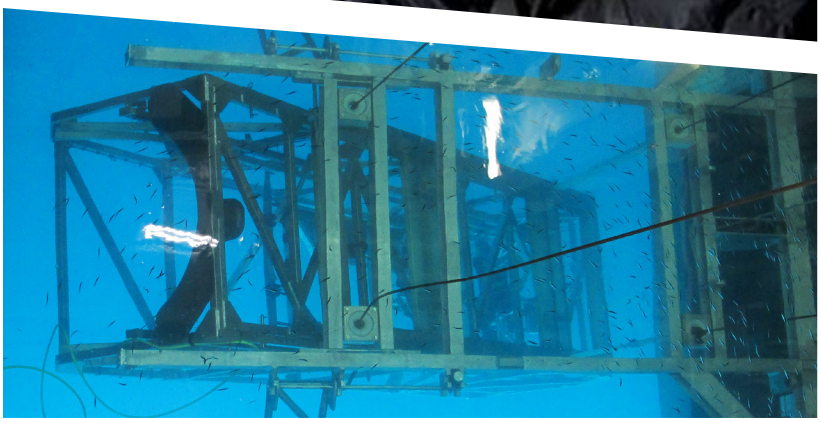
MISSISSIPPI DEFENSE DIVERSIFICATION INITIATIVE



Unmanned Maritime Systems (UMS) in Mississippi

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EXECUTIVE SUMMARY

This report provides details on the Unmanned Maritime Systems (UMS) industry in the State of Mississippi. Increasing interest in this industry is a result of activities centered around the newly-identified and still-to-be-defined Blue Economy and its potential to emerge as a major economic driver in the State. Spurred by the Navy's efforts to expand the use of unmanned systems in their surveys and missions, recent efforts by Governor Phil Bryant's office resulted in a report generated by the Governor's Ocean Task Force (GOTF). The GOTF report identified 36 companies working in the UMS industry in Mississippi. The industry is growing quickly; two additional companies have been identified since that report.

Most of the UMS work in Mississippi is performed by contractors supporting the Department of Defense (DoD) and specifically the Department of the Navy. Other federal agencies in Mississippi are involved in UMS, such as the National Oceanic and Atmospheric Administration (NOAA), that manufactures, deploys, and maintains large buoys worldwide and operates smaller unmanned systems for inspecting these assets.

There are a few large companies with satellite offices in Mississippi that support UMS that are satellite-based, airborne, or water-based (used on the surface or underwater). Only one (VT Halter Marine) has its headquarters in the State, but these companies represent a substantial segment of the market for traditional systems developed for government applications. Large companies in the industry with satellite offices in Mississippi include Lockheed Martin, Northrop Grumman, Leidos, Vencore, General Atomics, Pacific Architects and Engineers, and General Dynamics. Other companies, like The Boeing Company, are acquiring smaller companies developing technological advancements for UMS. More small companies are entering this industry as costs of entry are now lower and new applications are being identified.

To quantify the industry, a survey was distributed to the identified UMS companies in Mississippi. Thirty-eight companies were surveyed, and 14 responses were received. Data from the responses was extrapolated to develop a generalized picture of the UMS economy in the State. Reported revenues were $85.1M, which when extrapolated to the 36 qualifying companies (two were pre-revenue), yields revenues of $219M. If one applies a multiplier noted for technology industries (5x to 8x as indicated in Mississippi's Blue Economy Report),[1] the total economic impact of this sector of the Blue Economy exceeds $1B.

The industry is in a growth phase, with 64% of the responding companies reporting expected growth in 2018 and beyond. This is due to the reduced cost of entry, as well as the leaps in technology as these systems are utilized for non-military purposes.

Mississippi is poised for growth in this industry. The Navy has goals to expand the use of UMS, anticipating up to 1,000 additional underwater gliders, six to eight additional survey vessels for deployment, with 100 employees for each new survey vessel. Beyond military uses, emerging non-military applications such as inspection of tall marine structures including ship structures, bridges, and cranes, as well as fisheries monitoring, are being popularized throughout the country. In support of federal uses and the Oil & Gas industry, advances are needed in extending the time and depth of UMS operations. For other purposes, advances will be customized for their applications, focusing on ease of use, increased automation, smaller size, less deployment infrastructure, and affordability. As these technologies are adopted by Mississippi buyers (such as ports, fisheries, and aquaculture), even more opportunities will arise.

[1] Mississippi's Blue Economy, USM Capstone project; A. Edwards, S. Veglia, and K. Buckley; 2014

ABOUT THE INDUSTRY

INDUSTRY DEFINITION

For the purposes of this report, the Unmanned Maritime Systems (UMS) industry includes companies that design, build, and produce systems that are used to observe and assess waterways, coastlines, oceans, and other bodies of water. They may operate in or below the surface of the water (water-based), may be airborne, or may be space-based (satellites). This industry also includes companies that handle the data collected by these systems.

MAIN ACTIVITIES

The primary activities of this industry are:

- Designing and manufacturing UMS and component parts
- Maintaining UMS and component parts
- Deploying/operating UMS
- Obtaining/manipulating data from UMS
- Creating products based on UMS data

The major products & services include:

- UMS that are water-, aerial-, or space-based
- Datasets and databases of standardized data for use in decision-making tools
- Maps, model outputs, and other artifacts that assess water properties for various decision-driven uses

SIMILAR INDUSTRIES WITH 4-DIGIT NAICS CODES

- 3325 – Hardware Manufacturing
- 3345 – Navigational, Measuring, Electromedical, and Control Instrument Manufacturing
- 3364 – Aerospace Product and Parts Manufacturing
- 3366 – Ship and Boat Building
- 4881 – Support Activities for Air Transportation
- 4883 – Support Activities for Water Transportation
- 5171 – Wired Communications Carriers
- 5172 – Wireless Communications Carriers
- 5173 – Satellite Telecommunications
- 5182 – Data Processing, Hosting, and Related Services
- 5191 – Other Information Services
- 5414 – Specialized Design Services
- 5415 – Computer Systems Design and Related Services
- 5416 – Management, Scientific, and Technical Consulting Services
- 5417 – Scientific Research and Development Services
- 8112 – Electronic and Precision Equipment Repair and Maintenance

