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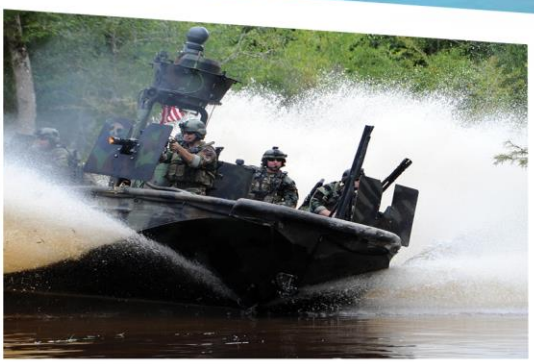

Military Unmanned Aerial Vehicles and Diversification Opportunities

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June 2018

PROMOTING INNOVATION, DIVERSIFICATION AND COOPERATION IN THE MISSISSIPPI DEFENSE COMMUNITY

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ACKNOWLEDGEMENTS

The authors express appreciation to the following individuals who contributed to the Military Unmanned Aerial Vehicles and Diversification Opportunity study.

The University of Southern Mississippi Trent Lott National Center
Dr. Shannon Campbell, Director
Heather N. Brown, Research Analyst

The University of Southern Mississippi College of Business
Andy Kilgore, Mississippi Defense Diversification Initiative Director
Derek Halbasch, Graduate Assistant
David Jordan, Graduate Assistant

Industry Contributors
Colonel Stephen "Lux" Luxion, ASSURE Associate Director
Major General James O. Poss, Retired Air Force
David Klein, AUVSI Research Analyst
Daniel Ward, NCS4 Assistant Director of Curriculum

This study was prepared under contract with the National Security Technology Acceleration Support and Economic Diversification Efforts for the State of Mississippi, with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of the National Security Technology Acceleration Support and Economic Diversification Efforts for the State of Mississippi and does not necessarily reflect the views of the Office of Economic Adjustment.

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Executive Summary

Traditionally, U.S. Department of Defense (DoD) procurement has dominated the Unmanned Aerial Vehicle (UAV) market. As defense spending on UAVs fluctuates and commercial markets driven by regulation clarification increase, new opportunities for defense diversification are opening. Opportunities for UAVs designed for military usage are growing in the public safety, transportation, infrastructure, agricultural and defense export markets. According to the industry experts interviewed for this study, the agriculture industry could utilize military UAV sensors to scan large fields for irrigation and blighting and possibly localized spraying of pesticides. Public safety and transportation agencies could utilize drones for situational awareness and video analytics to help law enforcement and other public services gain an understanding of emergency situations. Lastly, infrastructure that stretches over longer distances such as power lines and oil pipelines could take advantage of the long duration of the military UAV flight times, which could reduce the need to operate costly manned aircraft. However, achieving price competitiveness in commercial markets is difficult. For Mississippi, there are opportunities to expand current UAV production capacity and leverage UAV support infrastructure.

Introduction

The Unmanned Aerial Vehicles (UAV) industry is defined as the manufacture and design processes for unmanned aircraft and related control systems for military and private sector applications. This report will focus on the UAV system platform and not the peripherals such as software solutions, sensors, communications, weapons, and other subsystems. The various subsystem markets and their projected compounded annual growth in sales (CAGR) are presented in Table 1. Further this shows that there are diversification opportunities for defense peripherals as well as platforms.

Table 1

UAV Subsystems Markets

Subsystem	2014	2015	2020	CAGR 2015-2020
Control System	$1.34B	$1.50B	$2.39B	10%
Data Links	$82M	$92M	$1.51B	10%
Software	$76M	$86M	$1.45B	11%
Training and Simulation	$69M	$77M	$1.24B	10%
Total	$3.61B	$4.05B	$6.59B	10%

Source: BCC Research 2015

This report will focus on identifying commercial uses for military UAVs, with an emphasis on UAV opportunities in Mississippi. The purpose of this report is to provide insights for Department of Defense (DoD) drone manufacturers in the UAV civilian marketplace, and to guide diversification opportunities for the UAV platforms into the market. Further, this report will review the research on the current state of the UAV industry, and offer a strength, weaknesses, opportunities, and threats (SWOT) analysis.

The Department of Defense Office of Economic Adjustment (OEA) Mississippi Defense Diversification Initiative (MDDI) commissioned this report. This pilot program exists to strengthen and diversify the defense industry through the building of collaborative partnerships between defense contractors, educational institutions, and local and state government. Promoting commercialization and technology transfer of defense technology is an important component of the initiative.

Finally, an ecosystem has been created to outline how a military contractor could conduct diversification efforts in Mississippi by using the state's aerospace assets. A study of the UAV industry in Mississippi was conducted to further the diversification opportunities through industry collaborative partnerships, university assistance, and technology transfer. The primary method of research used in this report is secondary data analysis from industry reports. Primary research regarding military UAV diversification opportunities was conducted through interviews with industry experts. A Mississippi ecosystem asset list was compiled using secondary data.

UAV Industry Overview

Military UAVs for Diversification

Unmanned Aerial Vehicles (UAV) are extensively used by all branches of the United States military, which represents 87% of the industry revenue according to IBISworld (Longo, 2017). Over half the DoD spending is on procurement and the balance is on research and development. BCC Reports (see Table 2) also finds that the defense sector represents the largest market share but does not report it as being as dominate as IBISworld. Nonetheless, the DoD has clearly been a driver of UAV technology and demand.

Table 2

Global UAV Market by Application

Application	2014	2015	2020	CAGR 2015-2020
Defense	$1.41B	$1.56B	$2.37B	9%
Logistics and Warehousing	$66M	$74M	$1.18B	10%
Healthcare	$59M	$67M	$1.14B	11%
Entertainment	$52M	$59M	$1.03B	12%
Field Operations	$37M	$42M	$72M	12%
Others	$6M	$7M	$14M	14%
Total	**$3.61B**	**$4.05B**	**$6.59B**	**10%**

Source: BCC Research 2015

The military UAVs are mostly used on long duration missions for Intelligence Search and Reconnaissance (ISR) or precision strikes. Unmanned combat aerial vehicle (UCAV) can carry aircraft ordinance. The military uses smaller hand or catapult launched UAVs such as the RQ-7 Shadow or Scan Eagle for tactical situations. Larger military UAVs that can fly above 10,000 meters, such as the Reaper or Global Hawk, require an airfield. Military UAVs are high quality and designed for performance rather than cost.

A segment of the military UAVs has the potential to be placed in the U.S. commercial market. The smaller military UAVs can currently be used in commercial markets, but the larger ones cannot be used in the U.S. commercial market due to current Federal Aviation Administration (FAA) non-military regulations on flight ceilings. There are also pricing issues with the larger military UAVs.

End users can use smaller military UAVs, such as the AeroVironment Raven and Boeing Scan Eagle, in commercial markets due to its ability to meet FAA guidelines, and its usefulness in current civilian market (see Table 3). For example, the Boeing Scan Eagle is used to monitor forest fires in Olympic National Park; used by BNSF Railway to

monitor the tracks; and by the U.S. Coast Guard for ice flow monitoring for Alaskan oil rigs. The ScanEagle X200 is a civilian-variant of the military version with a restricted category type certificate issued by the FAA. BP Exploration Inc. is using the AeroVironment Raven to monitor pipelines. This report will focus on military UAVs with the best potential for U.S. commercial applications, but also discuss defense export opportunities for all military UAVs. Appendix A includes a partial list of military UAVs and photos.

Table 3

United States Armed Services Utilization of UAVs and Commercial Applicability

Maker	Military Branch	Model	Commercial Applicable
AAI Corporation (Textron)	Marine Corp	RQ-7 Shadow	Yes
AeroVironment, Inc.	Air Force, Army, Marine Corp	RQ-20 Puma	Yes
AeroVironment, Inc.	Air Force, Army, Marine Corp	RQ-Raven	Yes
Insitu (Boeing)	Marine Corp, Navy	Scan Eagle	Yes
Insitu (Boeing)	Navy	RQ-21 Blackjack	Yes
General Atomics	Air Force	MQ-9 Reaper	No
General Atomics	Air Force	MQ-1B Predator	No
General Atomics	Air Force	MQ-1C Grey Eagle	No
Lockheed Martin	Marine Corp, Navy	Lockheed Martin Stalker XE	Yes
Northrop Grumman	Air Force	Global Hawk	No
Northrop Grumman	Navy	Fire Scout	No
Northrop Grumman	Navy	MQ-4C Triton	No
FLIR	Army	Black Hornet 3	Yes
InstantEye Robotics	Marine Corp	Mk-2 GEN3-A0	Yes

Source: Military.com

The cost of military UAVs can be prohibitively expensive for commercial usage. The unit cost for the MQ-9A Reaper, which has 30 hours endurance and speeds of 220 knots operating at altitudes above of 50,000 feet, is $12M (Deagel 2017). The small AeroVironment RQ-20 Puma costs around $250,000. Each AeroVironment Raven cost approximately $35,000 but the total system costs approximately $250,000 (Army Technology, 2017). On-line commercial drones run the price gamut from hundreds of dollars to tens of thousands of dollars. With added peripherals, commercial drones such as the Aerigon Drone Phantom Flex4K, can reach price points comparable to the less expensive military UAVs. The specifications are not always comparable but only certain commercial applications need and can afford the performance capabilities of military UAVs.

Product Categories

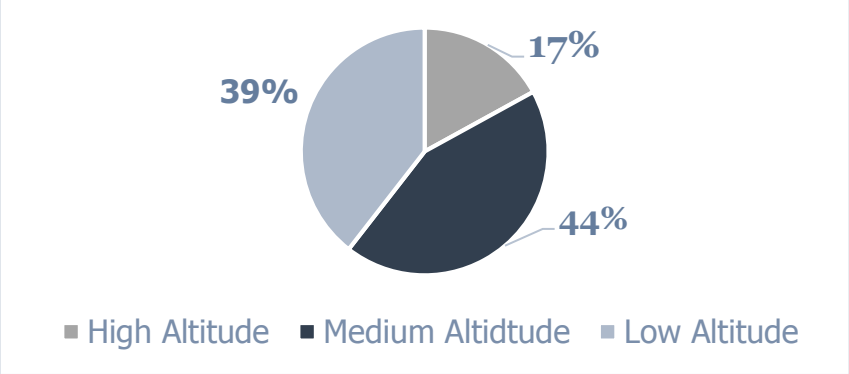
Unmanned Aerial Vehicles are divided by product categories into Low Altitude, Medium Altitude, and High Altitude. Low Altitude restricts the UAV to flying below 1,000 meters; Medium Altitude is restricted to fly between 1,000 meters to 10,000 meters; and High-Altitude is a UAV flown above 10,000 meters (Rienventhr, n.d.). The FAA allows for UAVs to be operated in the Low Altitude range up to 400 feet, which limits medium and high- altitude U.S. commercial sales. The low altitude UAVs are sold mostly to the civilian sector for uses like photography or insurance claims. Low-altitude UAVs have more applications for civilian and commercial uses because of the lower cost and ability for multi-use purposes like photography, communications, and research and development (Longo, 2017).

Nano drones are a sub-category of low altitude UAVs moving from civilian/commercial usage to military usage. These UAVs serve as personal reconnaissance systems. The Marines use the InstantEye Robotics Mk-2 GEN3-A0 UAV from Andover, Massachusetts. FLIR Systems of Wilsonville, Oregon, a manufacturer of thermal imaging sensors, bought a Norwegian company to get into the UAV market and now supplies the U.S.

Army with the Black Hornet 3 Nano-drone. This UAV was already in usage by the Norwegian, British, Dutch, and German armed forces. Developments in size, weight and power (SWaP) optimized technologies are creating whole new categories of UAVs and applications.

The highest revenue sector is the medium altitude (see Figure 1). This does include military UAVs such as the Scan Eagle and Fire Scout. Most medium and high-altitude UAVs are used for military surveillance and attack missions. High-Altitude UAVs such as the Global Hawk or Predator are sold in low volume to world militaries; however, the cost of capital for these UAVs creates a high sector revenue.

