science	71
Physics	69
Computer Science & Engineering	68
Environmental Engineering	61
Environmental Studies	32
Environmental Science	31
Environmental Science - Applied Geology	17
Environmental Chemistry	10
Environmental Science - Microbiology	8
Environmental Science - Chemistry	4
Environmental Science - Applied Math	2
Master	**139**
Mathematics	76
Chemistry	63

Embry Riddle Aeronautical University (ERAU)	1,462
Associate	**95**
Professional Aeronautics	72
Technical Management	15
Aviation Maintenance	7
Aviation Business Administration	1
Bachelor	**876**
Professional Aeronautics	744
Technical Management	68
Management of Technical Operations	58
Aviation Business Administration	5
Aviation Maintenance	1
Master	**491**
Aeronautical Science	266
Technical Management	172
Business Administration in Aviation	41
Management	12
Grand Total	24,466

Source: ASU, UA, NAU and ERAU Alumni Offices

A.3 Additional Technical Degree Programs at Branch Campuses[6]

Northern Arizona University – Yuma Branch Campus
Bachelor
B.A. Interdisciplinary Studies – Technology Management
B.A.S. Technology Management
B.S. Interdisciplinary Studies – Technology Management
Master
M.A.T. Mathematics
M.S. Applied Geospatial Sciences
Master of Engineering
University of Arizona South – Sierra Vista
Bachelor
Intelligence Studies
Network Administration
Computer Science
Mathematics
Master
Educational Technology

Source: UA South and NAU – Yuma Branch Campus Student Services
http://www.uas.arizona.edu/index.php?q=academics
http://yuma.nau.edu/DegreeSearch.aspx

[6] These programs are sub-categories of the degrees listed in A.2

Glossary

AADC	The Arizona Aerospace and Defense Commission is the State's sole coordinator of all aerospace and defense related commercial partnerships. It is tasked providing technical support, developing goals and objectives, recommending legislation and providing direction regarding Arizona's aerospace and defense related commerce.
ACE	The Arizona Center of Excellence serves as the focal point to unite all of Arizona's industrial, academic and public segments in the global marketplace by facilitating the objectives of the State's aerospace, defense, homeland security industry and academic sectors.
ADRC	The ADRC, funded under the Aerospace and Defense Initiative from Science Foundation Arizona, is an ASU-led state-wide initiative to build broad partnerships between higher education and industry.
AFRL	The Air Force Research Laboratory is a scientific research organization operated by the United States Air Force Materiel Command dedicated to leading the discovery, development, and integration of affordable aerospace warfighting technologies
Arizona MEP	Arizona MEP is an affiliate of the U.S. Department of Commerce's Hollings Manufacturing Extension Partnership (MEP), a national network of organizations that provide assistance to small and midsize manufacturers.
ASU	Arizona State University
ATC	The Arizona Technology Council is a non-profit trade association founded to connect, represent and support the state's expanding technology industry.
ERAU	Embry Riddle Aeronautical University
FFRDC	Federally Funded Research and Development Centers (FFRDCs) conduct research for the United States Government. They are administered in accordance with U.S Code of Federal Regulations, Title 48, Part 35, Section 35.017 by universities and corporations.
MS&T	Modeling, Simulation & Training is an industry focused on technologies that create abstractions of reality for the purpose of research and training.
NAU	Northern Arizona University
NDIA	The National Defense Industrial Association is a Defense Industry association promoting national security. It provides a legal and ethical forum for the exchange of information between Industry and Government on National Security issues.
NextGen	NextGen is a wide ranging transformation of the entire national air transportation system moving it away from ground-based surveillance and navigation to new and more dynamic satellite-based systems. It introduces new technological innovations in areas such as weather forecast, digital communications and networking.
NOAO	NOAO is the US national research & development center for ground-based night time astronomy with observatories in Arizona, Hawaii and Chile.
SBIR/STTR	Small Business Innovation Research and Small Business Technology Transfer are two Department of Defense programs which fund a billion dollars each year in early-stage R&D projects at small technology companies.

SDSI	The Security & Defense Systems Initiative at Arizona State University is a transdisciplinary, university-wide institute based on the New American University model to develop technology-enabled solutions for key national and global security challenges.
STEM	The acronym STEM stands for science, technology, engineering, and mathematics. According to both the United States National Research Council and the National Science Foundation, the fields are collectively considered core technological underpinnings of an advanced society.
TOWS Matrix	A TOWS matrix is a variant of a SWOT analysis used to evaluate the threats, opportunities, weaknesses and strengths involved in a project, business venture, industry or any situation requiring a decision.
TRL	Technology Readiness Levels range from 1 to 9 and correspond to the stages new technology passes through, from Basic principles observed and reported to actual system 'flight proven' through successful mission operations.
UAV	An unmanned aerial vehicle (UAV; also known as Unmanned Aircraft System (UAS)) is an aircraft that is flown by a pilot or a navigator (Combat Systems Officer) depending on the different Air Forces; however, without a human crew on board the aircraft.
UA	University of Arizona
VLM	Very large manufacturers as defined in this report are aerospace & defense firms with 500 employees or more.

Dr. Dennis Hoffman, Director of the Seidman Research Institute and Professor of Economics at the W. P. Carey School of Business at Arizona State University

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L. William Seidman Research Institute

W. P. Carey School of Business

Arizona State University

www.seidmaninstitute.com

Arizona's Aerospace & Defense Commission Annual Report

December 31

2010

The Arizona Aerospace and Defense Commission is the State's sole coordinator of all aerospace and defense related commercial partnerships. The Commission was established pursuant to A.R.S. §§41-1561, 41-1562, 41-1563 & 41-1564. The Commission is tasked with developing an aerospace and defense strategic plan that builds synergy between government, industry and education. The Commission shall submit a report of its findings to the Governor, the President of the Senate, the Speaker of the House of Representatives, the Secretary of State and the Director of the Arizona State Library, Archives and Public Records on or before December 31 of each year.

A.R.S. §41-1564

Arizona Aerospace and Defense Commission Strategic Plan Recommendations

Overview

In 2010, the Commission membership included the same appointees as in 2009 with nine active members. The Commission includes members from both public and private sectors in accordance with A.R.S. §41-1562. The Commission held eleven meetings during the calendar year of 2010. The Commission members worked in subcommittees to focus on the four strategies presented at the end of 2009: 1) Improve Business Environment, 2) Create Robust Pipeline of Business & Entrepreneurial Opportunities to Fuel Growth, 3) Build Arizona's Research Competitiveness, and 4) Attract, Educate, Retain and Retrain Arizona's Skilled Workforce.

Key goals for 2010 were:

- *Identify the Arizona State Aerospace and Defense (A&D) Value Proposition to position the State for economic growth*
- *Develop prioritized implementation plans with specific recommendations for external communications, legislative actions, and private-public partnerships*
- *Champion an A&D Industry Economic Impact Study*

Commission Process, Data Collection and Analysis

The Commission continued to receive input from industry and community leaders, participated in industrial forums, conducted focus groups to determine core A&D strengths and issues, and worked with an external marketing research firm to strengthen overall external communications.

The Commission, working in partnership with the Arizona Department of Commerce, championed the completion of an Industry Economic Impact Study for Arizona. The L. William Seidman Research Institute, W.P. Carey School of Business at Arizona State University was selected to complete the study. The Study was commissioned in May 2010 and completed in August.

The Commission also championed an effort to identify the Arizona State A&D Value Proposition working with Commerce and RIESTER, an external marketing firm. The process included conducting four focus groups (Tucson, East Valley, Phoenix-Central, and West Valley) with industry and community leaders. The process was developed to identify key A&D strengths, issues and concerns. In addition, several one-on-one interviews with senior A&D industry executives were also conducted. The results identified an overarching A&D Value Proposition that will be the focus for go-forward communications and marketing efforts.

An industry-specific website, currently in design phase, will reflect the identified Value Proposition, an internal statement meant to reflect Arizona's key advantage:

"Arizona has always attracted a certain type of person – the pathfinder, the builder, the explorer. That is why industries that depend on innovation to survive, like A&D, have prospered in Arizona. World class universities, large prime contractors and low operating costs are only part of the story. Find out more about Arizona."

The purpose of the website is to highlight Arizona's A&D industry strengths, promote the Commission strategic focus areas, and enhance economic development in the A&D industry growth sector.

On June 29, 2010, Governor Jan Brewer issued an executive order establishing the Arizona Commerce Authority, the Governor appointed Dr. Vicki Panhuise, Commission Chair, to the newly formed Arizona Commerce Authority (ACA) Board and the ACA A&D Growth Sector Chair.