ADDITIONAL RESOURCES

- www.auvac.org, Autonomous Undersea Vehicle Applications Center
- www.auvsi.org, Association for Unmanned Vehicle Systems International
- www.marinelink.com, Maritime Reporter
- www.mtsociety.org, Marine Technology Society
- www.gcoos.org, Gulf of Mexico Ocean Observing System

INDUSTRY DETAILS

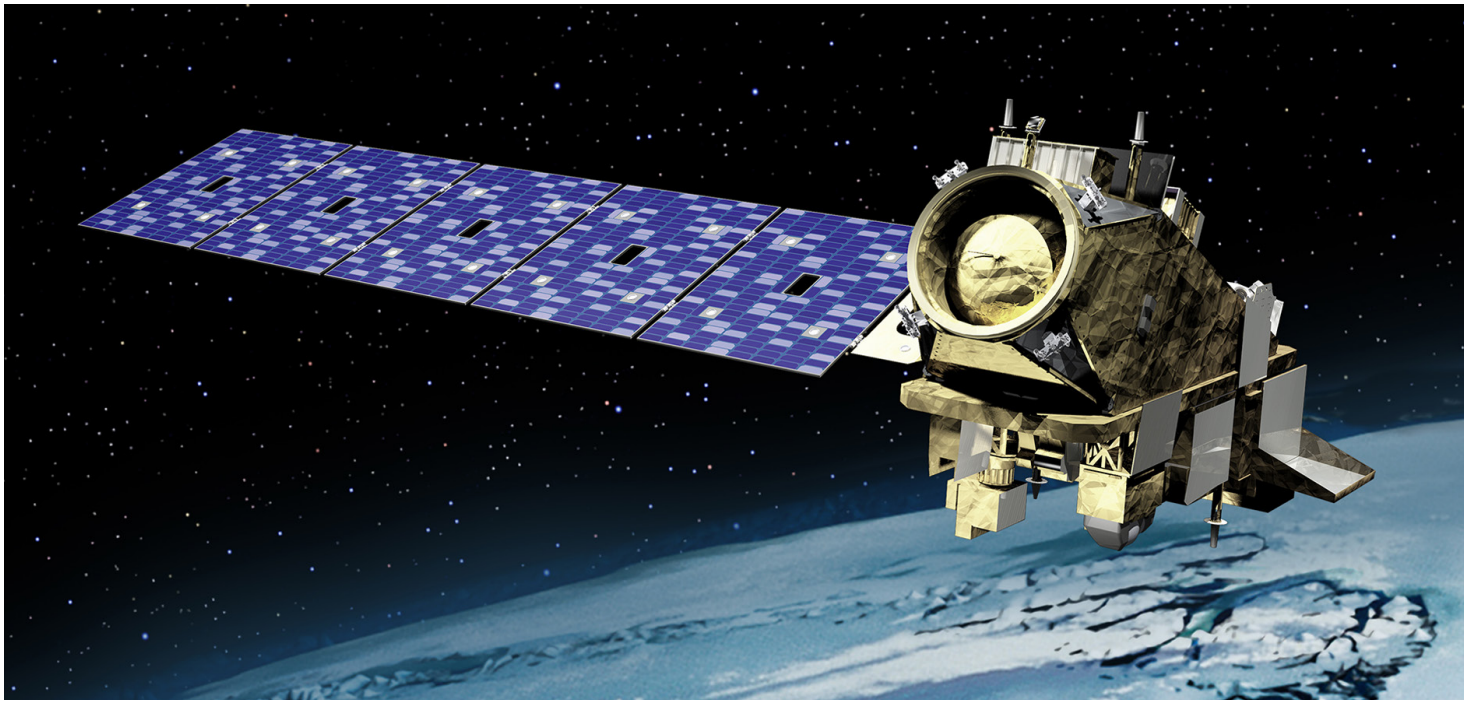
KEY STATISTICS

Revenue. Given the difficulty in determining company revenues using traditional databases, the decision was made to collect revenue information directly from the companies recognized as part of the UMS industry in Mississippi. Companies listed in the GOTF report were used, with two additional companies identified since that report, for a total of 38 companies. Two were pre-revenue in 2017 and were removed from the list of companies surveyed, reducing the number to 36.

Fourteen companies responded to the survey and provided enough data to be used for this report. This represents a nearly 40% response rate. Of the responses, three were from large companies and eleven from small companies. For the purposes of this report, it is assumed that those reporting are a representation of all companies, and numbers were extrapolated from their responses.

The 14 companies who responded reported revenues in 2017 at $85.1M. If extrapolated, the 36 companies would have revenues of $219M (direct dollars). To reach an economic impact from these revenues, a multiplier is applied to account for the indirect and ancillary jobs associated with the sector. In technology sectors, this can range from 5x to 8x.[2] Using these two multipliers, the economic impact of the UMS sector is estimated between $1B and $1.7B.

Annual Growth. Of the companies responding to the survey, nine (64%) indicated they expected to grow in 2018 and beyond. Four of the responders that indicated they would not grow have revenues that are solely based on federal contracts that provide specific services and are fixed over the contract's duration.



NOAA Joint Polar Satellite System

[2] Mississippi's Blue Economy, USM Capstone project; A. Edwards, S. Veglia, and K. Buckley; 2014

UMS BUSINESSES

There are 38 companies in Mississippi that currently support some aspect of the UMS industry. The list, along with their primary NAICS code and the other NAICS codes under which they work, are provided in the following table.