Figure 1: Product Categories by Revenue for the UAV Industry in 2017



Source: IBIS World

Market Overview of the UAV Industry

Manufacturers

The UAV industry generates revenues of $3.8 billion a year with profits of $401.2 million (Longo, 2017). There are eighty-eight UAV production businesses in this market paying out $846.8 billion in wages annually. Large defense contractors produce 70 percent of the total UAV market. The major companies producing Unmanned Aerial Vehicles are Northrop Grumman Corporation, Boeing, General Atomics Aeronautical Systems Inc.,

and Textron Inc. These companies will be the leaders in diversification opportunities because they hold the largest market share and resources.

There are opportunities for smaller UAV manufactures to diversify into the commercial market. AeroVironment produces military and commercial UAVs that employs 661 employees. The company produces UAVs such as the Puma and Raven for military ISR missions. In the commercial market, AeroVironment utilizes its Puma for precision agriculture purposes (Industry Experts, 2018). Smaller UAV manufacturers must find a niche that their UAV technology can service like the Puma in agriculture.

Barriers to Market Entry

UAV military manufacturers wanting to diversify into the civilian market must overcome barriers such as technological expertise, capital investment into research and development, and available resources. Manufacturers must also anticipate the high cost of advanced facilities and demand for skilled labor with lower profit margins than military orders. Companies previously reliant on defense contracts are accustomed to the military's high-quality assurance and patterns of choosing the same firms with a proven record of accomplishment and this is not always the situation in the private sector. Awarded contract firms have a high level of research and development and labor and advanced facilities because defense UAVs are the most technologically advanced UAVs. The civilian UAV manufacturing industry has lower barriers to entry because hardware and other components for production are less expensive. However, government regulations and competition from imports makes it difficult for new companies to gain market share. The one common barrier that affects all UAV industries entry into the market is in the UAV industry patterns which makes research and development expensive for a firm's product to be unique to compete in the market (Longo, 2017).

Congressional Spending

IBIS World estimates that the military is the largest market for UAVs. The military market is influenced by the Department of Defense (DoD) spending, which is volatile and fluctuates from year to year. A DoD report "Unmanned Systems Integrated Roadmap FY2013-2038," demonstrates how the DoD plans to spend funds and integrate UAVs into the military (USIR, 2013). According to this roadmap report, the DoD spending on UAVs has declined since 2015; however, spending has remained constant at just over $4 billion a year (see Table 4).

Table 4

Defense Spending for Military UAVs

Year	DoD Spending ($B)
2014	$3.8
2015	$4.8
2016	$4.5
2017	$4.2
2018	$4.4
Five-Year Total	**$21.7**

Source: Unmanned Systems Integrated Roadmap

Since most revenue from the UAV industry comes from military contracts, the total revenue in the UAV industry increases and decreases with congressional spending. During the Obama Administration spending was reduced from military; however, the Trump Administration is projected to increase spending on the military.

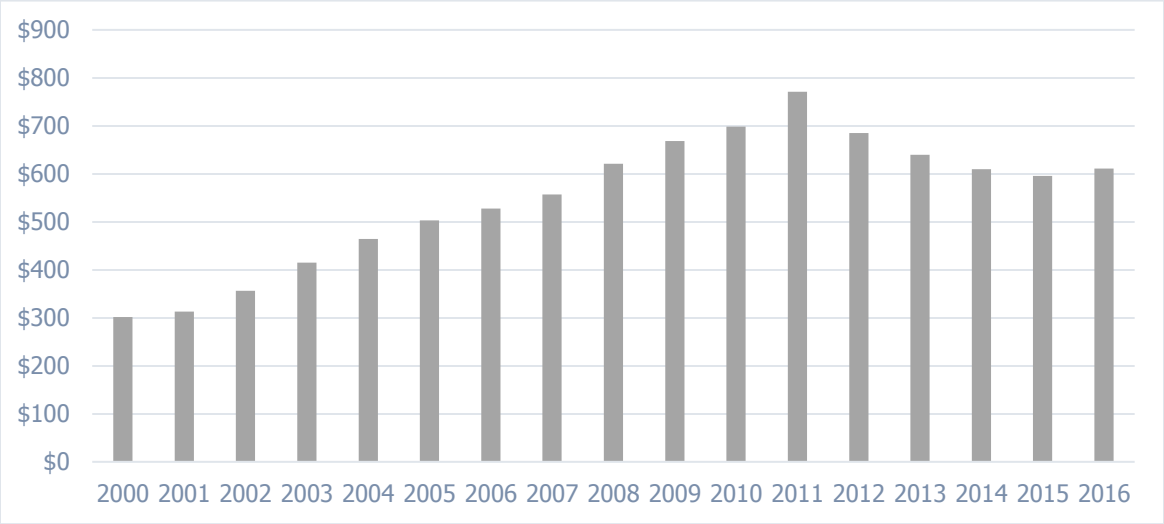
Current Market Performance

The overall UAV industry has experienced fluctuation in total revenue over the past five years. The revenue amounts were a result of U.S. troop withdrawal from the Middle East and sequestered military spending to reduce national debt. Strict regulations prevent the military from exporting UAVs to but only a select few nations from regulations like the United States Munitions List. This currently reduces the revenue in the overall industry from only being able to sale to certain nations. However, the Trump

Administration has intension of loosening these restrictions and to increase arms sales; for example, the president has made recent deals with Saudi Arabia, and South Korea (Burgers and Romaniuk, 2018).

Military spending fluctuates with different presidential administrations making it is important that military UAV companies diversify into the civilian sector (see Figure 2). On the commercial side, the diversification of UAVs has led to a 5.5 percent increase in employment, and a 3 percent increase in UAV startups to meet the demand for commercial UAVs (Longo, 2017). By diversifying into the private sector, commercial UAVs will be able to reduce risk for their company.

Figure 2: U.S. Defense Spending 2000 to 2016 (in $B)



Source: Statista

Industry Outlook

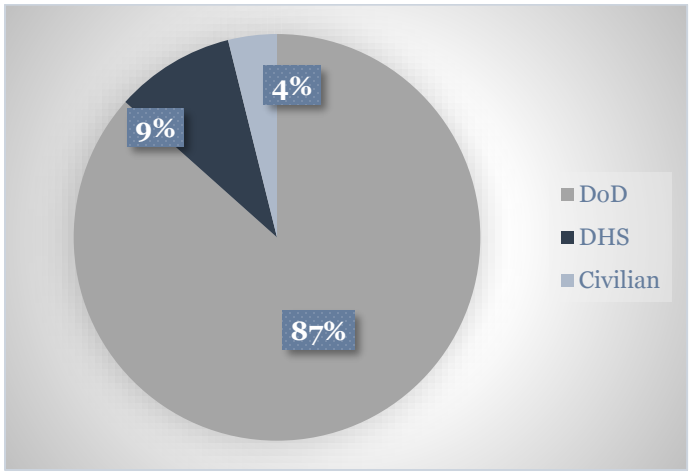
Military spending in the market is expected to increase in 2018 through the next five years. The DoD, which has a fleet of over 7,000 UAVs, allocated $4 billion in 2017 for new UAV development and acquisition (Michel, 2016). The FY 2019 DoD budget allocated $9.39 billion for unmanned systems and associated technologies up from $7.5 billion in 2018 (Gettinger, 2018). Over the last five years, it accounted for 87% of the

industry purchases (see Figure 3). The DoD is transitioning from the current generation of UAVs by researching and developing a new generation of UAVs which will lead to more military sales.

The finalization of the FAA's new regulations on operating UAVs has increased demand for commercial and civilian UAV. Therefore, the industry is expected to raise revenue by 3.6 percent to $4.5 billion and profits to 10.8 percent by 2022. Forecasting for the industry estimates an increase in employment by 3.5 percent to 11,039 employees and in UAV businesses by 3.4 percent to 104 payroll business locations (Longo, 2017).

The commercial UAV market is increasing. The commercial drone industry sold 174,100 UAVs in 2017 for $3.6 billion. By 2020, the personal and commercial drone industries are expected to increase to $11.2 billion in sales (Garner, Inc., 2017). *Business Insider* estimates that commercial drone sales will increase from 102,600 units in 2016 to 805,000 units in 2021, which is a 51 percent compound annual growth rate. In addition, *Business Insider* reports, "The enterprise drone (otherwise known as commercial UAVs) market has significantly greater long-term potential both in size and economic impact than the consumer or military drone industries. It is the smallest but fastest-growing drone market by revenue" (Meola, 2017).

Figure 3: Percentage of Industry UAV Purchases from 2012 to 2017



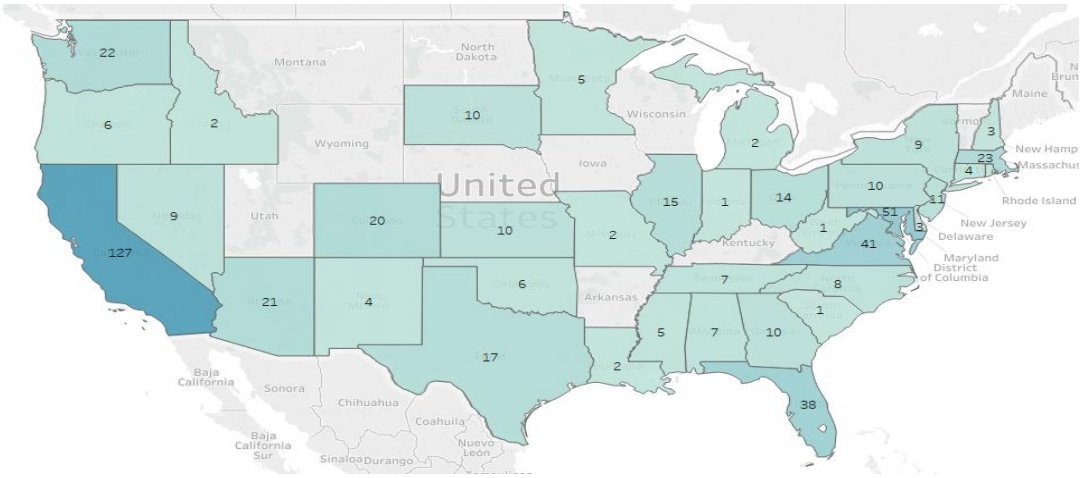
Source: IBIS Worl

Supply Chain

As the industry enters the post-Ford era of decentralized manufacturing, the UAV industry depends mostly on suppliers outside of the United States for product components. UAV companies purchase engines, computer chips, various circuits, and semiconductors from different suppliers. Once the UAVs are assembled, they are sold to institutions for research, surveillance, scientific, and technical services (Longo, 2017).

The industry is mainly concentrated in states with high-tech industries and locations that are close to suppliers and a skilled workforce (see Figure 4). The state of Mississippi produces five different UAV models, which is comparable to other southern states like Alabama and Louisiana along the Gulf Coast aerospace corridor. California has the largest amount of UAV models being produced in the United States. Virginia, Maryland, and Florida also have numerous UAV manufacturers. Some states like Kentucky and Arkansas currently do not have any UAV models being manufactured. They tend to be part of aerospace clusters.

Figure 4: UAV Production in the United States



Source: AVUSI

Military UAV production occurs across the United States. The ScanEagle production facilities are in Bingen, Washington. AeroVironment is based in California. The Shadow family of unmanned aircraft systems is produced at AAI's facilities in Hunt Valley, Maryland. However, production systems are spread out geographically. The base of the MQ-8C Fire Scout is the Bell 407 helicopter built in Texas with modifications to the airframes carried out in Ozark, Alabama, while final assembly is performed in Moss Point, Mississippi. Generally, military UAVs follow supply chain patterns of the defense aerospace industry.

International Trade

North America is the largest market for UAVs, but demand around the world is growing with a compound annual growth rate (CAGR) of around 10% (see Table 5). The Chinese dominate the civilian UAV market with 70% market share (Joshi, 2017). The Chinese have also started to export military UAVs. For military UAVs, the United Kingdom is the largest importer and Israel the largest exporter according to the Stockholm International Peace Research Institute (Sipri). The U.S. maintains about 25% of global market share of military UAVs and with loosened defense export restrictions, this is likely to grow.