Subcommittee Activity

Each subcommittee met regularly and worked on the specific recommendations to drive the four Commission strategies. Some key activities completed for each of the subcommittees are:

Improve Business Environment:

1. *Completed A&D Economic Impact Study*
2. *Developed A&D Value Proposition*
3. *Partnered with Dark Skies Initiative to collaborate on state-wide regulations to preserve natural resources*
4. *Collaborated with Commerce Board A&D Growth Sector Committee and identified key legislative incentives to help with retention of A&D industries in Arizona*

Create Robust Pipeline of Business & Entrepreneurial Opportunities to Fuel Growth:

1. *Identified business points of contacts and included them on the Commission distribution to increase awareness of Commission activities*
2. *Attended meetings, engaged with, and gathered information from professional organizations such as National Defense Industrial Association (NDIA), International Council of Systems Engineers (INCOSE), Arizona Technology Council (ATC) Arizona Manufacturers Extension Partnership (Arizona MEP), Air Force Association (AFA), Association of U.S Army (AUSA), Arizona Center of Excellence (ACE) and briefed Commission initiatives added representatives to Commission distribution*
3. *Spearheaded teaming relationships with Arizona companies on Army proposal at Ft Huachuca. Developed strategy with prime contractor to incorporate Letters of Non-Financial Support from Commerce and ASU for inclusion in Army proposal*

Build Arizona's Research Competitiveness:

1. *Established use of social media to promote communication and increase stakeholder awareness*
2. *Identified and cataloged Universities Centers of Excellence and Research Assets relative to A&D*
   http://www.esacorp.com/subcomm/Subcommittee2.htm

3. *Commerce coordinated a statewide collaborative proposal for SBA contract*
4. *Connected with SBIR State Directors to determine the cost/opportunity to host a SBIR Forum in the near future*

Attract, Educate, Retain and Retrain Arizona's Skilled Workforce:

1. *Completed an asset inventory linking Skilled Workforce recommendations to available talent, resources, and initiatives*
2. *Developed the concept of an A&D Resource Portal for employers, employees, students and faculty to help stakeholders access and exchange information on careers, education, training, internships, tutoring, mentoring and lifelong learning opportunities*
3. *Identified a potential provider and sought funding for deployment of the Arizona Aerospace Academy (school-within-a-school) model*
4. *Championed preservation of merit-based scholarships in Arizona, as well as other initiatives that will serve to entice promising students/graduates with A&D-related skills/education to remain in the State*

2010 Economic Impact Study Report Executive Summary (Link to the Complete Report)

The purpose of this report is to measure the impact of A&D companies on employment and income in Arizona. Estimated impacts include both the direct effects of the operations of A&D firms and their first-tier suppliers and the so-called multiplier effects that arise when employees spend a portion of their incomes and governments spend new tax revenues. The report also provides estimates of the contributions A&D companies and their employees make to Arizona state and local tax revenues.

The primary data used in the study were collected in a survey of local A&D firms. An initial list of 37 companies was compiled using contact files from Commerce with additional input from industry representatives. Completed surveys were obtained from 19 of these companies, including all of the very large employers. Based on initial estimates of company employment, the completed surveys appear to cover approximately 90 percent of total A&D employment in the state.

The survey was administered jointly by Commerce and the L. William Seidman Research Institute in the W. P. Carey School of Business at Arizona State University. By targeting known A&D firms in a special survey, one can obtain a more precise measure of the size of the industry than is possible from government statistics. The survey also provides information not available from other sources, such as purchases by A&D firms from Arizona vendors and state and local taxes paid by A&D firms.

The survey collected data for 2008 and 2009 on economic statistics important for conducting an economic impact analysis of the industry. Averaging the two years, the surveyed firms collectively employed 36,100 Arizona workers with a total annual payroll of $3.9 billion. Arizona A&D firms annually purchased $2.1 billion worth of goods and services from local suppliers.

One of the most important indicators of an industry's economic and fiscal impact is employee compensation per worker. As measured in the survey, compensation per employee in the Arizona A&D industry is approximately $109,000. This is 2.3 times the statewide average for all employed individuals.

Estimates of economic impacts were made with the aid of an Arizona-specific version of IMPLAN, an input-output model used widely by researchers throughout the United States. In measuring the impact of supplier linkages, IMPLAN was used to specify the detailed commodity requirements of each A&D industry. The survey data were used, however, to estimate the percent of total supplier purchases that are made from Arizona producers. IMPLAN also was used to measure the multiplier effects relating to consumer spending and spending by state and local governments out of new tax revenues.

In the interest of gaining a more complete sense of the industry's impact on the local economy, the survey numbers and their corresponding impacts were rescaled to adjust for aerospace-defense firms that did not complete the survey but for which employment could be estimated from other sources. This adjustment served to increase the size of the economic impacts by about 11 percent.

Including multiplier effects, and citing results for 2009, the Arizona A&D industry can account for a total of 93,800 jobs, labor income of $6.9 billion, and gross state product of $8.8 billion. The A&D companies themselves employ 39,400 individuals with a total payroll of $4.3 billion. Purchases of goods and services by A&D companies from Arizona suppliers generate 17,000 jobs and labor income of $1.1 billion. The most important multiplier effect derives from the local consumer spending of employees of A&D companies and their suppliers. These effects are responsible for 30,000 jobs and labor income of $1.2 billion.

This report also estimates the direct contributions of A&D companies and their employees to Arizona state and local taxes. Information on business taxes paid by A&D companies is taken directly from the survey. Individual income, sales and residential property taxes paid by A&D employees are estimated. The results suggest that the industry directly contributes approximately $300 million each year to Arizona state and local tax revenues.

An important public policy issue that arises in connection with the presence of an industry in a local economy is whether the industry generates enough in state and local tax revenues to cover the cost of public services delivered to the firms, their employees and families. Because public services at the state and local level are driven primarily by population, it is possible to assess the net fiscal impact of an industry by comparing taxes generated per industry employee with the statewide ratio of total taxes to total employment. Because of the high earnings of its employees, total A&D taxes per worker are about 10 percent above the statewide average. Specifically, total taxes per employee are $7,450 in the industry as compared with an average across the state of $6,691 per worker. These results suggest that the aerospace-defense industry in Arizona has a net positive fiscal impact, generating a surplus in tax revenues that may be used to subsidize public services for other households and businesses.

Exhibit 1-List of Survey Participants

Alliant TechSystems, Inc
Applied Energetics
BAE Systems
Boeing Company, The
Bombardier Aircraft Services
Engineering Science Analysis
General Dynamics C-4 Systems
Goodrich Interiors
Honeywell Aerospace
Hamilton Sunstrand Aerospace
Kutta Technologies
L-3 Electro-Optical Systems
Nammo Tally, Inc.
Orbital Sciences Corp.
Paragon Space Development Corp.
Planetary Science Institute
Qwaltec, Inc.
Raytheon Missile Systems
Universal Avionics Systems Corp

Exhibit 2 Summary of Primary Data from the Arizona A&D Survey

	2008	***2009***
Total Number of Employees	*36,548*	*35,559*
Total wages and Salaries (in millions)	*$2,946.8*	*$2,863.7*
Total Employee Compensation (in millions)	*$3,948.7*	*$3,894.60*
Total Purchases from Arizona Suppliers (in millions)	*$2,376.7*	*$1,864.10*
Compensation per employee	*$108,000*	*$109,500*
Supplier purchases per employee	*$65,000*	*$54,400*

Exhibit 3 Economic Impact of the Arizona A&D Industry, 2008

	Gross State Product ($ millions)	***Labor Income ($ millions)***	***Employment***
Direct Impact from A&D Company Operations	*$4,965.7*	*$4,371.2*	*40,474*
Direct Impact from Arizona Suppliers purchases	*$1,830.6*	*$1,349.1*	*21,849*
Indirect impacts from consumer spending by A&D employees and employees of A&D suppliers	*$2,172.4*	*$1,250.3*	*32,014*
Indirect impacts from spending of new state and local government tax revenues	*$402.2*	*$326.8*	*7,387*
Total Economic Impact	***$9,370.9***	***$7,297.4***	***101,724***

Exhibit 4- Economic Impact of the Arizona A&D Industry, 2009

	Gross State Product ($ millions)	***Labor Income ($ millions)***	***Employment***
Direct Impact from A&D Company Operations	*$4,897.6*	*$4,311.3*	*39,389*
Direct Impact from Arizona Suppliers purchases	*$1,433.4*	*$1,054.9*	*17,059*
Indirect impacts from consumer spending by A&D employees and employees of A&D suppliers	*$2,036.7*	*$1,172.1*	*30,014*
Indirect impacts from spending of new state and local government tax revenues	*$401.7*	*$326.7*	*7,377*
Total Economic Impact	***$8,769.4***	***$6,865.0***	***93,839***