COMPANY	PRIMARY NAICS	ADDITIONAL NAICS
A2Research	541715	561210
AeroTec LLC	N/A	
Aurora Flight Sciences	541330	
Chevron	424720	211120, 211130
Datastar	518210	541910
Debris Tech	N/A	
Drone Assist, Inc.	N/A	
Dungan Engineering	541330	
Eaton Aerospace	333914	332912, 336411, 336412, 336413, 336992, 811310
EMC, Inc.	N/A	
Entergy	221122	221112, 221113
Environmental Management Services	541620	541330, 541360, 541370, 541690, 562211, 562910, 562998
Fugro Marine Geoservices	541370	
General Atomics	N/A	
Geocent	541330	332312, 336415, 511210, 518210, 519130, 541430, 541511, 541512, 541513, 541519, 541611, 541612, 541614, 541715, 541720, 561110, 561210, 561311, 561320, 561330, 561621, 611420, 611430, 811212, 927110
General Dynamics Information Technology	541330	

COMPANY	PRIMARY NAICS	ADDITIONAL NAICS
Information Management Resources Inc.	541512	517410, 517911, 517919, 541330, 541511, 541513, 541519, 541611, 541618, 541690, 541990, 561110, 561210, 611420
Innovative Imaging & Research	541330	541370, 541380, 541511, 541690, 541990
Insitu (Boeing subsidiary)	541330	
Kopis Mobile	334519	335210, 335999, 339999, 511210, 541330, 541511, 541714, 541715
Leidos	541712	334511, 334516, 517110, 541330, 541370, 541380, 541511, 541512, 541519, 541611, 541690, 611519
Lockheed Martin Space Systems	334511	336413, 336414, 336415
Mississippi Enterprise for Technology (MSET)	813910	541330, 541360, 541380, 541430, 541513, 541519, 541611, 541618, 541620, 541690, 561210, 611430
Necessity Systems LLC	N/A	
Northrop Grumman	N/A	
NVision Solutions	541370	325211, 332710, 334111, 334220, 334418, 334419, 334511, 334519, 335911, 511210, 517919, 518210, 519130, 541330, 541360, 541380, 541511, 541512, 541513, 541519, 541611, 541690, 541720, 541990, 561110, 561210, 562991, 624230, 811212, 927110, 928110
Orion Engineering	541330	
PAE (Pacific Architects & Engineers)	541611	236220, 238220, 336411, 336611, 423490, 488119, 488190, 493110, 511199, 541330, 541380, 541614, 541618, 541620, 541690, 541715, 541930, 541990, 561210, 561499, 561612, 561730, 561990, 562112, 562920, 611519, 811111, 811310, 922190
Pelagic Research Services	N/A	
Power Dynamic	333120	237110, 237120, 237310, 331210, 332710, 333131, 333132, 333249, 333318, 333923, 333995, 333999, 336112, 336992, 336999, 811310
Qrisq Analytics	N/A	
Radiance Technologies	541715	332439, 332618, 332999, 333314, 333318, 334111, 334220, 334290, 334419, 334419, 334511, 335311, 335921, 335931, 336411, 336413, 336419, 541330, 541370, 541511, 541512, 541519, 541690, 541990, 611699, 811219

COMPANY	PRIMARY NAICS	ADDITIONAL NAICS
Riverside Technology	541715	541330, 541360, 541370, 541511, 541512, 541513, 541519, 541611, 541620, 541690
SaiTech	541512	512110, 517110, 518210, 519120, 541330, 541511, 541511, 541513, 541519, 541611, 541612, 541712, 561110, 561210
Stark Aerospace	339999	333316, 334310, 334510, 334511, 334515, 335999, 336411, 336412, 336413, 336992, 337215, 339113, 423410, 423860, 488190, 541330, 541370, 541380, 541511, 541690, 541990, 611512, 811219
Vencore Services & Solutions	541330	236220, 333314, 333318, 334419, 334511, 334513, 423430, 488310, 488330, 511210, 517311, 517410, 517911, 517919, 518210, 519190, 541370, 541380, 541511, 541512, 541519, 541611, 541613, 541614, 541618, 541620, 541690, 541715, 541720, 541910, 541990, 561210, 561612, 611430, 611512, 81121, 811213, 922190, 928110
VT Halter Marine	336611	213112, 237990, 332312, 336612, 483111, 483211, 541330

However, using just the companies listed in the table above to define the UMS industry in Mississippi omits a large part of the direct and support activities from local, state, and federal programs and projects. Below is a list of state and federal agencies currently supporting UMS.

State Agencies currently supporting UMS:

- Hancock County Port & Harbor Commission
- Harrison County Development Commission
- Jackson County Economic Development Foundation
- Mississippi State University
- National Oceans & Applications Research Center
- Pearl River Community College
- University of Mississippi
- University of Southern Mississippi

Federal Agencies currently supporting UMS:

- Camp Shelby Joint Forces Training Center
- Naval Meteorology and Oceanography Command
- Naval Oceanographic Office
- Naval Oceanography Operations Command
- Navy Special Operations Command
- Keesler Air Force Base
- National Aeronautics and Space Administration
- NOAA's National Data Buoy Center
- NOAA's National Center for Environmental Information
- NOAA's Navigation Response Team-1
- NOAA National Marine Fisheries Service
- Naval Research Lab - Stennis

While it may be difficult to assess the overall economic impact of the UMS industry in the State, it is slightly easier to obtain information on the federal agencies in the Stennis area, which can then be considered an indicator for the total industry. As mentioned, the Navy is a significant user of UMS, with a large and expanding fleet of underwater gliders and surface vessels. Additionally, NOAA has several offices at Stennis, all dedicated in some way to supporting unmanned systems. Over the past several years, the economic impact of the Navy and NOAA at Stennis is shown in the following table.

YEAR	NAVY IMPACT (DIRECT DOLLARS)	NOAA IMPACT (DIRECT DOLLARS)	TOTAL
2014	$359M	$42M	$401M
2015	$233M	$42M	$275M
2016	$246M	$37M	$283M

Note these values do not include any adjustment for indirect or ancillary jobs as a result of these direct jobs. Verbal indications from the Navy and NOAA for 2017 also reflect a modest increase. Navy plans for new survey ships and additional gliders, if approved, will facilitate even more growth. NOAA has also recently relocated the Navigation Response Team-1 to Stennis and will increase operations over the next few years. This organization uses manned and unmanned systems to survey navigable waters following severe storms.