Table 5

Global UAV Market by Region

Region	2014	2015	2020	CAGR 2015-2020
North America	$1.40B	$1.56B	$2.46B	9%
Europe	$1.14B	$1.28B	$2.08B	10%
Asia-Pacific	$90M	$1.02B	$1.70B	11%
Rest of World	$17M	$19M	$35M	13%
Total	**$3.61B**	**$4.05B**	**$6.59B**	**10%**

Source: BCC Research 2015

The export market for military UAVs is highly regulated by the U.S. government, making sales to foreign nations complex. Nevertheless, this market is growing. For example, Boeing sells its ScanEagle to 19 international customers including the military forces of Australia, Canada, Italy, Japan, the Netherlands, Singapore, Spain and the United Kingdom. U.S. allies such as Australia, Italy, Denmark, the UK and Spain have begun acquiring the AeroVironment Raven. Table 6 shows that the export of military UAVs is growing, and this trend is expected to continue.

Table 6

U.S. Sales of Military UAVs

Country	UAV Type	Quantity	Year	Value
NATO	MQ-9 Reaper	4	2012	Part of $308M deal
South Korea	RQ-4A Global Hawk	4	2014	Part of $657M deal
UAE	RQ-1 Predator	10	2014	Part of $200M deal
Afghanistan	ScanEagle	65	2015	$71M
Canada	RQ-21A Blackjack	5	2016	$14M
Spain	MQ-9 Reaper	4	2016	Part of $177M deal
Australia	MQ-4C Triton	7	2017	Part of $133M deal
France	MQ-9 Reaper	12	2017	
Germany	MQ-4C Triton	3	2017	Part of $2.5B deal
Lebanon	Scan Eagle	6	2017	$11M
Netherlands	MQ-9 Reaper	4	2017	
Philippines	ScanEagle	10	2017	$13.8M
Japan	RQ-4A Global Hawk	3	2019	

Source: SIPRI Arms Transfers Database

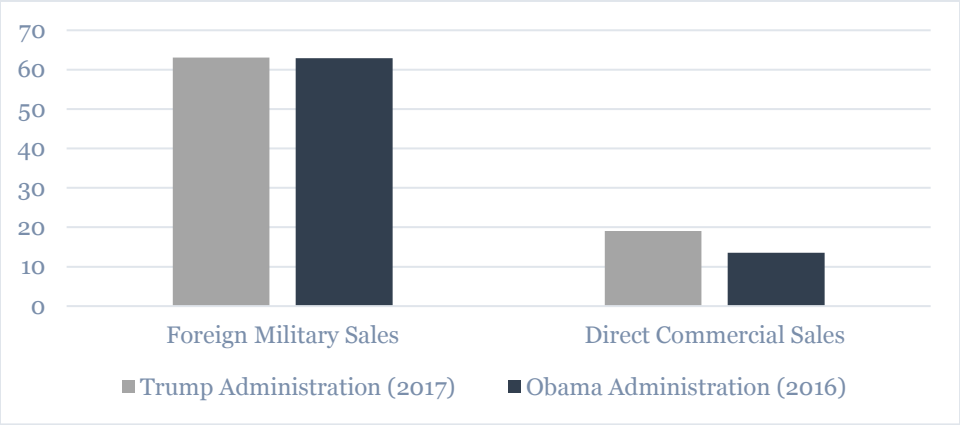
Direct Commercial sellers have export licenses issued by the Department of Commerce. These licenses allow UAV firms to negotiate directly with foreign

buyers which allows the foreign buyer to have direct involvement in contract negotiation. This makes it easier for UAV companies to conduct business with direct negotiation and allows for firm fixed pricing and fulfilling nonstandard requirements (Unmanned Systems Integrated Roadmap FY2013-2038, 2013).

Foreign Military Sales is a government program by which the United States government transfers defense article services and provides service to sovereign nations and international organizations. It is comprised mostly of the U.S. defense sales (see Figure 5). The United States government buys products or services on behalf of other nations or international organizations. These products or services are bought though the same acquisition process the DoD uses for its military. Therefore, defense articles such as military UAVs can only be sold to approved nations by the United States government (Unmanned Systems Integrated Roadmap FY2013-2038, 2013).

The International Traffic in Arms Regulations (ITAR) requires state department approval for exporting UAVs and it regulates most UAVs. The Missile Technology Control Regime (MTCR) restricts many UAVs from being exported because of national security. Under the Obama administration, regulations were relaxed on the UAV industry through the implementation of new policies. These policies allowed UAVs to be sold to allies that have a recipient nation's agreement and removed some UAV products from the ITAR list (Long, 2017). The Trump Administration furthers the sale of arms to foreign countries through its "Buy American" plan to create billions of dollars in overseas foreign military and direct commercial sales (see Figure 5). This plan will include fighter jets, UAVs, artillery, and warships. United States embassy staffers will engage foreign governments to negotiate more arms deals (Stone, 2018).

Figure 5: Defense Sales (in $B) by Presidential Administrations



Source: inforgram.com

Cost Structure Benchmarks

Production of the UAVs is highly advanced and specialized; therefore, the industry is predominately controlled by a few companies. Most UAV company startups focus on research and development while relying on government subsides until they can move a product to the market. There is a shortage of suppliers in the military market resulting in a high acquisition cost for military products; however, civilian UAVs are less expensive because of a greater number of suppliers.

UAV production requires a workforce skilled in science, technology, engineering, and math (STEM). These occupations earn a higher wage rate compared to other occupations, as a shortage of professionals in UAV manufacturing has led to increased wages in this industry. UAV companies will incur a large cost in operating their business to pay for salaries of their employees due to the STEM field.

By UAV startup companies diversifying into the commercial sector it can mitigate cost of doing business in the UAV industry. Diversifying into the private sector will reduce the cost of research and development, because research and development in the commercial sector is not as rigorous as

government contracts specifications. UAV firms will have a larger source of suppliers that will reduce cost of resources, from a better opportunity to make a deal.

Basis of Competition

The civilian market is limited by technological resources required to enter the market, but industry competition continues to grow. There are few defense contractors in UAV industry due to the ability to handle the research and development, technology specifications, and capital intensity requirements of a defense contract. Military defense contractors must continuously innovate to win contracts due to increasing performance requirements from the Department of Defense. As the United States defense budget shrinks, the UAV industry must compete with other defense programs for funding. The civilian market must compete with UAVs from foreign nations because of the stiff regulations in the United States. In the defense market, the United States government buys most products from United States UAV manufactures thus eliminating foreign competition (Longo, 2017. Pg. 22-23).

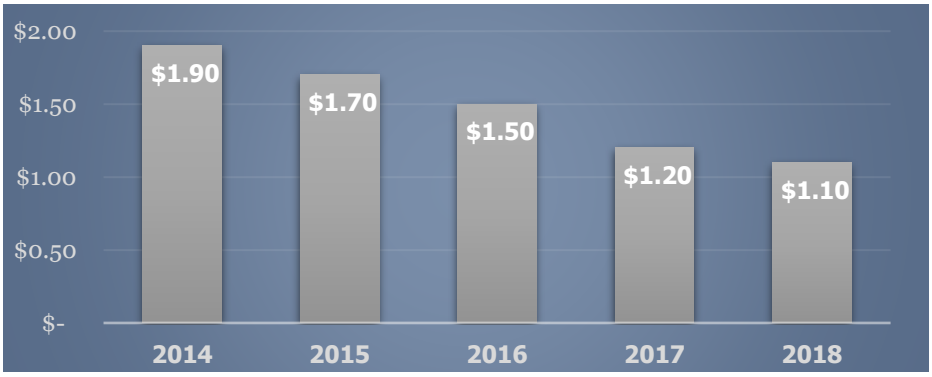
Operating Conditions in the UAV Industry

Capital Intensity

The capital intensity in the UAV industry is relatively low when compared to its historical rate. Start-up investments that include buildings and equipment are now saving firms money from not having to buy as much equipment and new buildings. Most of capital spent by firms is on advanced machinery and equipment. However, over the past five years the rate of capital investment has decreased because established defense firms are not spending as much capital on facilities and equipment (Longo, 2017).

The drawdown in capital intensity includes government expenditures, as the DoD has decreased spending into UAV modernization according to the DoD's report on "Unmanned Systems Integrated Roadmap FY2013-2038" (see Figure 6). However, the industry is expected to increase research and development by 2028 with spending expected to reach $4 billion. Capital intensity will then grow again by 2036, with a projected $30 billion being spent in research and development. Primarily this growth will come from manufacturing, long-haul cargo and passenger aircraft services (aia-aerospace, 2018).

Figure 6: Funding for Military UAVs from 2014 to 2018 (in $B)



Source: Unmanned Systems Integrated Roadmap

Regulation and Policy

Congress governs the exporting of UAV's by regulating the number of aircraft sold to foreign countries. According to Unmanned Systems Integrated Roadmap, the national security of the United States is achieved through serval forms of regulation including:

- Foreign Military Sales that regulates the transferring of defense articles, services, and training to approved sovereign nations and international organizations.
- Direct Commercial Sales allows the Department of Commerce to give UAV companies a license to sell directly to accepted foreign customers.
- International Traffic and Arms Regulation allows the President to control the export and import of defense articles and services.
- Export Administration Regulation controls the exporting of duel use items, which can be used for military and commercial uses.
- Missile Technology Control Regime is a group of member countries among which Military UAVs can be sold.

For commercial users to operate a UAV, certifications required to fly the drone are found in Section 333 of the FAA Modernization and Reform Act of 2012 or under Part 107 of Title 14 of the Code of Federal Regulations. Operating regulations are shown in Table 3. The Secretary of Transportation is authorized to render the airworthiness certification that is required for a UAV to operate safely in the National Airspace System. If a government agency wishes to fly a UAV then it has two options: to fly under a Part 107 Waiver or receive a Certificate Waiver of Authorization (COA) that permits nationwide flights in Class G airspace at or below 400 feet (Federal Aviation Administration, 2017). Each state and some municipalities have their own operating codes and regulations for UAVs operations that build onto FAA

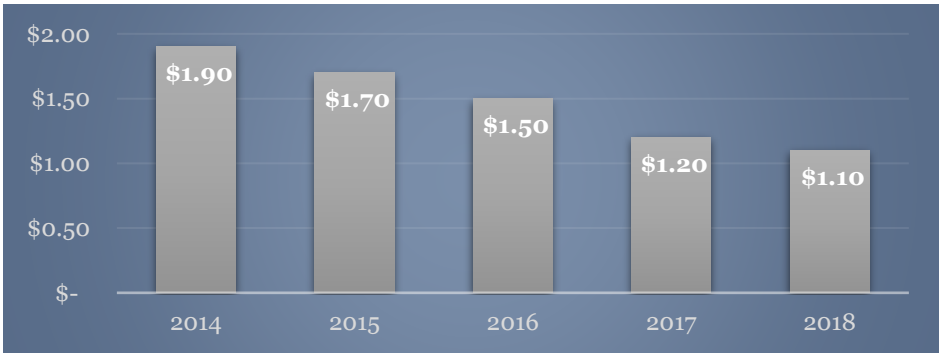
codes; for example, Mississippi has laws preventing people from using UAVs to spy on other people. (See Appendix A for more detail)

Exporting regulations limit the products that UAV firm can sell to certain specified countries. FAA regulations limit operators to fly under certain conditions, heights and uses. This is important for military UAV manufactures diversifying into the private sector to know to understand the needs and operating capacity of the customers they serve. For example, FAA currently regulates flight of drones for in line-of-sight and around 400 ft. Defense Contractors would use these regulations to understand why only small military UAVs could be used in the civilian market.