A&D Industry News and Facts

- *Annually Arizona receives over $13 billion in federal contracts. (FedSpending.org - 2008)*
- *Annually Arizona Aerospace Exports were $2.037 billion (AZ Commerce-international website)*
- *Governor Jan Brewer allocated $1.3 million to boost the state's A&D industry and help the state become more globally competitive in this growing and fast-paced sector. (Governor Brewer- Oct 2010)*
- *Arizona is ranked 5th in the nation for Defense Electronic jobs, employing 8,661. (TechAmerica Cyberstates 2010 Report)*
- *Boeing announced $247 million in new A&D business in Arizona. The company will begin initial production of the U.S. Army's AH-64D Apache Block III helicopter, the most advanced multi-role combat helicopter in the world. (BizJournal-Oct 2010)*
- *Tucson and Phoenix are two of the "Top 10 metro areas for aerospace/defense manufacturing" (Business Facilities Magazine 2010)*
- *Sargent Aerospace & Defense, a leading supplier of precision engineered components and aftermarket services, and an operating company within Dover Corporation's Industrial Products Segment, announced that it has chosen the Tucson region to expand and upgrade its operations in support of current and projected business growth.(Sargent Controls Website)*
- *Yuma Proving Grounds hosts the testing of Zephyr, a solar-powered unmanned aerial vehicle (UAV), attracted international attention for the two-week duration of its test flight. (Aviation Week)*
- *NASA Gears up For Exploration Exercise, Planetary rovers, a portable habitat, charging stations and geological tools will be tested in Arizona. (Aviation Week))*
- *U.S. News & World Report Ranks Aerospace Engineering Program at Embry-Riddle Best in Nation for 11th Straight Year, Embry-Riddle's Prescott campus ranked 3rd in America's Best Colleges for Master degrees in Aerospace/Aeronautical/Astronautical Engineering Programs. (U.S. News & World Report)*
- *Arizona hosted the annual Aviation Week A&D Programs Conference, 2010 Intelligence Surveillance & Reconnaissance (ISR) Requirements Day, Homeland Security Expo in Phoenix, Empire Challenge 10 at Fort Huachuca.*
- *Boeing moved production of its A160 Hummingbird unmanned helicopter from California, to Boeing military rotorcraft hub in Mesa, Arizona (FlightGlobal-March 2010)*
- *The University of Arizona and Honeywell have signed a "memorandum of understanding" to collaborate new research projects. The primary purpose of the research agreement is to eliminate much of the red tape inherent in any joint research project between industry and academia. (University of Arizona-November 2010)*
- *Arizona was awarded 583 Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Phase 1 and Phase 2 from 2000-2009 in the amount of $173 million.*
- *FAA has qualified CAE to offer pilot training ground school for the Eurocopter AS350 through its Simfinity e-learning program. Students are able to complete a pre-simulator review and qualification exam online before training with the CAE 3000 Series helicopter mission simulator in Phoenix, Ariz. (AviationToday- Nov 2010)*
- *Orbital Sciences is to acquire the spacecraft development and manufacturing business of General Dynamics' GD Advanced Information Systems subsidiary for an undisclosed sum. The business, in Gilbert, Arizona, is close to Orbital's 1,300-employee launch vehicle engineering and manufacturing facilities in Chandler and will add about 325 new employees to Orbital. (Orbital Science- March 2010)*
- *Paragon Space Development Corp. was named a Space Pioneer by NASA and awarded one of the first five Commercial Crew Development Space Act Agreements with NASA. Under the agreement Paragon successfully tested its new spacecraft life support system, the first such test in over 30 years. Paragon was also named the fastest growing private aerospace engineering firm in America by Inc. Magazine. (Paragon Space Development Corp.- August 2010)*
- *Arizona Economic Impact Study reported that compensation per employee in the Arizona A&D industry is approximately $109,000. This is 2.3 times the statewide average for all employed individuals. The Study also report on the multiplier effects, and citing results for 2009, the Arizona A&D industry can account for a total of 93,800 jobs, labor income of $6.9 billion, and gross state product of $8.8 billion. (Arizona Economic Impact Study 2010)*

Notable Companies, Universities, and Colleges that support A&D

BAE Systems Inc, The Boeing Company, Embraer Execute Jet Services, Evergreen Maintenance Center Inc., General Dynamic Corporation, Goodrich Corporation, Hamilton Aerospace Technology, Honeywell Aerospace, Lockheed Martin Corporation, MD Helicopters Inc., Raytheon Missile Systems, Standard Aero Holdings Inc., Timken Aerospace, Triumph Engineered Solutions, and Universal Avionics Systems Corporation.

University of Arizona (UA), Arizona State University (ASU), Northern Arizona University (NAU), Embry Riddle Aeronautical University, Maricopa Community Colleges, and Pima Community Colleges.

"Note: This table identifies the key Duties of the Arizona Aerospace & Defense Commission (left column) in accordance with A.R.S 41-1564. The four columns to the right identify the compliance matrix for the Commission's Strategic Plan to these duties.

		Aerospace and Defense Commission Strategies			
	A.R.S §41-1564 A&D strategic plan; requirements; report *A. The Commission shall develop, use and maintain an aerospace and defense strategic plan that builds synergy between government, industry and education. The strategic plan shall:*	***Improve Arizona's Business Environment***	***Create a Robust Pipeline of Business and Entrepreneurial Opportunities to Fuel Growth***	***Build Arizona's Research Competitiveness***	***Attract, Educate, Retain and Retrain Arizona's Skilled Workforce***
1.0	*Establish external communications & public information linkage to address and inform citizens and decision makers about aerospace and enterprises in this state.*	X	X	X	X
2.0	*Broaden and strengthen the communication and cooperation between the various key elements within the enterprises of commercial aviation, general aviation, defense, education, space, manufacturing, service and support and research and development.*	X	X	X	X
3.0	*Research and analyze economic, employment, competitive, capability, capacity and technology statistics to substantiate the health of the various enterprises.*	X	X	X	X
4.0	*Foster and leverage public or private partnerships to retain and promote aerospace, defense industries, related industry sectors and strategic zones of importance to the various enterprises.*	X	X	X	
5.0	*Facilitate growth of existing industrial assets and new business opportunities for the A&D enterprise supplier base.*	X	X		
6.0	*Provide procedures to liaison with other state and federal entities with related economic, educational, developmental and defense responsibilities or interests to support marketing of this state's unique A&D capabilities and assets.*	X	X	X	X
7.0	*Provide leadership and administrative support for targeted programs and incentives that promote A&D industry retention and development in this state.*	X	X	X	X
8.0	*Work to assure the workforce in this state is well trained, motivated and highly skilled in the areas important to A&D enterprises.*			X	X
9.0	*Work with educational institutions to encourage innovation and help attract A&D related research and development to this state.*		X	X	X

Improve Arizona's Business Environment - 2011 Recommendations

Evaluate the current business environment and the effectiveness of current Arizona policies to provide a foundation for advancing the industry. Develop and implement a market strategy to restore Arizona to a leading position and define Arizona's value proposition for the A&D Industry.

- *Create a "sense and respond" mechanism focused on A&D at the State level to proactively monitor and adapt to an ever-changing business and regulatory climate.*
- *Focus business development on retention, expansion and attraction of the industry in Arizona by evaluating the business climate and incentives with regard to domestic and international competitors and ensure the Commerce has the tools to compete.*
- *Collaborate with the new Commerce's A&D Growth Sector to champion 21st century economic development programs that build Arizona's knowledge and innovation based economy.*
- *Inventory and globally market Arizona's A&D capabilities and potential to include logistical and military assets including airports, roadways, rail, light rail and government installations.*
- *Collaborate with local jurisdictions, the Arizona Military Affairs Commission, and other Stakeholders to review and mitigate impacts by demands on land use surrounding civilian and Department of Defense (DOD) airports.*
- *Champion natural resources through such programs as the Dark Skies Initiative, as required to retain A&D related activities.*

2010 Report on Improving Arizona's Business Environment

The A&D industry remains a critical component of the Arizona economy. Arizona continued to face a challenging budget and economic environment in 2010, as did the nation. Below are measures of progress taken regarding improvement of Arizona's business environment with respect to the A&D industry.

Arizona Department of Commerce/Arizona Commerce Authority

- *On June 29, 2010, Governor Jan Brewer issued an Executive Order establishing the ACA. Pending creation of the ACA in statute, this measure addresses the first three of the recommendations proposed in this Strategy.*
- *As the U.S. defense market is anticipated to decrease, the competition among states will continue to increase. Arizona A&D firms from large prime contractors to second and third tier suppliers, will benefit if the ACA is able to: monitor and respond to the competitive environment; employ incentives relative to the competitive environment; and focus on the growth direction of the industry in the 21st century.*

Inventory and Globally Market Arizona's Aerospace and Defense Capabilities

- *With input from the Commission, Commerce has undertaken a new branding and marketing effort for Arizona aerospace and defense. Commerce held a series of four public listening sessions across the state to hear from stakeholders on the strengths and weaknesses of support of the industry.*
- *Commerce has identified the following A&D value proposition:*

  Arizona has always attracted a certain type of person – the pathfinder, the builder, the explorer. That is why industries that depend on innovation to survive, like Aerospace and Defense, have prospered in Arizona. World class universities, large prime contractors and low operating costs are only part of the story. Find out more about Arizona.

ASU Economic Impact Study

- *In September, L. William Seidman Research Institute at ASU completed an economic impact study on the industry in Arizona.*
- *The study noted the average compensation for industry employees is 2.3 times the statewide average for all employed individuals reflecting the high level of skills (e.g., engineering skills) required.*
- *Of an area for future focus, the study noted unexpectedly low numbers reported by industry purchases of intermediate goods and services from Arizona suppliers.*

Dark Skies Initiative – Next Steps

- *The Commission met with key members of Arizona's Dark Skies Initiative on August 27, 2010. The Commission subsequently endorsed the University of Arizona's proposal to retain the National Solar Observatory and also, sent white papers to the Governor's office to establish a working group to analyze the requirements to improve the State's Dark Skies.*

2011 Focus for Improving Arizona's Business Environment

- *Make recommendations on draft legislation for establishment of Commerce in statute.*
- *Analyze tools of new Commerce relative to competitor states.*
- *Identify opportunities for federal, state, and local government officials to collaborate in support of the Arizona A&D.*

Create a Robust Pipeline of Business and Entrepreneurial Opportunities to Fuel Growth - 2011 Recommendations-

Create and expand Arizona's pipeline of business opportunities throughout the State's industrial value chain to strengthen and exploit current assets within the entire State. Maximize Arizona's value generated from the State's industry by providing key technology linkages to new A&D requirements. Market the key State programs that enhance the entrepreneurial opportunities within the industry.