INDUSTRY STRUCTURE

Life Cycle State: **Growing**	High demand and high technology change.
Revenue Volatility: **Varied**	Historical heavy dependence on federal defense spending created unpredictability; new non-military uses proving more consistent environment.
Capital Intensity: **Medium**	Requires a fair amount of infrastructure and capacity investment.
Industry Assistance: **Medium**	The industry receives moderate assistance from federal R&D efforts.
Concentration Level: **Growing**	National and State efforts are working toward a higher concentration in the State.
Regulation Level: **Varied**	Regulations vary by type of system. Airborne systems are currently heavily regulated, while satellite and water systems are less regulated.
Technology Change: **High**	Systems are continually becoming more advanced, agile, and accessible.
Barriers to Entry: **Medium**	As costs decrease, barriers to entry decrease.
Industry Globalization: **Growing**	UMS are being used for military and non-military purposes globally.
Competition Level: **Growing**	As demand increases, more companies are entering the market.

INDUSTRY PERFORMANCE

SUMMARY

Currently, UMS are most heavily used in the Department of the Navy, the Oil & Gas industry, and for ocean research/exploration. For the Navy, water-based systems are deployed from survey ships and collect data in areas that have either not been surveyed previously or to re-survey an area following significant changes due to natural causes, disasters, or antiquated available information. The Navy survey fleet of water-based systems currently numbers 150, with expectations of additional systems as new survey ships are brought online and as UMS are more directly integrated into Navy missions.

Supporting the Oil & Gas industry, UMS are more commonly used for inspection services. Underwater, UMS equipped with cameras and other optical systems are used to identify weaknesses, breaks, and imperfections in pipelines and infrastructure. Use within this industry is growing as more operators become trained and as systems become more cost-effective. In applications developed more recently for the Oil & Gas industry, UMS are being used to detect natural seeps and concentrations of hydrocarbons following leaks below the water's surface.

UMS are being used regularly for ocean research and exploration. This includes uses within the Navy (understanding the operational environment) and the Oil & Gas industry (platform site locations, seep localization). Academic and scientific research organizations are using UMS to characterize various portions of the under-seascape that involve the biology, chemistry, geology, and physical properties of the water column and bottom characteristics. As more types of sensors are configured for use on UMS, the number of applications will increase Additionally, sea surface and near-surface characterization can be accomplished through the use of airborne and satellite-based systems.

More uses for UMS are being added as these systems become more operationally streamlined and available to a more general audience. In many ports and harbors, UMS are used to inspect and clean ship and boat hulls and anchored/moored structures. Above the water, UMS for inspecting and monitoring tall structures (e.g., cranes, ship stacks and masts) are becoming more commonplace. The use of UMS to confirm navigation channels following severe storms is another expanding application. Designs for unmanned cargo ships are currently in use or under consideration in Norway, the United Kingdom, and other countries.

Given the continued integration of the technology into other industries, innovative ways of implementing UMS applications are being discovered. At the recent Underwater Intervention Conference,[3] the following diverse applications were displayed:

- Hand-deployed UMS for search and rescue
- Small UMS for fisheries assessments and retrieval of small samples
- Marine archeology/marine wreck mapping
- Hazard mitigation (mines/unexploded ordinance)
- Water clarity assessments
- 360-degree observations
- Homeland security/law enforcement
- Cinematography
- Marine mammal/noise surveys

[3] www.underwaterintervention.com

In the State of Mississippi, the following UMS activities are key:

- Manufacturing of satellite, airborne, and buoy systems and components
- Navy survey support
- Inspections (of mostly above-water assets)
- University-based research
- Data handling/data storage/map generation

KEY EXTERNAL DRIVERS[4]

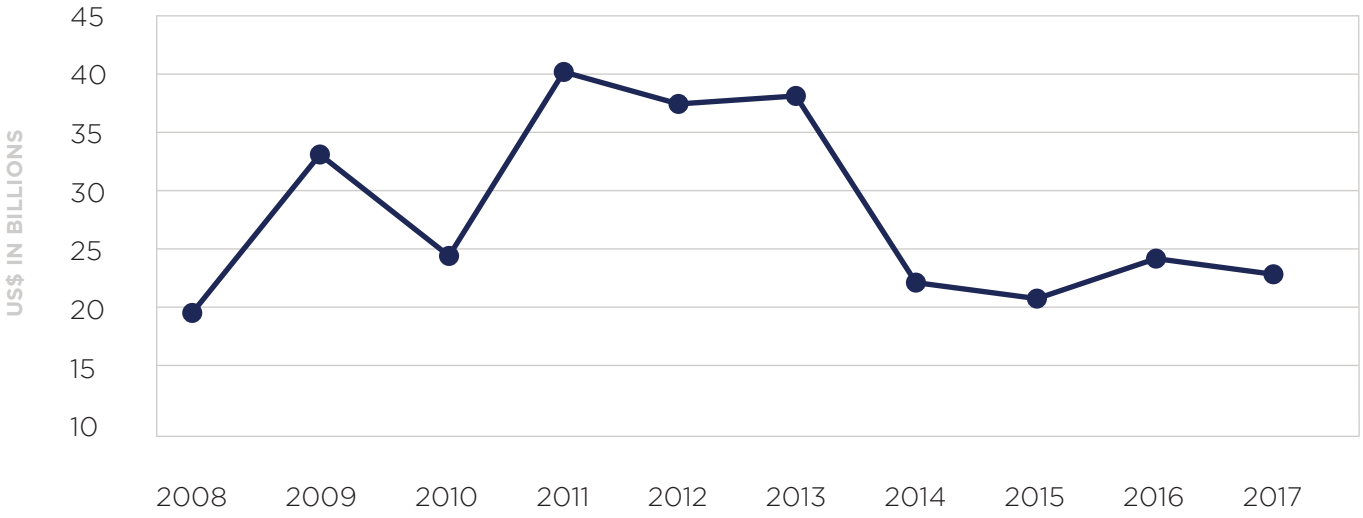
The key external drivers for this industry at the national level are:

- Federal funding for defense
- Demand from oil drilling and gas extraction
- Ports and Navigation
- Research and development expenditure
- Technology change and insertion
- Price of semiconductor and electronic components

As with the industry on a national level, the overwhelming external driver for the UMS industry in Mississippi is federal spending. Much of the funding for systems manufacturing in the State is providing by federal programs from the Department of Defense (Navy) and the Department of Commerce (NOAA). This includes the satellite component manufacturing at the Lockheed Martin Space Systems Company production center at Stennis Space Center, airborne systems manufacturing at Northrop Grumman's Aerospace Systems in Jackson County, and large contracts supporting the Navy at Stennis and NOAA's National Data Buoy Center.