Industry Assistance

Most defense contractors in the UAV industry receive government subsidies for research and development. Beyond research and development, these companies can receive government assistance for technology development and capital financing needs. Statistics.com projects the United States military UAV industry will continue to increase investments in research and development and testing of aircraft during the next five years (see Figure 7) (2018).

Figure 7: Military UAV Industry Spending on Research and Development (in $B)



Source: Statistics.com

Annual Growth

The annual growth for manufacturing establishments, employment, and federal funding for the UAV industry are shown in Table 7. This indicates the number of establishments and employment are growing; while federal funding for defense is expected to slightly decrease. Compared to the overall Aerospace Manufacturing Industry which is remaining very stagnant in the number of establishments and employment, the UAV industry is more fluid, rising and falling at various rates (see Table 8).

Table 7

Annual Change in the UAV Industry

Year	Establishments	Employment	Federal Funding
2012	0.0%	-4.1%	-5.7%
2017	3.1%	3.8%	2.1%
2022	4.4%	3.7%	-1.0%

Source: IBIS World Report

Table 8

Annual Change in the Aerospace Manufacturing Industry

Year	Establishments	Employment	Federal Funding
2012	1.0%	2.0%	-5.7%
2016	1.0%	-1.0%	2.1%
2022	0.9%	0%	-1.0%

Source: EMSI

This section demonstrates the UAV manufacturing industry as a relatively new industry that is volatile for defense contractors to enter. The Aerospace Manufacturing Industry has been stable over time, but the reason the UAV industry is so volatile is that the industry is still in the beginning of research and development to understand its capabilities in its industry.

Impact of UAVs on the State of Mississippi

The Aerospace Industry in Mississippi includes major corporations such as Airbus Helicopters Inc., Rolls Royce, Raytheon, Northrop Grumman, SpaceX, and Lockheed Martin who capitalize on the state's skilled and productive workforce. These skills are developed through the community colleges and universities throughout the state. Programs of study in this industry include Aviation Maintenance Technology, Avionics Technology Program, and Airframe License-Training programs. Technology innovation from the engineering programs in Mississippi are helping the aerospace industry to soar in the state (see Table 9).

The leading education pipeline in the state is Mississippi State University's Aerospace Engineering program which has a UAV concentration as well as its Raspet Flight Research Laboratory. Mississippi is a leader in the research of composites for the drone industry. For instance, Boeing decided to continue its research partnership with the University of Southern Mississippi and expand its research efforts with Mississippi State University.

Table 9

Engineering Programs at Mississippi's Four Major Research Universities

Degree Program	Mississippi State University	University of Mississippi	Jackson State University	University of Southern Mississippi
	Starkville, MS	Oxford, MS	Jackson, MS	Hattiesburg, MS
Aerospace Engineering	*			
Architectural Engineering Technology				*
Biological Engineering	*			
Chemical Engineering	*	*		
Civil Engineering	*	*	*	
Computer Engineering	*		*	*
Construction Engineering Technology				*
Electrical Engineering	*	*		
Electronics Engineering Technology				*
Geological Engineering		*		
Industrial Engineering	*			
Industrial Engineering Technology				*
Mechanical Engineering	*	*		
Polymer Science and Engineering				*
Software Engineering	*			
Petroleum Engineering	*			

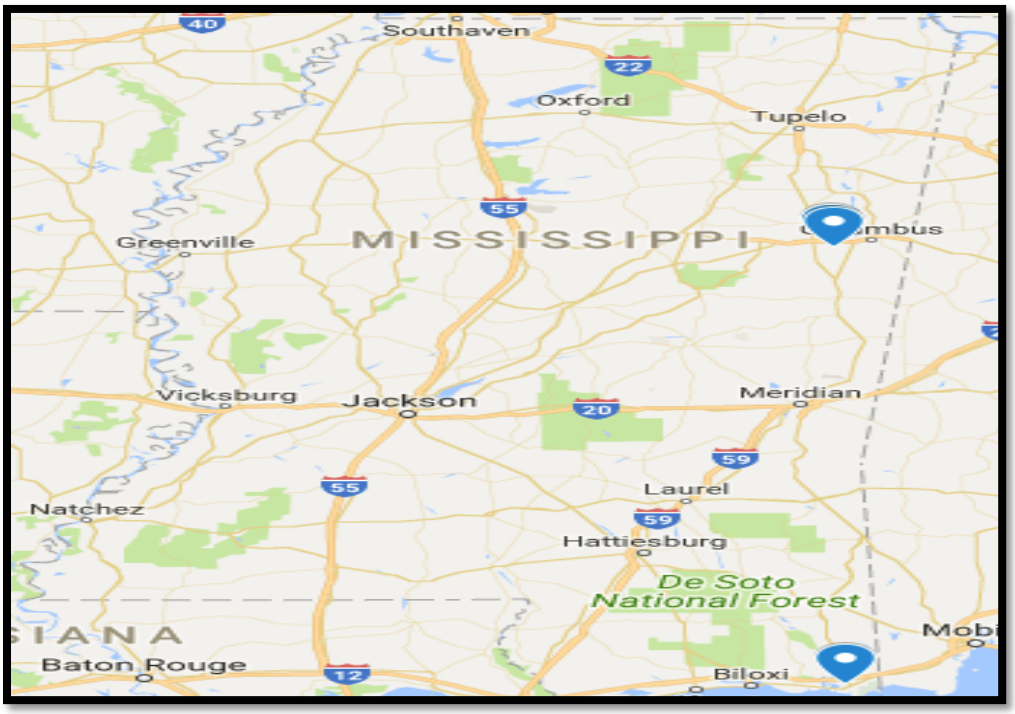
Source: Mississippi Development Authority

Northrop Grumman is a national manufacturer of UAVs and has a facility in Moss Point, Mississippi, located at the Trent Lott International Airport Industrial Park. The Moss Point location produces two versions of the fire scout at the facility for the United States Navy. The facility also produces other component parts for Northrup Grumman's Triton UAV and other aircraft.

Aurora Flight Sciences was bought in 2017 by the Boeing Company and now has control of the facility in Columbus, Mississippi. The UAV Company is located next to Stark Aerospace due to a collaboration from the two companies to produce the Hunter UAV. General Manger Greg Stewart said that Aurora currently does not have any UAVs in production; however, they are soon to begin production and testing of the Orion Hall hydrogen-powered unmanned aircraft.

Stark Aerospace is an Israel UAV company located in Columbus, Mississippi. In the past, Stark Aerospace has worked with Aurora Flight Sciences on the Hunter UAV. Currently, the company is producing a handheld UAV called AirLight. The company also does repair work on UAV component parts. The manufacturing facilities in Mississippi are shown in Figure 8.

Figure 8: Map of Mississippi Aerospace Companies



Source: Google Maps

The state of Mississippi also controls 1.25 percent of the Unmanned Aerial Systems (UAS) manufacturing in the United States (see Table 10). This brought $162 million in economic impact to the state and created 832 total jobs between 2015 and 2017. Mississippi competitively competes with other states for a percentage of manufacturing of UAVs. Mississippi directly competes with Alabama and Tennessee for UAV manufacturing production.

Table 10

Estimated Manufacturing Distribution for Aerospace and Defense UAVs

State	Manufacturing Distribution
Alabama	2.22%
Mississippi	1.25%
Tennessee	0.81%

Source: AVUSI

Mississippi is predicted over the next ten years to have an increase in economic impact from $162 million to $937 million and increase total jobs by 1,023 by 2025 (see Table 11). AVUSI projects the UAV manufacturing industry will increase employment in the state as the industry continues to expand. The direct jobs associated with the UAV industry are high paying; therefore, increasing the money spent in the community and the local tax base. The forecast for Mississippi is to continue to marginally add jobs every year as the UAV industry grows.

Table 11

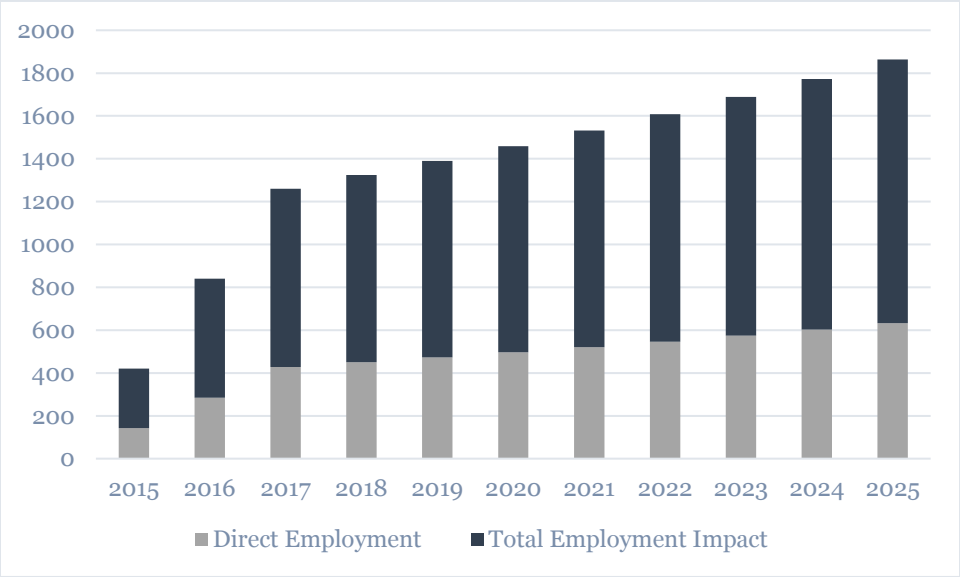
Mississippi Economic Impact from UAVs

Year	Direct Employment	Total Employment	Total Direct Spending ($M)	Total State Taxes ($M)	Percent Changed Over Previous Year
2015	143	277	14.48	26.97	100%
2016	285	555	28.97	53.94	50%
2017	428	832	43.45	80.91	5%
2018	450	874	45.62	84.95	5%
2019	472	918	47.90	89.20	5%
2020	496	963	50.30	93.66	5%
2021	520	1012	52.81	98.35	5%
2022	546	1062	55.46	103.26	5%
2023	574	1115	58.23	108.43	5%
2024	602	1171	61.14	113.85	5%
2025	633	1230	64.20	119.54	5%

Source: AUVSI

The state of Mississippi will experience an increase in indirect and induced jobs by 533 (see Figure 9). The direct jobs from the UAV industry will increase indirect jobs in the community. These might consist of teachers, medical personal, finance and insurance to handle the increase in population.

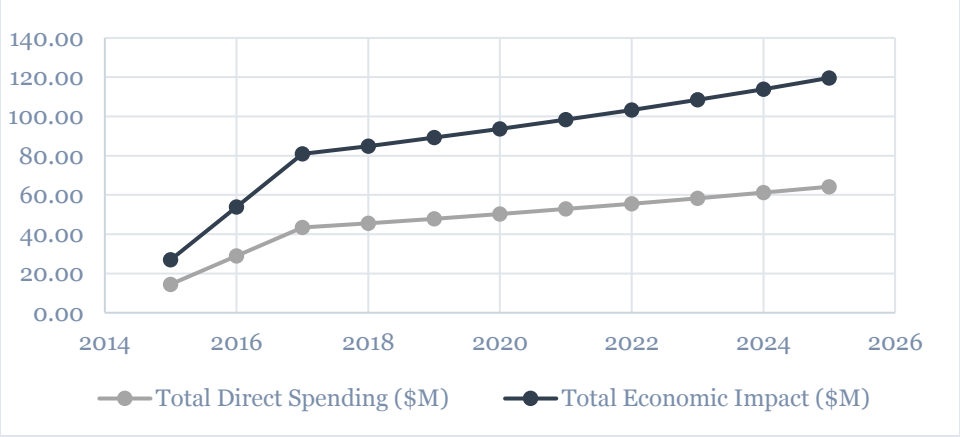
Figure 9: Mississippi Employment Increases from UAV Industry



Source: AUVSI

Lastly, the state of Mississippi is projected to see an additional increase in spending in the state's UAV economy by $49.27 million with a total economic impact of $119.54 million from the UAS industry (see Figure 10) (AUVSI Economic Impact Report, 2013).