- *Develop and implement Arizona Remote Pilot Vehicle (RPV)/ Unmanned Aircraft Systems (UAS) and Intelligence Surveillance & Reconnaissance (ISR) framework. Stakeholders include: ATC, Science Foundation Arizona (SFAz), ACE, and existing state industry partners along with UA and ASU.*
    1. *Organize working group and develop requirements*
    2. *Build System, Operational and Technical Views of State RPV/ UAS Framework*
    3. *Coordinate with stakeholders, military installations, ACA, State Military Affairs Committee, Congressional delegation staff.*
    4. *Identify opportunities develop capability statements and advertise Arizona capabilities nationally.*

- *Establish an Aerospace and Defense SBIR/STTR Collaborative. Stakeholder includes: ASU, UA, SkySong, UA Technology Park, Industry, Small Businesses, Regional Economic Development Teams, ATC and SFAz.*
    1. *Organize Industry/Academic/Small Business teams at SkySong and UA Tech Park*
    2. *Target 11-02 and 11-03 SBIR/STTR Solicitations*
    3. *Select topics, recruit participants, engage with topic author*
    4. *Double the number of proposals submitted from 11-02 to 11-03 Solicitation and increase smaller AZ community participation*

- *Promote business participation in the SFAz Arizona Aerospace and Initiative (AZADI). Promote business participation and develop a core competence in Modeling and Simulation.*

2010 Report on Creating a Robust Pipeline

This subcommittee focused on promoting robust communication throughout the A&D industry, as well as identifying mechanisms to confer a competitive advantage to Arizona A&D companies. Emphasis was on web presence and outreach to industry partners to foster collaboration, opportunities and programs like the refundable Research and Development (R&D) tax credits. Extensive progress made by the Commerce, ATC and SFAz have a significant positive effect on Arizona's competitiveness in attracting, growing, and retaining A&D and technology companies. A major accomplishment in 2010 was the development of a template for a dedicated aerospace and defense website.

Improved linkages

- *Engaged with professional associations such as the ATC, NDIA, Arizona MEP, ACE, the Armed Forces Communications Electronics Association, and the Southwest Defense Alliance.*
- *Participated in Aviation Week's A&D Conference.*
- *Established communications with Military Legislative Officers and the Arizona Congressional Delegation.*

UAS testing ground/facility in Arizona

- *Led a proposal for a Small Business Administration (SBA) RPV/UAS-ISR contract that, though unsuccessful, established a statewide collaboration of 15 organizations to be engaged for future opportunities.*
- *Collected valuable source data at the AUVSI Unmanned Systems 2010 conference.*
- *Contacted organizations such as ACEs who are working to create a dedicated UAS test facility, however little progress has been made as compared to other states, such as New Mexico.*

AZFAST program and SBIR/STTR Outreach

- *The loss of funding for the AZFAST program combined with the presence of such support programs in other states reduces the overall competitiveness of Arizona small businesses. Commerce seeks to reinstate the program in the first quarter of 2011.*
- *The Commission strongly encourages creation of a SBIR/STTR Matching Fund Program similar to Kentucky, North Carolina, Oklahoma, Michigan, etc. that have proven results improving federal contract win rates in the state.*

Smaller Arizona Communities

- *Through the Governor's recent commitment of $2M to rural Arizona, smaller communities will leverage regional assets and attract companies to cluster around available infrastructure.*
- *Programs such as the Job Training Fund, with portions earmarked for rural Arizona, are important in smaller communities as they help maintain a competitive workforce.*

2011 Focus for Creating a Robust Pipeline of Business and Entrepreneurial Opportunities to Fuel Growth

- *Establishment of an SBIR/STTR Matching Fund Program similar to Kentucky, North Carolina, Oklahoma, Michigan, etc. that have proven results increasing win rates for federal research contracts in the state. Facilitate collaboration among SBIR/STTR participants (industry, small business, and academia) to fuel small business innovative research.*
- *Work with industrial, science and technology organizations such as SFAz and ATC to develop and retain key capabilities such as modeling and simulation, cyberspace and micro technologies; as well as programs that confer a competitive advantage to the Arizona A&D Industry. These include the Job Training Fund, Creation of an SBIR/STTR Matching Fund Program, Angel Investment Tax Credit, and the Refundable R&D Tax Credit.*
- *Work with stakeholders to develop an RPV/UAS framework for Arizona. Identify system, operational and technical aspects that make Arizona competitive in the RPV/UAS environment. Market Arizona advantage and target opportunities. Develop pursuit teams and celebrate victories.*

Build Arizona's Research Competitiveness - 2011 Recommendations

Position Arizona at the cutting edge of the research agenda in A&D specific sectors by strengthening and marketing existing programs, seeking new opportunities in growth areas that align with national and global research and development objectives, and complementing industry and academic core competencies in Arizona.

- *Foster and leverage public or private partnership/organizations as they seek to retain and promote aerospace, defense, and related industries.*
- *Strengthen communication and cooperation within the various key elements of A&D; and encourage innovation and attraction of A&D-related research to the State.*
- *Support and promote academic centers of excellence in aviation, aerospace, homeland security and border security.*
- *Assure that Arizona industry and government understand and align, as able, with the US aerospace research agenda, as partially revealed in the National Aeronautical R&D Policy, the Office of Space Commercialization Strategy, UAS Roadmap, and the US Defense Modernization Roadmap.*
- *Evaluate and identify untapped or growth opportunities in UAS ,ISR and Next Generation Air Transportation System (NextGen) research and education, and encourage growth of related research activities and academic partnerships with industry.*
- *Better leverage and market the State's Astronomy, Planetary Sciences, and Space Sciences (APSSS) assets including Arizona Federally Funded Research Development Centers (FFRDCs).*
- *Promote and quantify fiscal and employment impact for the Arizona Research Tax Incentive.*

2010 Report on Building Arizona's Research Competitiveness

Foster and Leverage Public or Private Partnership/Organizations

Three new organizations have been identified as follows:

- *Arizona State University Security & Defense Systems Initiative (SDSI) - attached http://www.azcentral.com/business/articles/2010/11/03/20101103biz-defenseinstitute1103.html#comments#ixzz14Kbg9oxl*
- *SFAZ Aerospace & Defense Initiative (AZADI) - http://www.sfaz.org/live/collection/press/10996?subid=112214*
- *SFAZ seeded the ASU-led Aerospace & Defense Collaboratory - http://www.sfaz.org/live/collection/press/10996?subid=112217*

Support & Promote Academic Centers of Excellence (COEs)

Contacted Universities to identify COEs & Champions; catalogued resources on subcommittee website http://www.esacorp.com/subcomm/Subcommittee2.htm to support and promote COEs and to facilitate collaboration between centers and industry.

Assure Arizona Industry Alignment

Arizona Commerce internet linkage to government and industry reports were updated.

Evaluate and Identify Growth Opportunities

ISR technologies were identified as potential growth opportunities for Arizona. These complimentary technologies appear to be promising economic engines in R&D relating to sensor/optics, communication, data fusion, cognitive recognition, and energy/endurance of A&D platforms.

Better Leverage & Market APSS Assets

- *Engaged leadership of National Optical Astronomy Observatory (NOAO) and National Solar Observatory (NSO) to understand the impact of these FFRDCs on Arizona's economy.*
- *Submitted a letter of support to retain NSO in Arizona.*

2011 Focus for Building Arizona's Research Competitiveness

- *Work with public/private partnership in collaboration with SFAZ.*
- *Promote collaboration between industry and Arizona COEs through use of Arizona A&D website (in development) and the Arizona Innovation website (innovationaz.com)*
- *Continue to identify and disseminate information on federal funding opportunities, Defense and technology roadmaps, and economic development best practices that support R&D in Arizona.*
- *Identify NEXTGEN stakeholders in Arizona to discover untapped growth opportunities*
- *Promote APSSS, including the NOAO and NSO, in collaboration with SFAz*

Attract, Educate, Retain and Retrain Arizona's Skilled Workforce – 2011 Recommendations

Position Arizona as a first-tier destination for A&D knowledge-based industries by investing in and emphasizing education and training, facilitating school-to-work initiatives, and promoting Arizona programs that will generate national and global recognition. Recommendations that support this strategy are presented below, in three major areas (1) Attract, (2) Educate and (3) Retain and Retrain.