The following chart shows the total federal spending in Mississippi by fiscal year over the past decade.

FEDERAL SPENDING IN MS BY FISCAL YEAR (IN BILLIONS)



[4] IBISWorld Industry Report OD4420. Autonomous Underwater Vehicle Manufacturing, 2015.

Another external driver at the national level for the UMS industry is the demand for offshore oil and gas. Increasing demand for U.S. extracted oil and gas will in turn cause a demand for the UMS supporting this industry. This is not necessarily the case in Mississippi, although Chevron uses UMS for inspection purposes.

For the portion of the UMS industry related to ports and navigation, total trade value and consumer spending are also external drivers. This driver will become more significant in Mississippi as UMS are used for port security and maritime inspections of near-water structures and in-water assets.

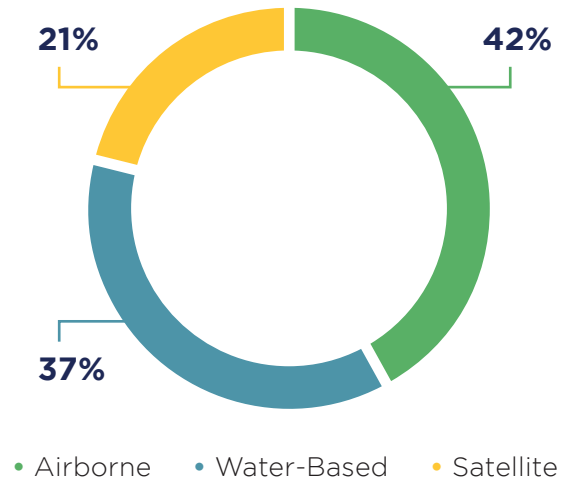
Technology change/insertion and research/development expenditures will be external drivers for the UMS industry as a whole and in Mississippi. As more applications for these systems are identified, and as more sensors are customized for use in these applications, more systems will be in demand.

CURRENT PERFORMANCE

The UMS industry is a relatively young, fast-paced industry in terms of technology development, but it has not yet realized its potential in terms of sales. This is mostly because of the prohibitive cost of the systems themselves. Prior to recent years, only federal agencies and very large industries (such as Oil & Gas) could justify the cost of acquiring and deploying the systems. NOAA has been instrumental in making the data from these systems available at no cost to the public for use in other applications. Data from airborne and satellite systems remain difficult and costly to obtain; however, as new systems become smaller and easier to deploy, costs for data from these systems will drop as well.

The breakdown of the types of UMS being supporting in Mississippi is as follows:

SUPPORT TO UMS VEHICLE TYPE IN MISSISSIPPI



Looking at needed developments to address planned future uses for UMS, the U.S. government and the Oil & Gas industry have focused on extending the time of operation and increasing the depth of operation of water-based systems. This offers technology development opportunities for existing systems. However, increasing operations was not the focus of potential commercial applications. Newer advances supporting commercial use, mostly coming from the small business community, are addressing how these systems can be affective in new applications. Advances include ease of use/automation, smaller size and less deployment infrastructure, and affordability. Of the companies that responded to our survey, nine of the 14 indicated they expected their UMS business to increase in the next year, and many are currently involved in implementing technology changes in UMS systems and data handling.

As UMS become more affordable, automated, and able to provide data that is easily understood for the application, additional uses for UMS will be adapted to support other industries. Recent new applications have been developed for ship hull inspection, fisheries assessments and triage, and search and rescue. Evolving uses for UMS include marine habitat and life assessments, homeland security, and cargo transportation.

DOWNSTREAM DEMAND (RISING)

Over the next three to five years, the Navy at Stennis is expected be a key buyer of UMS, especially water-based systems. They plan to double the survey fleet of UMS to 300 (or more) and are also looking to increase the number of survey ships. UMS will be in even greater demand if the Navy incorporates UMS into fleet operational missions (separate from Navy surveys). As many as 1000 UMS are planned.[5] Navy plans indicate these systems will be based at Stennis Space Center or another Mississippi location, with hopes for a commercially-operated warehouse to allow the systems to be used by others, and a repair/maintenance facility. With the increase of these systems, increased numbers of employees are expected, with 100 new jobs associated with each new survey ship (two new ships are currently working through Appropriations). As these systems are upgraded, services surrounding their use must be updated accordingly, and software companies will be responsible for updated data handling services, data serving, map/product generation, and now-casting/prediction/forecasting.

The demand for UMS inspection services is increasing in other relevant industries. Popularized by the Oil & Gas industry, this technology is now being used more broadly in industries such as marine construction and port security. A number of Mississippi companies provide or use inspection services for maritime projects, including Chevron, Debris Tech, Dungan Engineering, Environmental Management Services, and Orion Engineering.

As scientific exploration of more remote and more harsh parts of the Earth's oceans and coasts increases, the demand for these systems will also increase.

TECHNOLOGICAL ADVANCEMENT

Over the past few years, military uses for UMS have expanded greatly. Initially conceived for defense missions, UMS are now fully integrated into Navy ocean surveys, with plans for significant expansion.[6] Increasing military interest and expanded military uses are driving technology advances in battery power, sensing capabilities, harsh environment operations (e.g., deeper depths, under-ice), navigational accuracy, communications, and operational independence (automation/time of deployment). Rather than looking for new UMS hulls, the trend in Navy purchasing has been focused on improved components, sensors and payloads. Other potential advancements for Navy systems include more automated deployment systems and UMS coatings for less corrosion and fouling.

Many of the advances in technology listed above are also true for non-military uses; however, customized, more agile systems are increasing in demand, mainly for commercial purposes. For example, smaller systems for use in fisheries have been developed and customized with a remotely-controlled arm to collect samples. This system boasts amenities such as quick-swappable batteries; stability and optimization for the mission; operable with or without tether; pre-built sub-assemblies that are easily exchanged;

[5] Direct communications with Commander, Naval Meteorology and Oceanography Command.