Figure 10: Mississippi Spending and Economic Impact (in $M)



Source: AVUSI

Commercial UAV Industry SWOT Analysis

Industry experts were contacted to gain a better understanding of the current possibilities in the commercial market for military UAVs. These experts include the National Center for Spectator Sports Safety and Security (NCS4) Director of Research Daniel Ward, AVUSI Research Analyst Will Klein, ASSURE program Director Steve Luxion, and retired Air Force Major General James Poss. The industry experts disagreed on the types of UAVs that would be most successful in the civilian market based on FAA regulations, although all agreed that military UAVs could become a profitable industry if used in the right applications, such as video analytics and situational awareness.

Military UAVs are costly to acquire and are used for long duration purposes. Industries that could exploit the military UAV industries for long duration purposes include precision agriculture, public safety, transportation, and infrastructure. The weakness in the military UAV market is an inability to hover over a space for a long period of time; for example, a rotary wing drone can hover and move in to tight space to do bridge infrastructure inspections. The industry has an opportunity to capitalize on large military UAVs being used in the future; however, regulations to operate these UAVs have no clear time frame for changes. Figure 11 explains the SWOT analysis of the UAV military industry.

Figure 11: SWOT Analysis of the UAV Military Industry

Strength	Opportunity
• Growing market in the Precision Agriculture sector. • Public Safety and Transportation utilize UAVs for video analytics. • Infrastructure companies are using military UAVs for long duration purposes for checking oil and power lines.	• Possibly of using large UAVs like the Predator for commercial purposes. • Regulations are expected to be changed within the next 5 to 15 years to allow for commercial use of large military UAVs. • Niche markets like Land Management.
Weaknesses	**Threats**
• Many commercial UAVs are required to be rotary wing rather than fixed wing military UAVs. • The commercial market is in demand for photography and inspections, which military fixed wing drones do not have the capacity to do. • Military UAV are too expensive for the hobbyist UAV user.	• Regulation preventing the current use of large military UAVs. • There is no clear picture for a timeline on when regulation might change for UAVs. • It is challenging to attract investors in the UAV market from the uncertainty of regulation changes.

(See Appendix D for a full SWOT Analysis of the UAV industry)

Results

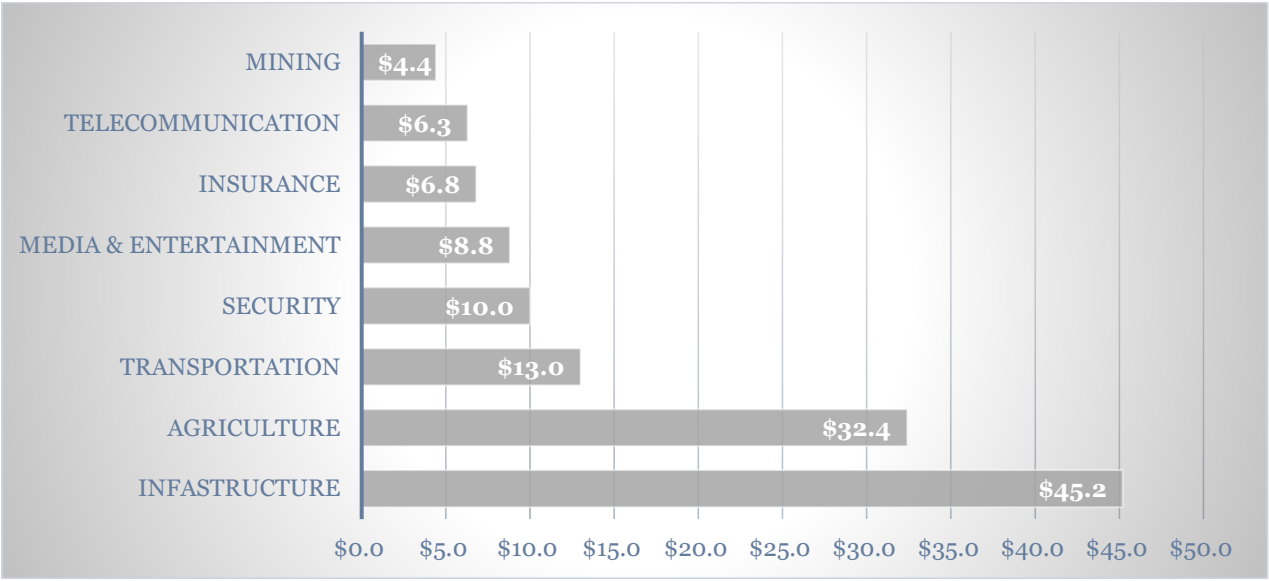
The SWOT Analysis provided for the development of four target segments of Precision Agriculture, Public Safety, Transportation, and Infrastructure. The following part of this report will outline the product, placement of the product, how to promote the product, and pricing strategies for the product. The report will then outline how defense UAV contractors could take advantage of assets available in Mississippi to create success for their business. These target markets will be discussed in detail in the target markets needs section.

Product

Target Market Needs

Commercial industries that intend to use drones must apply for a Section 333 exemption, which allows a firm to be certified to operate UAVs. The most profitable civilian industries using UAVs are infrastructure, agriculture, transportation, and safety, as seen in Figure 12 (Joshi, 2017).

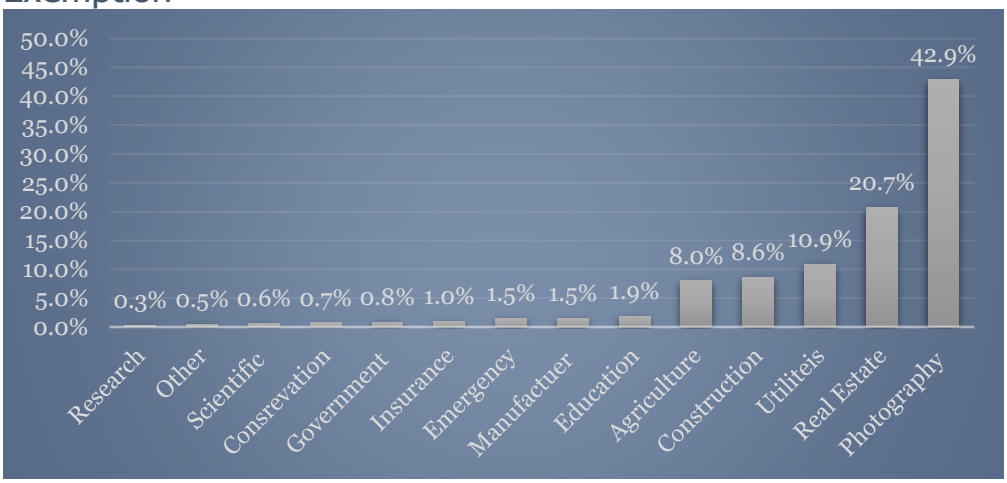
Figure 12: Commercial UAV Industry Predicted Value



Source: Business Insider

Section 333 demonstrates the UAVs that are above 55 lbs., which are operated in the civilian sector. Commercial users file for permits to operate their UAVs indicating the largest markets that utilize UAVs. These markets include markets like Real Estate, Utilities, and Agriculture (see Figure 13).

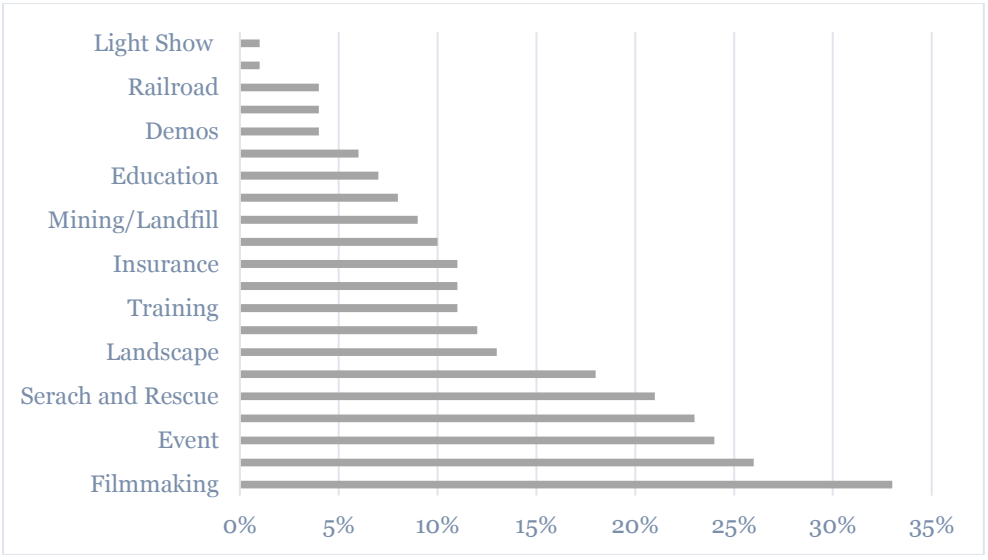
Figure 13: Percentage of Commercial Industries Applying for a Section 333 Exemption



Source: AUVSI

A Part 107 Waiver represents UAVs that are under 55 lbs., which requires a license for use. These UAVs are mostly rotary wing that are used for still video analytics. This goes outside of the operating capacity for military UAVs; however, they are also used to check infrastructure and public safety. Therefore, military UAV manufactures should focus on heavier and higher quality sectors of the civilian UAV market (see Figure 14).

Figure 14: Percentage of Commercial Industries Applying for a part 107 Waiver



Source: AUVSI

Product Uses

The target markets identified for UAV military contractors to diversity into the commercial sector are Public Safety, Precision-Agriculture, Infrastructure, and Traffic. Industry experts and online sources were used to compile an exhaustive list of uses for these target markets, based on best possible uses for current military UAV technology.

Market segments are developing currently in the UAV industry so there is limited hard data on these industries which are accustomed to rapid fluctuation. The market information in this report has been inferred from conversations with industry experts and secondary sources.

Market: **Agriculture UAV**

The Agriculture UAV market was created to service crop spraying and scanning of fields for crop problems. The agriculture industry is predicted to be a $32.4 million industry in the United States by *Business Insider*. The business is still growing according to AUVSI by the number of agriculture Part 107 Waivers granted. These waivers allow operators to use their UAVs for agriculture commercial purposes; therefore, the number of new waivers projects number of new users. The Agriculture market had 288 applications from August 2016 to August 2017 indicating a growing market. This market is characterized as a high revenue industry that has continual growth.

Product:

Agriculture UAV products are best used for the UAVs camera to make 3D soil analysis to know where to best plant crops. UAVs are being used for crop planting and spraying by having the ability to shoot seeds and the right amount of nutrients into the right spot from the air. Farmers with large

fields are also beginning to use UAVs to monitor crops to have the proper irrigation, and health nutrients for the soil (Mazur, 2017).

Promotion:

Industry Experts illustrated that the most efficient way to sell an agriculture UAV would be trade show, e-commerce, personal selling, and trade magazines. Agriculture trade show like the Ag Aviation Expo in Reno, Nevada allows users to gain hands-on experiences and visuals of the UAVs and for UAV salespersons to sale directly to clients. A large portion of UAV sales have transitioned to e-commerce while a few promotional items can be found in trade magazines like UAS Magazine.

Placement:

The high cost of Agriculture UAVs is going to eliminate them from being sold in stores. Therefore, the placement of the products will be either at trade shows or e-commerce. The acquisition will be directly from the seller to the buyer. Some UAVs can be sold by third party vendors like Amazon to end users.

Market: **Public Safety**

The public safety sector is defined as a market for government entities i.e. law enforcement or fire departments. This market can also be in the private market with security firms using UAVs at large events, such as sporting events and concerts. This industry is projected to be a $10 billion industry by 2020 by *Business Insider*. The safety industry applied for 210 Part 107 Waivers to operate commercial safety UAVs from August 2016 to August 2017 indicating a growing market (AUVSI, 2018). These factors indicate that the Public Safety market is a growing market that has high profitability.