Attract

- *Inventory and leverage social networks, industry-relevant websites, and employers to engage youth and promote inspiration, mentoring and exploration of A&D careers.*

Educate

- *Support initiatives related to training and education with targeted investment in K-12 Science, Technology, Engineering & Mathematics (STEM) education, in line with the Governor's P20 Council recommendations and via Aerospace Academies (dedicated locations and school-within-a-school model).*
- *Support and promote Arizona-based aeronautical engineering, aviation (e.g., aeronautical science/flight, maintenance, business, and technology), space studies, math and defense (e.g. military science, intelligence/security) programs at public and private academic institutions.*
- *Facilitate A&D oriented curriculum alignment and credit transfer between secondary and post-secondary academic institutions in Arizona.*
- *Encourage A&D-related collaborations, including industry involvement in teaching/learning, faculty development, school-to-work transition (internship/co-ops and mentoring), and lifelong learning for those in industry and academia.*

Retain and Retrain

- *Support programs in initial and adaptive workforce training (including adult worker transition) required for high quality technical and trade positions, to include supporting union-certified training.*
- *Create opportunities/pathways for interested professionals into academia (such as current or retired industry) and for sharing expertise between different segments of academia.*
- *Promote awareness and support training for small business owners in key areas such as ISO/AS Certification and Federal program assessments (e.g., technology, business and manufacturing readiness levels) so that small businesses are better prepared to compete.*
- *Support Arizona high school-to-college initiatives and post-secondary incentives (scholarships and fellowships) and transition-to-work programs that encourage promising students to remain in the State for college and/or career.*

2010 Report on Skilled Workforce

Via numerous interviews, meetings, literature review, and data collection, the Skilled Workforce subcommittee identified community and industry stakeholders and activities that compliment AADC goals for this strategy. This "asset inventory" linked 2009 Skilled Workforce Recommendations with available talent, resources and initiatives, including:

- *Statewide initiatives that support the development of PK-20 pathways and faculty development.*
- *National industry-based skills training and certification supported by Arizona institutions of higher education.*
- *Regional skills competitions that provide youth with exposure to technology careers and the importance of STEM education.*
- *Federal and/or state funding for programs which supports the development of curriculum and fosters the smooth transition of students along the k-16 pipeline.*
- *System modeling tools and data sets for evaluating the effect of possible changes in the education system.*
- *Statewide and regional workforce studies and surveys that provide current information on workforce demand and skill requirements.*
- *Federal workforce development dollars that can be used for training/retraining of Arizona's workforce.*
- *Regional industry sponsored extracurricular activities that engage youth and young adults in technology areas.*
- *National and local resources to inspire, attract, educate, and employ individual in the aerospace and other high tech industry segments.*
- *Industry associations and organization linkages at the national and local level to promote sharing of best practices and lessons learned.*

Creation of this asset inventory confirmed progress in eight of the twelve former Skilled Workforce recommendation areas, including identification of a "champion" and/or synergistic programs, activities, or initiatives. However, there is ample room for additional progress in the Commission's efforts to attract, educate, retrain and retain Arizona's skilled workforce, particularly in light of fiscal challenges in Arizona that threatened to slow or reverse progress.

Thus, for the 2010 Annual Report, the number of Skilled Workforce recommendations has been reaffirmed, but narrowed to nine, via the actions noted below:

- *Recommendation Consolidation - (Last year's #3 & 6, #5 & 7, and #8 & 10), as it was determined there is opportunity for synergy between those stakeholders/activities jointly, that may not be realized (or funded) separately.*
- *Recommendation Retention - (Last year's #2, #4, #9, #11, #12), as limited progress was achieved.*
- *Recommendation Retirement - (Last year's #1), now covered as a "Business Environment" goal.*

2011 Focus for Attracting, Educating, Retaining and Retraining Arizona's Skilled Workforce

In support of the 2011 recommendations, the Commission will seek opportunities for further collaboration between academia, industry and A&D associations where the joint assets, capabilities and resources can serve to support or accomplish our goals. Accordingly, the Commission will seek "champions" and/or resources to support the following prioritized initiatives:

- *Development of an A&D Resource Portal for employers, employees, students and faculty which will allow these stakeholders to access information on careers, education, training, internships, tutoring, mentoring, lifelong learning opportunities, etc.*
- *Funding and deployment of the Arizona Aerospace Academy (school-within-a-school) model.*
- *Promotion of merit based scholarships or other initiatives that will serve to entice promising students/graduates with A&D-related skills/education to remain in the State.*

A&D Commission References

(All Resources are Located on http://www.azcommerce.com/Councils/Arizona+Aerospace+and+Defense+Commission.htm)

Industry Reports

- *Aerospace and Defense 2010 Economic Impact Study*
- *Arizona Value Proposition Focus Group Research-Final Report An Initial Assessment – Creating an Arizona Aerospace Institute*
- *Advancing Arizona's Innovation Economy*
- *Astronomy, Planetary Sciences, and Space Sciences Research Opportunities to Advance Arizona's Economic Growth Presentation*
- *AZ Aerospace, Defense, and Avionics Industries Study*
- *Department of Defense Quadrennial Defense Review and Science and Technology*
- *Economic Impact Analysis Information - Airport Cooperative Research Program*
- *Economic Impact Analysis Information, The Boeing Company*
- *Economic Impact of the Ground-Based Midcourse Defense Program in the State of Arizona*
- *Economic Impact Study - Aerospace and Defense 2010*
- *Federal Spending*
    - *Contracts Performed in Arizona FY2006*
    - *Contracts Performed in Arizona FY2007*
    - *Contracts Performed in Arizona FY2008*
- *National Aeronautics Research and Development Policy*
- *Office of Space Commercialization Strategic Plan, U.S. Department of Commerce/National Oceanic and Atmospheric Administration*
- *Report of the Interagency Aerospace Revitalization Task Force*
- *Unmanned Aircraft Systems Roadmap 2005-2030*
- *U.S. Aerospace Industry: Progress in Implementing Aerospace Commission Recommendations, and Remaining Challenges*
- *U.S. Defense Modernization Readiness for Now and for the Future*

Aerospace and Defense Commission's Annual Reports

- *2009 Commission Report*
- *2008 Commission Report*
- *2006 Commission Report*
- *2005 Commission Report*

Issue Forms Submitted to the Aerospace and Defense Commission:

- *Preserving our Resource of Dark Skies for Arizona's APSS Sector*
- *Science Foundation Arizona Support for Collaborative Development of Arizona APSS Enterprises*
- *A Physical Science Complex at the University of Arizona*
- *Arizona Center of Excellence*

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THE ECONOMIC IMPACT OF AEROSPACE AND DEFENSE FIRMS ON THE STATE OF ARIZONA

Final Report
September 2010

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Executive Summary

The purpose of this report is to measure the impact of aerospace and defense (A&D) companies on employment and income in Arizona. Estimated impacts include both the direct effects of the operations of A&D firms and their first-tier suppliers and the so-called multiplier effects that arise when employees spend a portion of their incomes and governments spend new tax revenues. The report also provides estimates of the contributions A&D companies and their employees make to Arizona state and local tax revenues.

The primary data used in the study were collected in a survey of local aerospace and defense firms. The survey was administered jointly by the Arizona Department of Commerce and the L. William Seidman Research Institute in the W. P. Carey School of Business at Arizona State University. By targeting known A&D firms in a special survey, one can obtain a more precise measure of the size of the industry than is possible from government statistics. The survey also provides information not available from other sources, such as purchases by A&D firms from Arizona vendors and state and local taxes paid by A&D firms.

An initial list of 37 companies was compiled using contact files from the Arizona Department of Commerce with additional input from industry representatives. Completed surveys were obtained from 19 of these companies, including all of the very large employers. Based on initial estimates of company employment, the completed surveys appear to cover approximately 90 percent of total A&D employment in the state.

The survey collected data for 2008 and 2009 on economic statistics important for conducting an economic impact analysis of the industry. Averaging the two years, the surveyed firms collectively employed 36,100 Arizona workers with a total annual payroll of $3.9 billion. Arizona A&D firms annually purchased $2.1 billion worth of goods and services from local suppliers.

One of the most important indicators of an industry's economic and fiscal impact is employee compensation per worker. As measured in the survey, compensation per employee in the Arizona A&D industry is approximately $109,000. This is 2.3 times the statewide average for all employed individuals.

Estimates of economic impacts were made with the aid of an Arizona-specific version of IMPLAN, an input-output model used widely by researchers throughout the United States. In measuring the impact of supplier linkages, IMPLAN was used to specify the detailed commodity requirements of each A&D industry. The survey data were used, however, to estimate the percent of total supplier purchases that are made from Arizona producers. IMPLAN also was used to measure the multiplier effects relating to consumer spending and spending by state and local governments out of new tax revenues.

In the interest of gaining a more complete sense of the industry's impact on the local economy, the survey numbers and their corresponding impacts were rescaled to adjust for aerospace-defense firms who did not complete the survey but for whom employment could be

estimated from other sources. This adjustment served to increase the size of the economic impacts by about 11 percent.

Including multiplier effects, and citing results for 2009, the Arizona aerospace and defense industry can account for a total of 93,800 jobs, labor income of $6.9 billion, and gross state product of $8.8 billion. The A&D companies themselves employ 39,400 individuals with a total payroll of $4.3 billion. Purchases of goods and services by A&D companies from Arizona suppliers generate 17,000 jobs and labor income of $1.1 billion. The most important multiplier effect derives from the local consumer spending of employees of A&D companies and their suppliers. These effects are responsible for 30,000 jobs and labor income of $1.2 billion.

This report also estimates the direct contributions of A&D companies and their employees to Arizona state and local taxes. Information on business taxes paid by A&D companies is taken directly from the survey. Individual income, sales and residential property taxes paid by A&D employees are estimated. The results suggest that the industry directly contributes approximately $300 million each year to Arizona state and local tax revenues.