[6] Gallaudet, Tim, RDML. Naval Oceanography Unmanned Systems Strategy, Naval Meteorology and Oceanography Command, July 2015, 6 pages.

and open-source software. Another example is the U.S. Coast Guard using a very small (45-inch/45 pound) towed UMS for search and rescue operations. As these systems become easier and more streamlined in their uses, more will be demanded in industries where they are currently used, and additional industries will find uses for them.

The current state of UMS technology can be viewed as a sum of its parts, whereas future applications will integrate the use of all types of systems (satellite, airborne, and water-based) in concert toward addressing the selected problem at hand. This might include the use of different types of assets (in-water and airborne, for example), or swarming of many of the same type of system. For the Navy, this may mean better understanding (mapping) of the operational theater using the best data available from all UMS assets and deployment of the most effective assets given the threat. Following a storm, various systems will come into play to support search and rescue efforts, as well as logistical efforts in getting needed supplies safely to port.

INDUSTRY LANDSCAPE/OUTLOOK

Large companies developing UMS in Mississippi include Lockheed Martin, Northrop Grumman, General Atomics, General Dynamics, Boeing, Vencore (DXC), VT Halter Marine, and Leidos. However, many advances in UMS technologies are being developed within small, innovative companies that are often acquired by larger companies seeking those advances. Most commonly, the purchased company operates as a subsidiary of the larger company. Such is the case with Insitu (a Hinds County-based company), which is a whole-owned subsidiary of The Boeing Company.

From our survey, 64% of the companies responding expect to grow in the next year. In general, responding companies that support military missions indicated their revenues to remain flat, as increases to multi-year contracts are not expected in the next couple of years. Companies working on UMS for commercial applications indicated growth. For the most part, these companies are developing and supporting new systems entering the market to address new applications. In a slightly longer time frame (three-to-five years), growth in Mississippi is expected to continue and most likely increase as contractors supporting military applications will see growth in their contracts in association with the Navy's Task Force Ocean plans.

INDUSTRY EXPANSION

The Commander, Naval Meteorology and Oceanography Command at Stennis developed the Navy's strategic plan for expanded use of UMS, calling for additional capabilities during both surveys and operational missions. This is being addressed by the Office of the Oceanographer of the Navy as part of the Navy's Task Force Ocean,[7] a collaboration created to address the status of ocean science in the Navy. The Task Force will investigate the Navy's oceanographic infrastructure, technologies, technical workforce, and how ocean science is applied to Naval operations. Supporting surveys conducted out of the Naval Oceanographic Office at Stennis, the Navy is requesting six to eight additional ships. Only recently have survey ships included design elements for the efficient deployment of unmanned systems, with the first-of-its-kind built by VT Halter Marine, which became operational in February 2018. Alternatively, existing ships (originally built for Navy, Oil & Gas, or other uses) could be modified to handle Navy surveys.

[7] https://www.defense.gov/News/Article/Article/1129450/navy-announces-launch-of-task-force-ocean/

This would create an opportunity for additional shipbuilding. Also, each survey ship must be staffed, and the Navy estimates an additional 100 jobs are needed to support each new survey ship. Requests for these billets are currently in process.

Following the public release of the Navy's strategic plan, the Governor of Mississippi initiated the Governor's Ocean Task Force, charged with identifying the ways the State could position itself to better support the strategy. The recently released report from the group lists nine main recommendations that would position the State for even more DoD opportunities. Main recommendations were:

- Brand and market a Maritime Technology Corridor
- Establish a program to foster communications among Blue Economy stakeholders
- Establish an Unmanned Maritime Systems (UMS) operational range
- Establish an UMS warehouse and depot
- Establish an Innovation and Commercialization Center for UMS
- Establish a federally-supported regional engineering and development center
- Provide high-performance cloud computing capabilities
- Enhance education and training opportunities
- Establish a new center for UMS policy and law

If actualized, these recommendations will position the State to attract additional business in the new and growing field of unmanned systems, as well as provide the infrastructure to support other expanded technology advances, such as cross-disciplinary Navy missions involving the interoperability of various assets, testing of new autonomous technologies, and the combined use of manned-unmanned systems.

Other federal agencies with offices in Mississippi use UMS as part of their overall missions as well. NOAA's National Data Buoy Center builds, maintains, and handles data from several buoy arrays within the world's oceans. Surface UMS are used to closely inspect buoy hulls. The office is also integrating submersible UMS into their repair/maintenance cycle to inspect buoy moorings. Other NOAA offices at Stennis handle the large datasets obtained from these buoys and other sources. Most recently NOAA moved their Navigation Response Team-1 to Stennis. Their UMS are used to ensure clear navigation channels following episodes of severe weather. This team is expecting to expand their work in the next few years, and will include opportunities for contractors.

UMS for marine inspection is an area where Mississippi is poised for growth. A number of companies currently provide inspection of tall marine structures during their construction. These companies could easily offer additional services to our local ports and to future ports that may be located offshore. Inspection of ship hulls and port security are other uses of UMS that have not been fully adopted in the State. Another use for UMS that could be more fully adopted in Mississippi is support for port and harbor operations, specifically hull inspection, port security, and maritime construction support.

As new UMS are designed to support new applications, additional growth can be expected. For example, a recently-released, small, affordable UMS was developed for fisheries assessments. Applications in Mississippi include all fin fisheries, shellfisheries, and aquaculture efforts. UMS would be particularly applicable to the latter, as they could also be used for fishery surveillance and environmental monitoring.

INDUSTRY LIFE CYCLE

The UMS industry in Mississippi is in the growth stage of its lifecycle. The majority of companies responding to the survey developed for this report (64%) expect to grow in the next year. This number may be on the conservative side, especially if some of the non-military uses for UMS are adopted by their targeted industries in the State.

Another indicator of growth in the industry is its high rate of technological change. Capability advancements, specifically in computing power, sensors, sonars, and cameras, have allowed UMS to become more accessible for other uses.