Product:

Public Safety drones are used in search and rescue missions, situational awareness for first responders, and video analytics (Industry Experts, 2018). This can be accomplished by a UAVs ability to cover vast amounts of ground during search and rescue missions. Police and SWAT teams can use the drone to get an idea of the potentially dangerous situation without risking first responder's lives. Firefighters can use infrared camera technology for video analytics to be able to see through smoke and hazards (Wells, 2016).

Pricing:

Security UAVs have a wide price range allowing end users to buy them in stores like Wal-Mart or buying from a personal dealer. Prices range from $31,599 for high quality (XFold, Rigs, X12, U11, RTF) down to $15,627 for the First Responder Drone Advanced Kit. Lower end UAVs can be range from $2,000 (DJI Phantom 4) down to $106 for the Polaroid Pl 3000 Camera Drone. The pricing difference depends on the end users desire for quality and operation capacity for the drone.

Promotion:

The military UAV sector of the public safety market will require personal selling and trade shows to diversify into the commercial sector (Industry Experts, 2018). Military UAVs command a premium price, which eliminates them from being sold in big box stores. The National Guard Air Show and the Paris Air Show are just two avenues for defense contractors to sell directly to end users. Companies can use third party vendors such as Grainger.com for e-Commerce. Lastly, companies can use a direct business-to-business sales person to go to law enforcement and fire departments for direct sales.

Place:

A large portion of Public Safety UAVs are sold online from third party vendors or directly from the manufacturer's websites. These drones can be sold at air shows and directly to the end users. The price eliminates military UAVs from being indirectly sold to end user at stores like Wal-Mart and Best Buy.

Market: **Infrastructure**

Infrastructure for commercial UAVs consists of inspections of buildings, roadways and bridges and utility, oil and gas inspections. From August 2016 to August 2017, the infrastructure market has requested 407 Part 107 Waivers exemptions indicating a growing market. According to *Business Insider* this market is projected to be worth $45.3 billion.

Product:

UAVs are used in infrastructure for electric, oil and gas pipelines due to their long duration capabilities. Energy companies use UAVs to map out miles of power lines and other maintenance issues. They are also utilizing drones to assist personnel on where to restore power to customers by being able to detect damage after a natural disaster and hazards (Shape, 2017). UAVs are used in infrastructure projects for safety monitoring on potential hazards, and to collect data for inspections and data-based decisions (O'Donnell, 2017). UAVs are used to check miles of oil and gas pipelines so to reduce human injuries and to access places humans cannot get to (Gagon, 2016).

Pricing:

The cost on the open market for an UAV Utility Drone Kit is $15,600 on Grainer.com and $16,071 on Neobits.com. These UAVs can be modified to fit specification of the infrastructure market needs. Most of these UAVs are

handled through a Request for Proposal (RFP) where the cost is determined by the user's specifications.

Promotions:

Industry experts expressed that the way to sell to these market is by trade shows, e-Commerce and personal selling. An example of an air show would be the AMA Expo East in Secaucus, New Jersey, and the Paris Air Show. These events allow infrastructure users to promote their UAV and sales representatives to see the UAV. A RFP process can be handled directly on the UAV company website.

Place:

Infrastructure UAVs are sold through e-Commerce on UAV company websites. A place for UAV firms to sell their products is at an air shows so to allow sales personnel to meet with customers in a neutral environment. Sales persons can also go directly to infrastructure or utility firm's business locations for direct sales.

Market: **Transportation**

The transportation market for UAVs is defined by this report as product transportation and traffic monitoring. According to Theconversation.com companies such as Amazon, UPS, Google, and DHL are researching ways to deliver packages with UAVs. Airbornedrones.com defines traffic monitoring as the necessary collection of data that provides detailed descriptions for the use or performance of road networks. Currently there is no data for Part 107 Waivers on AUVSI.com for transportation of UAVs. According to *Business Insider*, this industry is projected to be a $13 billion industry by 2020. This industry has the potential to have sustainable and stable growth; however, due to current regulations on operations of UAVs, it is still developing.

Product:

The traffic sector of the UAV industry would mostly be for a military UAV for traffic monitoring situations, because delivering packages is not in the scope of military UAVs. Traffic monitoring uses UAVs to assist first responders in automobile wrecks or possibly providing medical supplies (Ward, 2018). Operators are able to use the live data from UAVs to help establish detours to reduce traffic jams and to help law makers create new roadways or extra lanes (Naveed, 2015).

Pricing:

Many UAVs that would be used for product transportation are currently still under development, according to Theconverstion.com. Therefore, the pricing for these UAVs is currently not available. Traffic monitoring UAV pricing is estimated to be around $250 for two hours of operation (Brooks, 2016).

Promotion:

According to industry experts, the typical places for these UAVs are trade shows, personal selling, and e-Commerce. The University of Southern Mississippi's UAV Technology and Innovation Forum allowed UAV companies to promote their products to public government entities. As these products continue to develop, manufacturers continue to promote the RFP process on their websites.

Placement:

UAV manufactures can demonstrate their UAV capabilities at trade shows that allow for end users to buy directly. Personal selling allows the sales person to develop a relationship with the government agencies. E-Commerce for manufactures sell their products via their website due to the pricing process.

Market: **Exports**

The Military Export Market consists of foreign military sales and direct commercial sales. Foreign Military Sales provided by the United State government provides articles or services to foreign nations. Direct commercial sales defense contractors are allowed to sale directly to foreign nations that are on an approved list. UAV manufactures have an opportunity to diversify their UAVs by selling to commercial markets. These markets fluctuate regularly with administration changes; however, under the Trump Administration, Foreign Military and Direct Commercial Sales have increased. This indicates that this is a growing market.

Product:

On April 19, 2018, the U.S. loosened restrictions on the marketing of and selling of military UAVs to approved allied nations (Reim, 2018). The military market revenue is mostly composed of high and medium altitude UAVs that can also be sold to foreign militaries. Therefore, for military defense contractors the best product to sell to foreign nations will be high and medium altitude UAVs verses small altitude UAVs.

Pricing:

The military drone market is handled through a RFP process where the price depends on quality and type of UAV. Predator and Reaper drones cost $2,500 to $3,500 per flight hour to operate. A Global drone costs $30,000 per flight hour (fcnl.org, 2018). According to Defenseweb.com, in a recent foreign military sales deal, the United States provided RQ-20B Puma II for $400,000.

Promotion:

According to Stone and Spetalnick, President Trump's new buy American plan will have embassy staffers engage in U.S. Arms Sales. These staffers will be used to promote military UAVs through foreign military sales. The loosening of the regulations of Direct Commercial Sales will allow companies to market directly to these foreign nations.

Placement:

U.S. Embassy officials will be able to sale and position their product to foreign governments. Sales persons from UAV manufactures will be able to sell directly to foreign governments. Military UAVs will be required to be positioned in direct sales to governments.

Results

The military UAV industry will cost too much for consumers in low altitude commercial drone market. For example, a RQ-20 Puma cost $400,000 per UAV most high end commercial sectors are from $15,000 to $30,000. Military UAV manufactures should focus on diversifying through the Foreign Military Sales and Commercial Direct sales to foreign nations.

Table 12

Target Market Needs

Target Market	Target Needs
Public Safety	Search and Rescue Situational Awareness for First Responders Video Analytics for Hazardous Situations
Precision-Agriculture	3D Soil Analysis Crop Planting Localized Spraying Crop Monitoring for Irrigation and Nutrient
Infrastructure	Power Lines Inspections Oil and Gas Line Inspections Inspections after Natural Disasters
Traffic	Traffic Flow Assessment Wreck Assessment Department of Transportation Work Safety

Source: Industry Experts

Competitors

The commercial UAV market is controlled mostly by the Chinese firm DJI. Most hobbyist UAVs come from China because it is less costly. Military UAV manufacturers would need to pursue a higher quality market that demands premium performance, an example is precision agriculture uses for sensor technology. The military UAV manufacturers could follow AeroVironment's led in this industry for their business model of producing military and commercial UAVs.

Table 13

Top Five Commercial UAV Manufactures in the World

Rank	Company	Country
1	DJI	China
2	Parrot	France
3	Xiaomi	China
4	Hover	China
5	AeroVironment	USA

Source: Dronell.com

Place

Indirect Sales

Indirect sales are a way for companies to have a neutral place for buyers to compare products for quality or pricing purposes and a faster way to get products to market. UAV companies use indirect sales to promote and sell their products through retailers and wholesalers, including retail stores such as electronic stores or local specialty hobby stores. Many UAV manufacturers are indirectly selling their products to consumers online as a way to highlight products to a greater target audience. Many UAV users buy aircrafts from e-commerce websites that allow them to compare different types of UAVs and interact with other UAV users around the world.

Direct Sales

UAV firms utilize direct sales to promote and create demand for their product by going directly to the user/purchaser. This takes place in the form of face-to-face sales operations with a salesperson marketing and selling directly to the customer. Buying in-person establishes a business-to-customer relationship where a salesperson can explain the detailed features of UAVs and operating directions to end users. Trade shows are the predominate way of doing direct sales in this industry which gives small companies the ability to network, market, and compare products to larger UAV companies. Examples of major trade shows are the Paris Air Show in France, CES-Unmanned Systems in Las Vegas, AMA Expo East in Secaucus, New Jersey, and FAA UAS symposium in Daytona Beach, Florida. UAV companies at trade shows use a direct selling business strategy called multi-level marketing that includes personal selling which allows for UAV companies to present their products to larger audiences and then in breakout sessions to market individually to customers to solve their needs.

Promotions

Promotions for UAVs are the communication mediums that marketers from UAV companies choose to convey awareness and the benefits that they can bring (Kar, 2010). UAV companies must determine a target segment for promotions that have four distinct roles in advertising, public relations, personal selling, and sales promotion (Kar, 2010). Advertising for UAV companies consists mainly of online advertisements, anecdotal, and trade shows. UAV companies build relationships with their organizations by having good communication with their distributors. The best way to promote Mississippi companies producing UAVs to our market segments, i.e. public safety, transportation, utility companies, and agriculture, is explained in table 14. Air shows are the best opportunities for UAV companies to sell their UAVs by marketing to a larger target audience at one time using demonstrations and conducting personal selling at breakout sessions. For example, if a Mississippi Defense Contractor selling an agriculture or utility UAV could promote their products at a trade show like the Commercial UAV Show in Las Vegas (Unmanned Systems Technology, n.d.).

Table 14

Methods to Promote to Target Markets

Target Market	Promotion Method
Public Safety	Trade Shows Personal Selling
Precision - Agriculture	Trade Shows E-commerce Personal Selling Trade Magazines
Infrastructure	Trade Shows E-Commerce Personal Selling
Traffic	Trade Shows Personal Selling E-Commerce

Source: Industry Experts

Pricing

Pricing Strategies Utilized by the UAV Industry

Skimming is the process of charging a higher price as the product first enters the market to stimulate customer demand. Then as the life cycle of the product advances and more competition enters the market, the price is lowered to match price sensitivity (Brookins, n.d.). Penetration is the pricing strategy of setting your price lower than the standard price as it enters the market, with an expectation of capturing greater market share. As firms gain hold on the market share for their industry, prices will then start matching price sensitivity (Griffin, n.d.). For Mississippi UAV businesses that are diversified in commercial markets, the best pricing strategies to use are penetration and skimming. These strategies are geared towards helping companies break into market as they first introduce a product. Examples of price penetration and skimming include:

- Skimming: Henri Seydoux illustrated how firms such as DJI and 3D Robotics use price skimming to establish high prices for their UAVs. This creates demand for their products from the perception by customers of their product being the best in the industry (Ryan, 2015).
- Penetration: Parrot's Chief Executive Officer Henri Seydoux in an interview with Forbes magazine gave an example of pricing penetration in the new wave of UAV companies entering the market. Many of these companies, located in China, are trying to create demand for their products entering the market by driving down their prices to gain market share (Ryan, 2015).