An important public policy issue that arises in connection with the presence of an industry in a local economy is whether the industry generates enough in state and local tax revenues to cover the cost of public services delivered to the firms, their employees and families. Because public services at the state and local level are driven primarily by population, it is possible to assess the net fiscal impact of an industry by comparing taxes generated per industry employee with the statewide ratio of total taxes to total employment. Because of the high earnings of its employees, total A&D taxes per worker are about 10 percent above the statewide average. Specifically, total taxes per employee are $7,450 in the industry as compared with an average across the state of $6,691 per worker. These results suggest that the aerospace-defense industry in Arizona has a net positive fiscal impact, generating a surplus in tax revenues that may be used to subsidize public services for other households and businesses.

The Economic Impact of Aerospace and Defense Firms on the State of Arizona

I. Introduction

The purpose of this report is to measure the impact of aerospace and defense (A&D) companies on employment and income in Arizona. Estimated impacts include both the direct effects of the operations of A&D firms and their first-tier suppliers and the so-called multiplier effects that arise when employees spend a portion of their incomes in the local economy and when state and local governments spend new tax revenues.

The primary data used in the study were collected in a survey of local aerospace and defense firms. The survey was administered jointly by the Arizona Department of Commerce and the L. William Seidman Research Institute in the W. P. Carey School of Business at Arizona State University. By targeting known A&D firms in a special survey, one can obtain a more precise measure of the size of the industry than is possible from government statistics, where firm survey data are classified using alternative industry definitions. The survey also provides information not available from other sources, including purchases by A&D firms from Arizona vendors and state and local taxes paid by A&D firms.

Estimates of economic impacts were made with the aid of an Arizona-specific version of IMPLAN, an input-output model used widely by researchers throughout the United States. In measuring the impact of supplier linkages, IMPLAN is used to specify the detailed commodity requirements of each A&D industry. The survey data are used, however, to estimate the percent of total supplier purchases that are made from Arizona producers. IMPLAN also is used to measure the multiplier effects relating to consumer spending by employees and the spending of state and local tax revenues by governments.

The report also provides estimates of the direct impact of A&D operations on Arizona state and local tax revenues. These taxes include the business taxes paid by A&D companies and the individual income, sales and property taxes paid by A&D employees. By comparing total direct taxes per employee in the A&D industry with the statewide ratio of taxes to employment, it is possible to assess whether aerospace-defense companies and their employees contribute more in taxes than they receive in public services.

II. Survey of Aerospace-Defense Firms

A survey of Arizona aerospace-defense companies was undertaken in the late spring and early summer of 2010. The survey was administered jointly by the Arizona Department of Commerce and the L. William Seidman Institute in the W. P. Carey School of Business at Arizona State University. An initial list of 37 companies was compiled using contact files from the Arizona Department of Commerce with additional input and oversight from industry representatives. Completed surveys were obtained from 19 of these companies, including all of

the very large employers. Based on initial estimates of company employment, the completed surveys appear to cover approximately 90 percent of total A&D employment in the state.

The survey was written to collect information important for conducting an economic impact analysis of the industry. The following information was requested from each company.

- *Description of productive activity:* This information was used to assign a six-digit NAICS code to each company. The NAICS code was then used to link the company to one of the 427 industry sectors in IMPLAN.

- *Employment in 2008 and 2009*

- *Wages and salaries in 2008 and 2009*

- *Employee compensation in 2008 and 2009:* Figures were to include wages, salaries and fringe benefits, including employer contributions to health care and retirement plans.

- *Purchases of goods and services from Arizona suppliers in 2008 and 2009:* To avoid double-counting, companies were asked to exclude purchases from other A&D companies who agreed to participate in the survey.

- *Business taxes paid to Arizona state and local governments in 2008 and 2009:* Figures were to include state corporate income taxes, sales taxes and property taxes.

The survey makes it possible to obtain a more precise measure of the size of the aerospace-defense industry than is available from government statistics. Regular surveys of employment and wages by the Bureau of the Census and the Bureau of Labor Statistics classify data by NAICS industry code. One NAICS industry (NAICS 3364) deals specifically with firms that manufacture aerospace products and parts. However, there is no clear scheme in the NAICS classification system for identifying defense-related activity. Firms producing under contract for the Department of Defense are scattered across several NAICS industries and, in many cases, these industries also include nondefense activity.

Another useful aspect of the survey is that it provides information not available from government sources. Particularly important for economic impact analysis is information on purchases by A&D firms from Arizona vendors and state and local taxes paid directly by A&D firms.

Exhibit 1 lists the 19 companies that completed the survey. The surveyed companies vary greatly in size (see Exhibit 2). One-third of the companies have fewer than 100 employees, while one-half have at least 500 employees.

Exhibit 3 provides a summary of some of the key findings from the survey. By any measure, economic activity in the aerospace-defense industry was moderately lower in 2009 than in 2008. Averaging the two years, the surveyed firms collectively employed 36,100 Arizona

workers. Total wages and salaries were $2.9 billion, and total employee compensation (including benefits) was $3.9 billion. Arizona A&D firms purchased $2.1 billion worth of goods and services from local suppliers.

One of the most important indicators of an industry's economic and fiscal impact is employee compensation per worker. Industries with high compensation per worker have relatively large multiplier effects that operate through induced consumer and government spending. These industries also tend to make a net positive fiscal contribution to the state. As measured in the survey, compensation per employee in the Arizona A&D industry is approximately $109,000 on a size-weighted basis. This is 2.3 times the statewide average for all employed individuals (IMPLAN data files). The relatively high rate of compensation paid by aerospace-defense companies reflects the high level of skills (e.g., engineering skills) required of their employees. Exhibit 4 shows the entire distribution of survey findings for compensation per employee in 2009. Compensation per worker ranges from a low of $59,400 to a high of $163,300.

Given the large amount of vertical disintegration that has evolved in modern economies, it is incomplete and potentially misleading to simply look at a company's own employment and payroll when assessing the importance of the company to the local economy. Companies that are highly specialized rely on independent suppliers, many of whom are local, to produce essential parts, components and services. Thus an important goal of the survey was to obtain information from aerospace and defense companies on the value of the intermediate inputs they purchase from Arizona suppliers.

The survey results suggest that local vendor purchases are significant but considerably smaller than what is suggested by IMPLAN's internal data files (see Appendix A for more detail). Averaging results for the two years, supplier purchases were around $59,000 per employee, or 54 percent as large as payroll compensation per worker. Exhibit 5 shows the complete distribution of Arizona supplier purchases per employee for the year 2009. Ten of the 19 firms spent less than $25,000 per worker purchasing goods and services from Arizona vendors. There were two firms in the sample, however, that spent over $120,000 per worker on locally-produced intermediate inputs.

III. Economic Impact Analysis

A separate economic impact analysis was done for each of the years 2008 and 2009. The results are shown in Exhibits 6 and 7. The reader is referred to Appendix A for detailed notes on methodology and estimation procedures. Economic impacts are measured in terms of three variables: gross state product, labor income and employment.

The general size of the numbers is driven by results reported in the AA&D survey. However, in the interest of gaining a more complete sense of the industry's impact on the local economy, it was decided to rescale the numbers to adjust for known aerospace-defense firms who chose not to complete the survey. This adjustment was accomplished by using estimates of individual company employment for each of the nonrespondents and then assuming that their impacts per employee were the same as the values calculated for responding firms.

Nonrespondent companies are estimated to employ only 11 percent as many workers as do the firms that completed the survey.

We review the findings for 2009. Aerospace and defense firms in Arizona directly employ 39,400 workers and make income payments to labor totaling $4.3 billion. Purchases by A&D firms from Arizona suppliers can account for an additional 17,000 jobs and labor income of $1.1 billion.

Multiplier effects relating to the consumer spending of A&D employees and employees of suppliers add up to 30,000 Arizona jobs and labor income of $1.2 billion. Note that labor income per worker among the individuals whose jobs are supported by these multiplier effects is only $39,000—much smaller than the numbers on labor income per worker in the first two rows of the table. This is because many of the jobs supported by consumer spending in the multiplier process are in the service sector where skills and wages are relatively low and where part-time employment is more common.

Line four of the table shows the economic impacts that would result when state and local governments spend tax revenues directly generated from business taxes paid by A&D companies and individual taxes paid by A&D employees. The impacts are based on an estimate of $301 million for the direct taxes generated by A&D operations (see next section). When these monies are spent, the result is an additional 7,400 jobs and $0.3 billion in labor income.

Including all direct and indirect impacts, the Arizona aerospace and defense industry can account for a total of 93,800 Arizona jobs and $6.9 billion in labor income. The industry contributes $8.8 billion to gross state product—a broad measure of income that includes capital income as well as labor income.

IV. Impact on State and Local Tax Revenues

This section of the report provides estimates of the direct contributions of the aerospace-defense industry to Arizona state and local taxes. A&D companies themselves pay corporate income taxes, sales taxes and business property taxes. The figures used for these payments are the ones reported in the survey. A&D employees also pay individual income, sales and residential property taxes. The procedures used to estimate these taxes are explained in Appendix B. Individual taxes paid by employees are estimated on a company-by-company basis to account for differences in location which will affect sales and property tax rates. The contributions A&D employees make to Arizona taxes are based solely on their earnings. Taxes effectively generated from capital income received by households or income from working spouses are not considered, even though in some cases an A&D household might not reside in the state were it not for the employment the industry provides to the primary earner.