The leading cause of UMS industry growth has been spending from the DoD/Navy and Department of Commerce/NOAA. The Navy has the world's largest fleet of 150 UMS at Stennis Space Center in Hancock County, Mississippi, and has the goal to grow the fleet size and to expand their use during Navy missions. The NOAA offices at Stennis use surface and underwater systems to monitor ocean weather conditions worldwide. The R&D spent by the federal government has covered the non-recoverable expenses associated with such efforts, and the industry is just getting to the point where customized, more affordable systems are being conceived, designed, manufactured, and deployed.

Expansion into new commercial markets also plays a role in this industry's growth, specifically in oil and gas exploration, search and rescue operations, disaster relief, fisheries/aquaculture, and recreational use. As UMS tools become readily available and increasingly integrated into daily operations, the industry will continue to grow.

PRODUCTS AND MARKETS

SUPPLY CHAIN

Key Buying Industries

- 1125 – Aquaculture
- 1141 – Fishing
- 3366 – Ship and Boat Building
- 4831 – Deep Sea, Coastal, and Great Lakes Water Transportation
- 4832 – Inland Water Transportation
- 5241 – Insurance Carriers
- 5417 – Scientific Research and Development Services
- 5419 – Other Professional, Scientific, and Technical Services
- 9281 – National Security and International Affairs

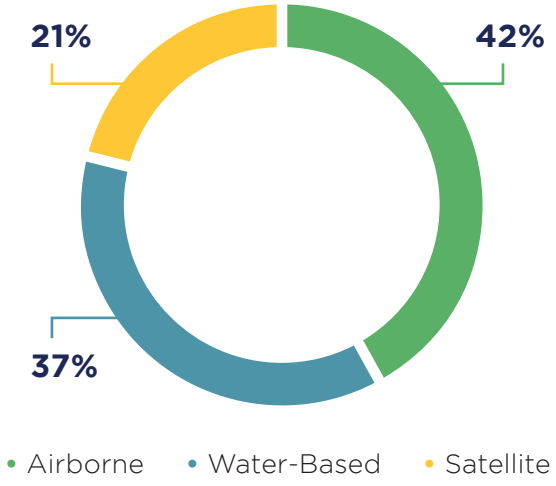
Key Selling Industries

- 3325 – Hardware Manufacturing
- 3345 – Navigational, Measuring, Electromedical, and Control Instrument Manufacturing
- 3364 – Aerospace Product and Parts Manufacturing
- 3366 – Ship and Boat Building
- 4881 – Support Activities for Air Transportation
- 4883 – Support Activities for Water Transportation
- 5171 – Wired Communications Carriers
- 5172 – Wireless Communications Carriers
- 5173 – Satellite Telecommunications
- 5182 – Data Processing, Hosting, and Related Services
- 5191 – Other Information Services
- 5414 – Specialized Design Services
- 5415 – Computer Systems Design and Related Services
- 5416 – Management, Scientific, and Technical Consulting Services
- 5417 – Scientific Research and Development Services
- 8112 – Electronic and Precision Equipment Repair and Maintenance

PRODUCTS AND SERVICES

For this report, UMS includes all systems that are used to observe and assess waterways, coastlines, oceans and other bodies of water—whether they be airborne, space-based, or water-related systems. The chart below shows the percentages of those three categories in UMS based on the companies currently supporting UMS in Mississippi.

SUPPORT TO UMS VEHICLE TYPE IN MISSISSIPPI



The products generated by the industry include the systems themselves, as well as components and sensor payloads. As airborne, space-based, and water-based systems become more affordable, more customized versions are starting to emerge. CubeSats, although not necessarily yet affordable for generalized use, are much more affordable than ever before and are in the range of $40,000–$50,000. Drone use by hobbyists is another example, and those drones can be purchased for as little as $30. Water-based systems tailored for fisheries assessments are now in the $3,000 range.

The services provided by these systems include:

- Datasets available for use in maps and with other products supporting coastal and ocean monitoring, environmental characterization, forecasting and prediction
- Digital maps with various environmental and hazard notations
- Pictures and videos for exploration and/or inspection
- Forecasts and predictions of severe coastal and ocean weather
- Samples relevant to specific use (e.g., bottom sediments, biological samples)

Increased product differentiation is currently driving the industry. The Navy is pushing for systems that can be deployed for longer time frames. This spurs on advancements in the power industry, as well as reduced size and weight in payloads and communications methodologies. This also drives advancement in materials and electronics. Additionally, the desire for underwater docking stations is another avenue for expansion.

Other users, such as the Oil & Gas industry, are pushing for better, more precise navigation as the systems are increasingly used for precise inspection. Enhanced capabilities, such as the simultaneous location and repair of a damaged pipeline, are also driving technology advances in this industry.

DEMAND DETERMINANTS

Traditionally, the major demand in the UMS industry is the U.S. military, followed by the Oil & Gas industry. This was mainly due to the high cost per system and the customized functionality. Systems were engineered for specific purposes and, in the case of military uses, were protected against general and foreign sales. In more recent years, new systems addressing new needs are being released. These are focusing on tailored applications and cost-effectiveness. As technological advancements allow for the development of more applications and the systems become more affordable, sales will increase, perhaps dramatically.

MAJOR MARKETS

The largest current markets for UMS are the DoD and the Oil & Gas industry, given the high unit cost of the systems originally designed for these industries. The cost of these systems remains elevated and other users tend to purchase only one or two systems. Given the commitment to existing designs for their purposes, DoD and Oil & Gas users will most likely continue to purchase from the vendors already in place, with the emphasis on expanding the capabilities of the systems.

In the commercial UMS market, innovations in UMS have lowered the cost of these systems, mostly as new applications have been identified and systems customized for new purposes. As costs have decreased and innovative capabilities have been added to UMS, additional markets have been created. These include hull/underwater inspections, port security, disaster response, and fisheries mapping/assessments. Unmanned cargo ships are even being designed for future use.

INTERNATIONAL TRADE

Historically, UMS were only affordable by larger users such as the DoD or the Oil & Gas industry. For the most part, UMS designed, built, and operated by these users will continue to be more controlled in their distribution and subject to trade restrictions.