State of Mississippi Aerospace Ecosystem

Testing Facilities

Camp Shelby Joint Forces Training Center (CSJFTC)

Camp Shelby, located in south of Hattiesburg, has over 252 kilometers of restricted airspace for UAV pilots to test fly their aircraft. The military site is home to the only Unmanned Aircraft Regional Flight Center, which will enhance search and rescue missions and natural disaster missions (Beveridge, 2017). The flight center has public and private investments and research at the facility. The U.S. Department of Homeland Security (DHS) selected CSJFTC as a center to test and evaluate unmanned aircraft systems. This research includes aircraft certification, ground and airborne sensors, avoidance systems, data link security, ground control station, system safety, data gathering, commercial, environmental, and marine applications (Camp Shelby Joint Forces Training Center, n.d.). Campy Shelby has unused land with two hangars, two general industrial buildings, vehicular maintenance buildings, and an administration building from the United States Naval Construction Forces that could be used by a UAV company (Hinton, 2017). There is unused land near Camp Shelby's runway that can be used for UAV research and development, but this land will require significant investment in order to be viable for use. A map of Camp Shelby's Unrestricted Airspace can be found in Appendix B.

Research and Development

ASSURE UAS

The Alliance for System Safety of UAS through Research Excellence (ASSURE) is an organization of twenty-three research universities, and over one hundred industry and government partners, which is led by Mississippi

State University. The purpose of ASSURE is to provide the FAA with research to efficiently integrate UAVs into the United States airspace system with minimal impact. ASSURE is a nonprofit 504C that can conduct research for private industry and local governments. The research aspects of ASSURE include:

- Air traffic control interoperability
- UAV noise reduction
- UAV airport ground operations
- Control and communications for UAVs
- Detection and avoidance
- Human factors
- UAV weight requirements (minimum standards)
- UAV aircraft pilot training and certification (minimum standards)
- Safety minimum standards for operating a UAV at low altitude operations safety
- UAS traffic management

Product Develop Assistance

Mississippi Polymer Institute

The Mississippi Polymer Institute (MPI) at The University of Southern Mississippi occupies a 6,000 square ft. building known as The Accelerator, which has office space, wet labs, mechanical testing labs, 3D printing, compounding, extrusion, and training labs. These resources are used to help firms with polymer synthesis, composite manufacturing, CAD modeling, and workforce training (Mississippi Polymer Institute, 2018). MPI has worked with major corporations like GE Aviation, Boeing, Northrup Grumman, and Cytec Resins.

Raspet Flight Research Laboratory

The Raspet Flight Research Laboratory is located in the research park at Mississippi State University. Raspet helps with the design and testing of materials for prototyping lightweight manned or unmanned aircraft. Other services include education for K-12 students about the aerospace industry, providing industry technical training, and certification or authorization of waiver to operate a UAV. They provide manufacturing space and access to university assets with the Aviation Incubator, allowing start-ups to have an economical opportunity to start their venture. Raspet helped with flight-testing for Stark Aerospace's UAV called the Heron (Raspet MS State, 2018). They have also worked with other aerospace industry leaders such as Airbus Helicopters, GE Aviation, and Aurora Flight Sciences (MDA, 2018).

Center for Advanced Vehicular Systems

The Center for Advanced Vehicular Systems (CAVS) is located in the research park at Mississippi State University. CAVS' purpose is to assist Mississippi industries in enhancing engineering, manufacturing, design, and information technologies to help industry perform to their highest potential. The services provided to the aerospace sector are multiscale materials modeling, extreme environment analysis and testing, manufacturing process simulation, structural reliability testing, and surrogate modeling (CAVS, 2018).

Center for Manufacturing Excellence

The Haley Barbour Center for Manufacturing Excellence (CME) is located on The University of Mississippi Oxford Campus. This center helps prepare students to excel in advanced manufacturing by providing hands-on experience, theory fundamentals, and critical thinking skill sets. CME works with manufacturers at their factories to establish efficient productivity, reduce overhead and bottlenecks, and increase the value to customers by

improving product quality. The employee training programs and Kaizen Activity program strive to improve safety, quality, quantity, and cost, and model process training to help improve workflow (CME MS, 2018). They have advised large companies such as GE Aviation and Toyota Motor Manufacturing Mississippi (MDA, 2018).

Education Pipeline

Mississippi State University

Mississippi State University founded its aerospace engineering program in 1935 as one the first established programs in the United States for aerospace research. The aerospace engineering program is ranked 64th out of the top 100 programs in the country, according to Aerospace-schools.com. The program has a primary focus on design, fabrication, testing, and analysis of aircraft/spacecraft. This is accomplished through two concentrations: 1.) aeronautics, and the study of aircraft in earth's atmosphere, and 2.) astronautics, the study of spacecraft outside of the earth's atmosphere. The department offers master and doctoral programs in aerospace engineering with research areas that include fluid dynamics, experimental fluid mechanics, multidisciplinary design, flight mechanics, composite structures, flight-testing, stability/control, data acquisition, and materials test and evaluation. The master's program can create a research project from problems industry companies are facing so to help meet industry needs. According to Davie Belk, the undergraduate program currently has one class; however, the university is expanding its footprint into the UAV field. The University recently hired a professor to help create more UAV-centric classes and labs for the aeronautics curriculum. By the end of the program, students will be able to build their UAV in the lab. Students at Mississippi State

University will also have access to the Raspet Flight Center, and the ASSURE program for UAV regulation testing.

Hinds Community College

The commercial aviation program allows students to achieve an associate of arts degree while earning a private pilot license, which can enable students to transfer to Delta State University to earn a Bachelor of Science in Commercial Aviation. The aviation technology program is designed to prepare students for entry-level positions in the aviation industry while achieving an associate of applied science. The focus areas of the program are air traffic control technology, airport operations technology, aviation security technology, and unmanned aerial systems. Hinds Community College's UAS program will prepare students for careers in operations and coordination of UAVs. This is achieved by student's exposure to:

- Hands-on operation of fixed-wing and rotary aircraft
- Full-scale simulator software/hardware systems
- Form basic stages to the advanced stages
- Launch and recovery techniques, and autopilot operation
- Construction and repair of UAVs
- Risk awareness
- Data links and sensors
- Commercial applications
- Aerial photography, agriculture, surveying, mapping
- Monitoring ecological livestock
- Inspection-tower, buildings, real estate

Pearl River Community College

Pearl River Community College (PRCC) has received a Career and Technical Education Challenge Grant from the Mississippi Community College Board for

the purposes of establishing UAV program. Scott Alsobrooks, the Vice President for Workforce and Economic Development, said the program is taught at the Hancock Center in Waveland, Mississippi (AUVSI, 2017). The program is likely to model its curriculum after Hinds Community College Aviation Technology UAS program. PRCC is searching for an instructor to lead the course and the program remains under development (Nettles, 2017).

Financial Assistance

- Mississippi Aerospace Initiative Incentives Program is a 10-year exemption from state income, franchise, sales taxes, and use tax exemption for the purchase of component building materials and equipment related to the industry. For firms to qualify they must locate or expand in the state for manufacturing, assembling components, provide research and development, or training services for the aerospace industry. Firms must invest $30 million and create over 100 full-time jobs to qualify.
- Advantage Jobs Programs gives Mississippi aerospace manufacturing firms locating or expanding in the state a rebate of 90 percent of the income tax withheld for employees, for ten years. Firms must meet or exceed the average annual wage of the state or the county it locates to.
- On-the-Job Training Reimbursement is a job training program that local community colleges and WIN Job Centers partner with local industry to tailor a training program to meet their needs. The training programs depend on the length of the training and wages of the employees. The Mississippi Department of Employment Security can reimburse firms up to 50 percent of employees' wages, which the firms pay during training. Firms can receive additional savings from the Opportunity Tax Credit program. Employers must have a full-time position and have worker's

compensation policies to train new hires with no experience, or train current employees to gain new technology skills.

- Standard Property Tax Exemptions are available for aerospace industries locating to the state of Mississippi. Local governing authorities may grant a property tax exemption for up to 10-years on real and tangible personal property being used in the state. The exemption may be granted for all local property taxes except school district taxes on any property and finished goods or rolling stock. The exemption usually applies to property taxes on land, buildings, machinery, equipment, furniture, fixtures, raw materials and work in process. If a company invests more than $100 million, then a local governmental authority may negotiate a fee that will be paid in place of the calculated property tax typically due on the property, which cannot be less than one-third of the property tax levy.
- For more information on Finical Incentives see figure 15 and 16, from the Mississippi Develop Authority.

Figure 15: Financial Incentives for Mississippi Aerospace Companies

PROGRAM	BENEFIT	ELIGIBILITY REQUIREMENTS*
Mississippi Aerospace Initiative Incentives Program	The Mississippi Aerospace Initiative Incentives program provides aerospace businesses with 10-year state income and franchise tax exemptions and a sales and use tax exemption for the start-up of a facility or completion of an expansion.	The incentive is available to companies that manufacture or assemble components for the aerospace industry or provide research, development or training services for the sector. Companies must invest at least $30 million and create at least 100 full-time jobs to qualify for these incentives.
Jobs Tax Credit	In Mississippi, companies receive a corporate income tax credit for creating jobs. These credits are equal to a percentage of payroll for each newly created job. Companies can either use these credits, which range from 2.5% to 10% of payroll depending on the business location, or they can opt for a job training grant as a direct reduction of workforce training costs. Credits are available for a five-year period and are taken in years two through six after jobs are created. Job training grants can cover up to 75% of the cost of training employees and range from $1,000 to $2,000 per worker, depending on the business location.	A business must create and maintain between 10 and 20 jobs, depending on the location of the company's operations. Eligible businesses include: manufacturers, processors, wholesalers, distributors, warehouses, research and development facilities and technology intensive industries.
Research and Development Skills Tax Credit	An income tax credit of up to $1,000 per year for a five-year period is available for any full-time position requiring research or development skills.	Any business with positions requiring research or development skills may apply.
Existing Manufacturer Tax Credit	An income tax credit equal to 5% of an existing Mississippi manufacturing business's additional investment in buildings and/or equipment is available.	Existing manufacturers that have operated in Mississippi for at least two years and invest an additional $1 million or more in buildings and/or equipment may apply.
Rural Economic Development (RED) Tax Credit	An income tax credit used in conjunction with Mississippi Business Finance Corporation-issued industrial revenue bonds is available. Based on the amount of bond-related debt service, credits can be used to offset up to 80% of a company's state corporate income tax liability each year for the life of the bonds.	Manufacturing, distribution or warehouse facilities and other businesses in Mississippi utilizing industrial revenue bonds issued by the Mississippi Business Finance Corporation may apply.
Ad Valorem Tax Credit	An income tax credit equal to the ad valorem (property) taxes a company pays on inventory is available.	Manufacturers, processors, distributors, wholesalers or retailers may apply.
Sales and Use Tax Exemption for Construction or Expansion	A ½ or full sales and use tax exemption, depending on the county in which the facility is located, is available on eligible machinery and equipment purchases related to a new or expanded facility and on building materials used in construction, provided the materials are purchased directly by the eligible business.	Manufacturers, processors, data and information processing businesses and technology-intensive enterprises are eligible to apply.