Our estimates of the state and local taxes directly generated by the aerospace-defense industry are shown in Exhibit 8. The industry generated approximately $300 million in tax revenues in each year. Employees contribute the lion's share of these taxes. Our calculations suggest that individual income, sales and property taxes account for 88 percent of the industry's total direct tax payments.

An important public policy issues that arises in connection with the presence of an industry in a local economy is whether the industry generates enough in state and local tax revenues to cover the cost of public service delivery to the firms, their employees and families. An industry with a net positive fiscal impact generates a surplus in tax revenues that may be used to subsidize public services for other households and businesses. Public service delivery at the state and local level is driven by population. Ignoring differences in the demographic makeup of households (e.g., population to employment ratios), it is possible to assess the net fiscal impact of an industry by comparing taxes generated per industry employee with the statewide ratio of total taxes to total employment. Such a comparison involving the aerospace-defense industry is shown in Exhibit 9. A separation of business taxes from individual taxes in the statewide figures was made using estimates from Ernst and Young (2009) on business taxes paid in Arizona in 2008. Arizona taxes are expressed on a per worker basis using estimates from the Bureau of Economic Analysis of total employment, including self-employed individuals.

According to the survey, business taxes paid by aerospace-defense firms in Arizona amount to $880 per employee. This is only 30 percent as large as the statewide figure on business taxes per worker. Because of their high earnings, however, an average A&D employee makes 1.7 times the contribution to state and local taxes made by an average Arizona worker. Individual taxes per A&D worker are $6,570 as compared with a statewide figure of $3,782. The large size of the tax contributions from employees is enough to leave total A&D taxes per worker a little more than 10 percent above the statewide average. Total taxes per employee are $7,450 in the aerospace-defense industry as compared with an average across the state of $6,691 per worker.

V. Recommendations for Future Study

An important finding in this study was unexpectedly low numbers reported by A&D companies for purchases of intermediate goods and services from Arizona suppliers. For nine of the twelve companies with at least 250 employees, the ratio of Arizona supplier purchases to company employee compensation was smaller in the survey than what is contained in IMPLAN's internal data files. In fact, the ratio in the survey was less than half of the IMPLAN ratio in eight of the cases. The data on local supplier purchases obtained from the survey then implied much smaller interindustry impacts than would be estimated in a routine IMPLAN run.

It would be useful to conduct a follow-up survey in which A&D companies are asked to detail the supplier purchases they make from companies located outside of Arizona. How firm are these out-of-state supplier relationships? Are close substitutes available from existing Arizona businesses? Or are the prices and/or technical standards of out-of-state products difficult to match by Arizona suppliers?

Sources

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Minnesota IMPLAN Group, Inc., *IMPLAN Professional: Social Accounting & ImpactAnalysis Software, Version 2.0* (Stillwater, MN).

Phillips, A.; Cline, R; and T. Neubig, "Total State and Local Business Taxes: 50 State Estimates for Fiscal Year 2009," Ernst and Young, January 2009.

U.S. Census Bureau, *State and Local Government Finances, FY 2008*, http://www2.census.gov/govs/estimate/08slsstab1a.xls

Appendix A: Economic Impact Calculations

Scope of impacts

The economic impacts measured in this study are classified into two groups. *Direct impacts* refer to the jobs and incomes immediately supported by A&D company operations and the productive activities of their first-tier suppliers. *Indirect impacts* are those arising from the consumer spending of company employees and the employees of local suppliers. Also considered among the indirect impacts are the jobs and incomes supported by the spending of state and local governments out of tax revenues obtained from A&D business taxes and the individual taxes paid by A&D employees.

Economic impact variables

Impacts are reported for three economic variables: gross state product, labor income and employment. *Gross state product* is a broad measure of income (value added) consisting of employee compensation, proprietor income, property income, and indirect business taxes. Employee compensation includes wages, salaries, bonuses, vacation and sick-leave pay, and employer contributions to retirement, health and life insurance plans. *Labor income* is the sum of employee compensation and proprietor income. *Employment* is a count of both full- and part-time jobs. Employment figures include both wage and salary workers and self-employed individuals.

The study area for the analysis was the state of Arizona. Impacts refer to jobs and incomes generated somewhere in the state.

The IMPLAN model

Estimates of economic impacts were made with the aid of an Arizona-specific version of IMPLAN, an input-output model used widely by researchers throughout the United States. The specific model used was based on IMPLAN's 2007 economic database.

IMPLAN is maintained and licensed by the Minnesota IMPLAN Group, Inc. (MIG). IMPLAN was originally developed by the USDA Forest Service to assist the Forest Service in land and resource management planning. MIG began work on IMPLAN databases in 1987 at the University of Minnesota. In 1993, Minnesota IMPLAN Group, Inc. was formed to privatize the development of IMPLAN data and software. IMPLAN data and accounts closely follow the conventions used in the "Input-Output Study of the U.S. Economy" by the Bureau of Economic Analysis.

Direct impacts from company operations

The AA&D survey provided information on employment and employee compensation in A&D companies. Estimates of company total value added (gross state product) were made using the ratio of value added to employee compensation available in the IMPLAN data files for individual industry sectors.

Direct impacts relating to purchases from Arizona suppliers

IMPLAN provides estimates of the economic impacts that arise when an industry purchases intermediate inputs from local suppliers. These impacts are sometimes referred to as interindustry impacts and are available, for example, from a Type 1 multiplier analysis. IMPLAN's estimates of these impacts are based on a detailed list of commodity requirements drawn from national survey data together with locally-specific estimates of the percent of commodity purchases made from local suppliers—what are known as "regional purchase coefficients."

Because of a lack of data on interregional trade flows, any estimates of regional purchase coefficients will have relatively low reliability, especially in the case of goods that can be readily sourced from outside of the local economy. For this reason, the AA&D survey specifically requested information from A&D companies on the total value of goods and services purchased from Arizona suppliers. The survey responses were used to scale the IMPLAN estimates of interindustry impacts.

The data on local supplier purchases obtained from the survey suggest much smaller interindustry impacts than would be estimated in a routine IMPLAN run. For example, for nine of the twelve companies with at least 250 employees, the ratio of Arizona supplier purchases to company employee compensation was smaller in the survey than in IMPLAN. The ratio in the survey was less than half of the IMPLAN ratio in eight of the cases, and it was less than 20 percent in five cases.

Indirect impacts from consumer spending

In economic impact analysis, estimates are made of the indirect impacts that arise when a company's employees and the employees of its suppliers spend a portion of their incomes in the local economy. To estimate these impacts, we assume that the overall propensity to consume out of labor income, including both local goods and goods produced out of state, is 0.6. IMPLAN is used to evaluate the effects of this spending on gross state product, labor income and employment. IMPLAN utilizes data from the Bureau of Labor Statistics' *Consumer Expenditure Survey* to determine the detailed commodity pattern of consumption expenditures. We also rely on IMPLAN for its internal estimates of regional purchase coefficients. There is less of an issue with these coefficients in the case of consumer spending than with supplier purchases since a large share of consumption expenditures are for services which can only be provided locally.

Indirect impacts from spending by state and local governments

As an additional indirect impact, we consider the effects of spending by state and local governments of new tax revenues generated by A&D companies. The analysis is limited to the direct tax revenues paid by A&D companies in the form of business taxes and the individual taxes paid by A&D employees. IMPLAN was used to assess the impact of this spending on the Arizona economy.

Appendix B: Tax Calculations

Estimates of state and local taxes generated by the operations of Arizona aerospace and defense firms were limited to the direct business taxes paid by companies and the individual income, sales and residential property taxes paid by their employees. The numbers for direct business taxes were those reported by companies in the AA&D survey. Individual taxes associated with the earnings of employees were estimated on a firm-by-firm basis using information on the location of the company's operations and the average annual compensation of company employees. Details of the procedure for estimating individual taxes are provided below.

Individual income taxes

Because income taxes are progressive, we first estimated the Arizona income tax liability of a representative company household. Then a pro rata share was used to obtain the contribution made by the company's employee to those taxes. Separate calculations were made for each year (2008 and 2009) using the company's average employee compensation in that year and the relevant Arizona tax schedule.

To illustrate, consider a hypothetical A&D company with average employee compensation of $110,000 in 2009. Based on nationwide statistics, 19 percent of that compensation is assumed to take the form of nontaxable benefits. This leaves $89,100 as the taxable earnings of the company worker. To this amount we then add $25,000 for other household taxable income, i.e., that related to the earnings of other household members and nonlabor income such as rent and dividends. A figure of $114,100 then is used to represent the Federal Adjusted Gross Income of the company household. Once taxes are calculated at the household level, 78 percent (i.e., $89,100/$114,100) of the taxes are assumed to be attributable to company payrolls.

To calculate the household's state income tax liability, we use the rate schedule pertaining to a family of four with a status of married filing jointly. Under 2009 tax law, Arizona taxable income would be $98,446 and the family's tax liability would be $3,298. Taxes attributable to each company employee are 78 percent of that amount, or $2,575.

Sales taxes

Based on national data from the Consumer Expenditure Survey, consumption expenditures subject to general sales taxes are approximately 20 percent of money income for households with income between $80,000 and $120,000. Using a figure of $114,100 for average household money income, $22,820 of that amount would be subject to the general sales tax. For the cities in which our A&D companies are located, the combined state/county/city sales tax rate ranges from a low of 7.95 percent (Scottsdale) to 8.60 percent (South Tucson). Using the lower rate to illustrate, and assuming that employees purchase taxable items in the city where they work, the general sales taxes paid by an average company household would be $1,814. When pro-rated, the portion attributable to the employee's earnings would be $1,417.

In Arizona, revenues from selective sales taxes on motor fuel, tobacco, utilities, etc. are approximately 25 percent of general sales tax revenues. We use this figure to estimate the selective sales taxes paid by A&D employees. Continuing with the above illustration, the average employee would pay $354 in selective sales taxes.

Residential property taxes

The average market value of residential property occupied by A&D households is assumed to be three times that of their Federal Adjusted Gross Income, or about $342,000 in our illustration. The tax rates used to estimate residential property tax payments were taken from the compilation of 2009 rates made by the Arizona Tax Research Association. In choosing a particular rate for each group of employees, employees were assumed to reside in a highly-rated school district near the company site. To illustrate, for an employee who lives in the Scottsdale Unified School District, the total (primary and secondary) property tax rate in 2009 was $4.458 per $100 of assessed value. This implies a household property tax liability of $1,525. When pro-rated, property taxes per employee amount to $1,191.

Exhibit 1
List of Survey Participants

Alliant Techsystems, Inc.
Applied Energetics
BAE Systems
Boeing Company, The
Bombardier Aircraft Services
Engineering Science Analysis
General Dynamics C-4 Systems
Goodrich Interiors
Hamilton Sunstrand Aerospace
Honeywell Aerospace
Kutta Technologies
L-3 Electro-Optical Systems
Nammo Talley, Inc.
Orbital Sciences Corp.
Paragon Space Development Corp.
Planetary Science Institute
Qwaltec, Inc.
Raytheon Missile Systems
Universal Avionics Systems Corp.

Exhibit 2

Size Distribution of Surveyed Companies

(as measured by employment)

Employment Size Class	Frequency
1 to 19 employees	3
20 to 99 employees	3
100 to 249 employees	1
250 to 499 employees	3
500 to 999 employees	4
1,000 to 2,499 employees	1
2,500 employees or more	4

Source: Arizona Aerospace and Defense Survey (2010)

Exhibit 3
Summary of Primary Data from the AA&D Survey

	2008	2009
Total number of employees	36,548	35,559
Total wages and salaries (in millions)	$2,946.8	$2,863.7
Total employee compensation (in millions)	$3,948.7	$3,894.6
Total purchases from Arizona suppliers (in millions)	$2,376.7	$1,864.1
Compensation per employee	$108,000	$109,500
Supplier purchases per employee	$65,000	$52,400

Source: Arizona Aerospace and Defense Survey (2010)

Exhibit 4
Compensation per Employee in the Arizona Aerospace-Defense Industry, 2009
Source: AA&D Survey (2010)

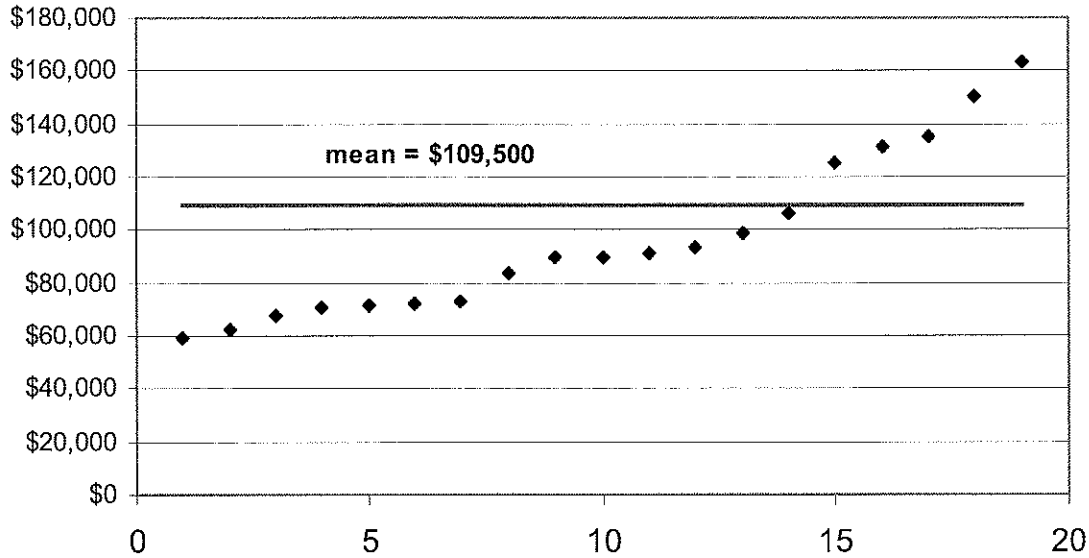

Exhibit 5
Arizona Supplier Purchases per A&D Employee, 2009
Source: AA&D Survey (2010)

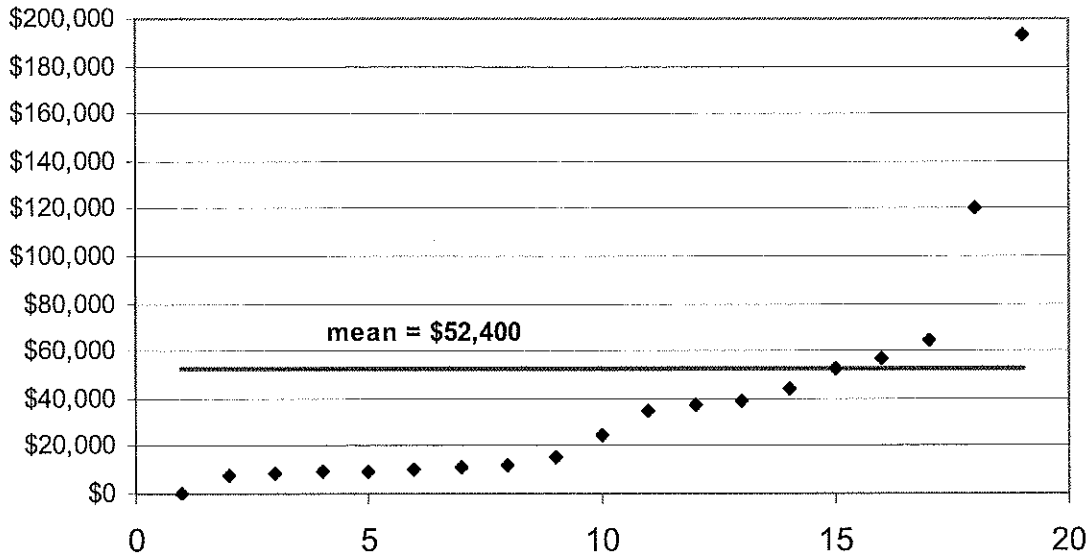

Exhibit 6

Economic Impact of the Arizona Aerospace-Defense Industry, 2008

	Gross State Product ($ millions)	Labor Income ($ millions)	Employment
Direct impacts from A&D company operations	4,965.7	4,371.2	40,474
Direct impacts from Arizona supplier purchases	1,830.6	1,349.1	21,849
Indirect impacts from consumer spending by A&D employees and employees of A&D suppliers	2,172.4	1,250.3	32,014
Indirect impacts from spending of new state and local government tax revenues	402.2	326.8	7,387
Total economic impact	$9,370.9	$7,297.4	101,724

Source: Center for Competitiveness and Prosperity Research, L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

Exhibit 7

Economic Impact of the Arizona Aerospace-Defense Industry, 2009

	Gross State Product ($ millions)	**Labor Income** ($ millions)	**Employment**
Direct impacts from A&D company operations	4,897.6	4,311.3	39,389
Direct impacts from Arizona supplier purchases	1,433.4	1,054.9	17,059
Indirect impacts from consumer spending by A&D employees and employees of A&D suppliers	2,036.7	1,172.1	30,014
Indirect impacts from spending of new state and local government tax revenues	401.7	326.7	7,377
Total economic impact	$8,769.4	$6,865.0	93,839

Source: Center for Competitiveness and Prosperity Research, L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

Exhibit 8

Direct Impact of A&D Industry on Arizona State and Local Taxes

(in millions of dollars)

	2008	2009
Taxes paid by A&D companies:		
Income	5.0	5.0
Sales	7.3	9.3
Property	23.3	22.8
Taxes paid by A&D employees:		
Income	116.2	114.8
Sales	69.8	69.3
Property	79.9	80.0
Total state and local taxes	$301.5	$301.1

Source: Center for Competitiveness and Prosperity Research, L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

Exhibit 9
Comparing State and Local Taxes per Worker, 2008
(dollars per worker)

	Aerospace & Defense	All Arizona Industries
Business taxes per worker	880	2,909
Individual taxes per worker	6,570	3,782
Total taxes per worker	$7,450	$6,691

Source: Center for Competitiveness and Prosperity Research, L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University