Source: Mississippi Development Authority

Figure 16: Financial Incentives for Mississippi Aerospace Companies

PROGRAM	BENEFIT	ELIGIBILITY REQUIREMENTS*
Sales and Use Tax Exemption for Bond Financing	A sales and use tax exemption is available to eligible businesses that have obtained bond financing through the Mississippi Business Finance Corporation. A sales and use tax exemption is also available on building materials purchased directly by the eligible company.	All businesses using industrial revenue bonds issued through the Mississippi Business Finance Corporation are eligible.
Fee-in-Lieu	A company may be approved by local authorities to pay a fee in lieu of standard property taxes. This negotiated fee is valid for 10 years but cannot be less than 1/3 of the property tax levy.	Local units of government may consider a fee-in-lieu agreement when a company's private investment in land, building(s) and equipment exceeds $100 million.
10-Year Property Tax Exemption	An exemption from property taxes on land, building and equipment is available for up to 10 years. School taxes are not exempt.	Eligible businesses include: manufacturers, processors, research and development facilities, refineries, warehouse and distribution facilities, data and information processing companies, telecommunications and technology-intensive industries. Local authorities must approve the exemption.
Exemption on In-State Inventory	An exemption from property taxes on finished goods that will remain in Mississippi is available. School taxes are not exempt. Any taxes paid become a direct credit to Mississippi income tax.	Manufacturers, processors, distributors, wholesalers or retailers are eligible. Local authorities must approve the exemption.
Free Port Warehouse Exemption	An exemption from property taxes paid on finished goods inventories leaving Mississippi is available. The exemption may be for all property taxes and may be perpetual.	Local authorities must approve the exemption.
Growth and Prosperity (GAP) Program Tax Exemptions	Businesses that locate or expand in specific geographic areas of the state may receive state income tax, franchise tax and property tax exemptions for up to 10 years, as well as a sales and use tax exemption on all equipment and machinery purchased during initial construction or an expansion at an approved facility. GAP counties include Adams, Bolivar, Claiborne, Coahoma, Holmes, Humphries, Issaquena, Jefferson, Leflore, Noxubee, Oktibbeha, Quitman, Sharkey, Sunflower, Tallahatchie, Tunica, Washington, and Yazoo counties.	An eligible business must be located in a county designated as a GAP county. To receive a GAP designation, a county must have an unemployment rate that is 200% of the state's annual unemployment rate or 30% or more of its population must fall below the federal poverty rate.
Advantage Jobs Incentives	Many businesses creating new jobs in Mississippi are eligible to receive a rebate equal to a percentage of their Mississippi payroll for up to 10 years. The average wage of all jobs created must meet the program's minimum average wage requirements.	Eligible businesses include any businesses that pay an average annual wage of 110% of the average county or state wage (whichever is less) and create at least 25 jobs. Businesses must provide a basic health benefits plan.

Source: Mississippi Development Authority

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APPENDIX A

UAVs Currently Utilized by the Department of Defense

The DOD remains the largest revenue generating source for the UAV industry from purchases. Based on publicly available information, Table A1 shows the UAVs that the United States military is currently operating. This chart demonstrates the downstream demand of the supply chain industry for the UAV industry.

Table A1

United States Armed Services - Total Utilization of UAVs

Branch	Model	Maker
Special Forces	CQ-10 Snow Goose	Misty Mobility Integrated Systems Technology
United States Air Force	RQ-20 Puma	AeroVironment
United States Air Force	Predator	General Atomics
United States Air Force	Global Hawk	Northrop Grumman
United States Air Force	MQ-9 Reaper	General Atomics
United States Air Force	RQ-Raven	AeroVironment, Inc.
United States Air Force	Wasp III	AeroVironment
United States Air Force	Lockheed Martin RQ-170 Sentinel	Lockheed Martin
United States Air Force	Lockheed Martin Stalker XE	Lockheed Martin
United States Army	RQ-Raven	AeroVironment, Inc.
United States Army	RQ-20 Puma	AeroVironment
United States Army	Lockheed Martin Stalker XE	Lockheed Martin
United States Army	Switchblade	AeroVironment
United States Army	Prioria Robotics Maverick	Prioria

United States Marine Corp	Scan Eagle	Boeing (Inistu)
United States Marine Corp	RQ-21 Blackjack	Boeing (Inistu)
United States Marine Corp	RQ-7 Shadow	AAI Corporation (Textron)
United States Marine Corp	RQ-2A Pioneer	Pioneer UAV Inc.
United States Marine Corp	Black Hornet Nano	Prox Dynamics
United States Navy	Fire Scout	Northrop Grumman
United States Navy	MQ-4C Triton	Northrop Grumman

Source: MMIST Fact Sheet, Army Technology, Degal.com, General Atomics, Air Force Technology, fi-aeroweb.com, Lockheed Martin, Prioria.com, Marine Corps times, Northrop Grumman, and Navy Technology

High Altitude UAVs

Model: MQ-1 Predator

Source: deagle.com

Model: Global Hawk

Source: northropgrumman.com

Medium Altitude UAVs

Model: Fire Scout

Model: AeroVironment RQ-20 Puma

Source: army-technology.com

Low Attitude UAVs

Model: AeroVironment Wasp III

Source: army-technology.com

Model: AeroVironment Wasp III

Source: www.af.mil/About _US/FACT-Sheets

Appendix B

The FAA controls the operations of UAVs in the United States Air Space. An operator of a UAV of above 55 lbs. must apply for a Section 333 to operate these UAVs. Smaller UAVS under 55 lbs. operators must receive a Part 107 Waiver. The critical factor for UAV manufactures to understand is the operating conditions for the Section 333 exemption since most military UAVs will operate under these conditions.

Table B1

Explanations of Operating Conditions for UAVs from the FAA

Topic	Part 107	Section 333
Initial Training	At least a sport-Pilots License and Current flight review	Pass an initial aeronautical knowledge test at an FAA-approved knowledge testing center
Recurrent Training	Pass a recurrent aeronautical knowledge test every 24 months	Biennial flight review
Medical certificate	Pilots must ensure that they don't have any condition that would interfere with safe drone operations	FAA medical certificate
Crew Size	1 pilot with a remote piloted airman certificate with a small UAS rating	At least 2: Pilot + visual observers
Fight Restrictions	Cannot Operate in:	Cannot Operate in:
	1) Class A airspace (18,000 feet and above)	1) Prohibited Areas
	2) Prohibited or restricted area	2) Special Flight Rule Areas
	3) Temporary/Permanent Flight Areas	3) DC Flight Restricted Zone
	Prior authorization needed from air traffic control when in controlled airspace (Class B, C, D, E)	4) Temporary/Permanent Flight Restricted Areas that requires Special Permission (Airports)

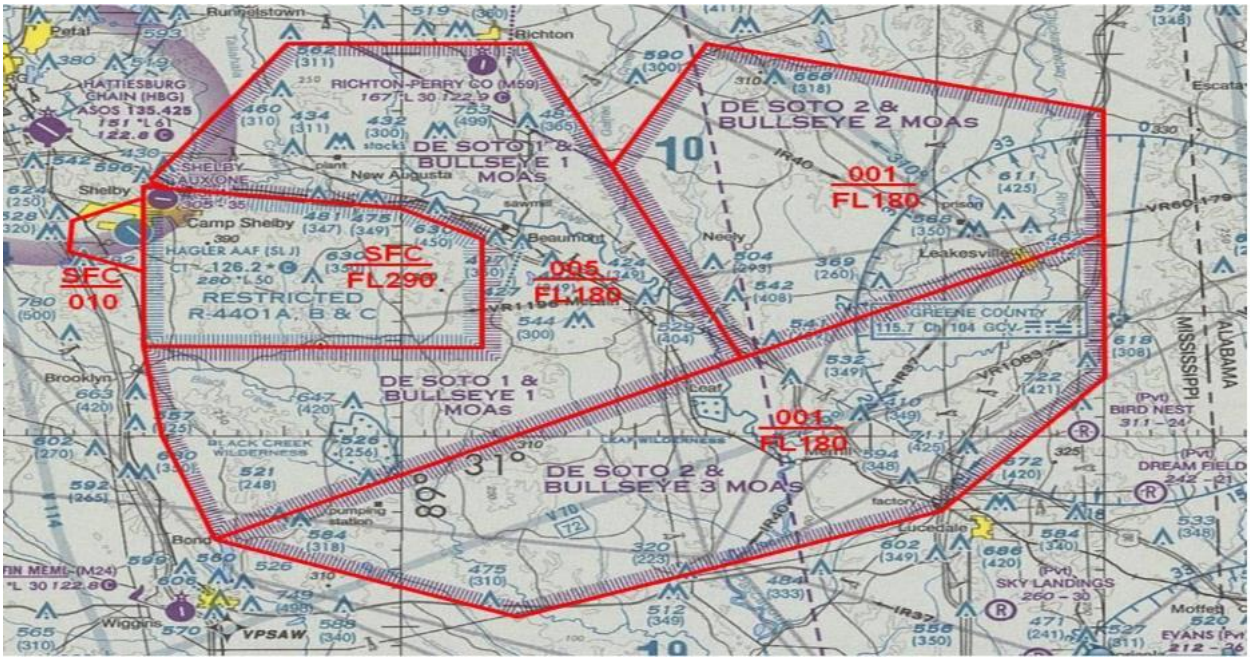
Time of Day	Only between official sunrise and sunset (can be used at dawn and dusk with lights)	Daylight operation only
Weight Limit	55 pounds	55 pounds
Speed Limit	100 Miles per hour	100 miles per hour
Weather	3-mile visibility, 500 below clouds, 2000 feet horizontally away from clouds	3-mile visibility, 500 below clouds, 2000 feet horizontally away from clouds
Height limit	400 feet, if on a structurer 400 above the structurer	400 feet
Visual Line of Sight	Required	Required
Operation above people	Not Allowed	Not Allowed
Buffer	No Buffer	At least 500 feet from other property
Aircraft registration	Required	Required
Aircraft allowed	Any aircraft under 55 pounds	Specified by FAA
NOTAM filing	No	Yes
Monthly COA reporting	No	Yes
Incident reporting	Within 10 days for a serious injury, damage greater than 500, and any loss of Consciousness	Yes

Source: FAA.org

Appendix C

Camp Shelby has over 252 kilometers of unrestricted Airspace that encompasses two counties in Perry and Forrest, MS. Figure 16 is a map of the unrestricted airspace at Camp Shelby.

Figure 15: Camp Shelby's Unrestricted Air Space



Source: Camp Shelby Joint Forces Training Center

Appendix D

Strengths

Smaller military UAVs are built for longer duration reconnaissance and surveillance missions to assist troops gain better situational awareness without putting a person's life in danger. This technology could be converted to sale the UAV in the commercial markets of precision agriculture, public safety, transportation, and infrastructure. Precision Agriculture could utilize military UAV sensors to scan large fields for irrigation and blighting, and possibly localized spraying of pesticides. Public Safety and Transportation could utilize drones for situational awareness and video analytics to help law enforcement and other public services gain an understanding of emergency situations. Lastly, infrastructure that stretches over longer distances like power lines and oil pipelines could take advantage of the long duration of military UAVs flight times, which would reduce their need to operate costly manned aircraft.

Weaknesses

Smaller military UAVs are used for longer duration surveillance and reconnaissance missions. These aircraft are fixed wing UAVs that cover longer distances and have long flight patterns. For the commercial market, aerial photography and inspections are in demand from consumers; however, the military drones are not adequate for this field. These types of industries require an aircraft that can hover to take still images, which is accomplished by a rotary wing drone. For example, military UAVs could not be used for inspecting bridges or rafters of a dome stadium, due to their inability to stay still long enough for picture or video streaming. Lastly, for most aerial photography or inspections many firms would not be willing to pay the premium prices for a military UAV.

Opportunity

The UAV industry has the opportunity to expand its footprint into the commercial market by using large UAVs such as the Predator and Reaper. These aircraft could cover the ground of several UAVs at once for public safety purposes. The Air Force test lab and FEDEX are working on creating an unmanned cargo plane that could cut logistics costs. The problem is there is no current regulation allowing the commercial use of these UAVs. Regulations are projected to be a few years away from being passed for the use of large UAVs; however, there is a high chance that these could be passed within three years. When these regulations are passed, a Mississippi UAV manufacturer could take the opportunity to capitalize on niche markets like Land Management, and Surveying.

Threats

The threat to the UAV commercial industry as a whole is due to the heavy regulations on the operation of large UAVs. Many firms would like to operate out of the line of sight of the pilot to be able to deliver products, to preform inspections, and to use video analytics. All of the industry experts disagreed about how long regulation would take to change and the scope of the regulation change. Therefore, for investment and research purposes in the commercial market in the United States, it is hard to predict where the future of the market will be. This length could reduce investments by firms.

Results

The SWOT Analysis has provided for the development of four target segments of Precision Agriculture, Public Safety, Transportation, and Infrastructure.