Technology advancements in miniaturization and customization for other purposes are opening new market areas for UMS. As the costs for UMS drop, and the vehicles themselves become more customized for specific uses, international trade possibilities will expand.

BUSINESS LOCATIONS

There is one large company in Mississippi that manufactures ships customized for the deployment of UMS, VT Halter Marine. There are no large companies that manufacture UMS with headquarters located in Mississippi, although some have quite large satellite offices. These include Lockheed Martin, Leidos, and Northrop Grumman. Smaller offices of UMS engineering and manufacturers are owned/operated by The Boeing Company. U.S. Marine is working with Leidos to support Navy developments in UMS.

Major market share holders for manufacturers in the UMS industry are located in Texas, California, and in/around the Washington D.C. area. These include Kongsberg Marine, Teledyne Webb, General Dynamics, as well as other satellite offices of Lockheed Martin.

COMPETITIVE LANDSCAPE

MARKET SHARE CONCENTRATION

Concentration in this market is growing. Historically, the number of companies in the UMS industry has been low, with larger companies such as Kongsberg Marine, Lockheed Martin, The Boeing Company, and Northrop Grumman holding the major market share. However, over the past few years, smaller companies have emerged, developing smaller, more cost-effective systems that address new needs. The major players are keeping the majority share through the acquisition of smaller companies; however, more medium- to small-sized companies are entering the market.

It is difficult to determine the market share of the UMS industry in Mississippi, primarily due to the difficulties in using traditional databases such as EMSI and NAICS. Companies in the UMS industry work across many NAICS codes (see previous section on UMS Businesses). Large companies such as Lockheed Martin, Northrop Grumman, and Leidos have moderate-sized manufacturing facilities in the State, but their larger facilities are located elsewhere in the U.S. Rarely do these companies provide information that separates their UMS business from other types of business activities, or provide revenues separated by state. For this report, data were collected directly from companies in Mississippi recognized as supporting UMS. This data, combined with an understanding of the industry, is used in the sections that follow.

KEY SUCCESS FACTORS[8]

Access to highly skilled workforce. Highly skilled personnel are needed to design the systems themselves, as well as the systems to handle the data. Following the design/prototype stage, the skill needed from the workforce is intrinsically different, requiring more training and hands-on experience for operations and maintenance. In a recent report, an assessment of the workforce in the State indicates a workforce that has a significant number of underemployed representatives, indicating high skill level jobs would be filled without delay.

Ability to quickly adopt new technology. Across the country, companies are quickly identifying new uses for customized UMS and are working to reduce the cost of these systems. The more willingness to adopt their uses in new industries will be a driver of the UMS industry success in Mississippi.

Economies of scale. Whether satellite, airborne, or water-based, UMS are becoming more cost effective as their uses gain popularity in non-military industries. Lower prices will in turn generate higher sales.

Ability to expand and curtail operations rapidly in line with market demand. For companies supporting military uses of UMS, waxes and wanes in federal funding are always an issue. However, as the uses of UMS expand to support more non-military uses, this should not be as critical.

COST STRUCTURE BENCHMARKS

Profit. The margin of profit a company in the UMS industry has supporting military uses can be rather low. One of the companies responding to the survey indicated a profit as low as 4.2%. The upside for those working on military systems is the high cost per system. For companies supporting UMS for non-military purposes, the profit margin is significantly higher; one company responded to the survey indicated as much as a 40% profit on their sales. The downside of this is the lower cost per system, requiring a higher volume of sales.

[8] Key success factors identified in the IBISWorld report on Autonomous Underwater Vehicle Manufacturing were used.

[9] Mississippi's Blue Economy, USM Capstone project; A. Edwards, S. Veglia, and K. Buckley; 2014.

Labor. Labor costs, including wages, salaries, and benefits, are high at the beginning of the design/prototype cycle for UMS. Until recently, economies of scale could not be achieved; however, even UMS created for military uses are beginning to see costs savings on larger purchases. As these systems become more fully integrated into military missions and other industries, the need for skilled labor is reduced, with trained operators representing the biggest need.

Purchases. The cost structure for each individual company supporting UMS varies depending on the firm's involvement with the hardware aspects of UMS or not. One of the largest costs for the systems is the hardware needed for their manufacture, which primarily includes material for the hull and its machining to system specifications. Hull materials will remain the highest associated cost; however, as they are implemented repeatedly once purchased, this cost is reduced with time as purchases include volume discounts and the systems go into production phase. Costs associated with UMS hardware are expected to decline in years to come as advanced materials, polymers, and 3-D printed parts are adapted for UMS.

In addition to the hardware costs for the system itself, other initial purchases can include navigation/guidance system (cost increases with accuracy and field-of-view), propulsion system, sensor suite, power system, communications system, and data handling software. Purchases for services associated with UMS are also expected to decrease as prototype communications, data handling, and software become standardized.

Other Costs. The most significant other cost associated with UMS is the cost of R&D. Technology development and the identification of new uses for these systems will drive the market in the next few years. Once operational, another significant cost is associated with deployment.

BASIS OF COMPETITION

Competition is increasing in the UMS industry. Existing companies in related fields are adding UMS to their products and services, while new start-ups are working on technology advances. In this environment, competition for intellectual resources becomes critical. Companies are now competing for the few technical experts in UMS. Larger companies, working for mostly military clients, are focusing on production of existing UMS models, with advances focused on improvements and extensions to their models. Smaller, more agile companies are entering the market to address new needs where these traditional systems remain more costly and harder to use (more infrastructure, training, and post-deployment handling required).

The most important benefit provided to customers and providers of UMS in Mississippi is cost-effectiveness of doing business in the State.[10] This is primarily because of the cost-effectiveness of the workforce, of which approximately one third have advanced degrees. In other locations, the cost of such a workforce is significantly higher given the cost of living in areas with a strong Navy presence. Most UMS research and manufacturing in Mississippi takes place along the Gulf Coast where the cost of living and doing business is significantly lower than in competing states such as Texas, California, and the D.C. area.

[10] Hancock County Port & Harbor Commission roundtable discussion on Workforce Development, 2017.

BARRIERS TO ENTRY

As the manufacturing cost of UMS has declined, the industry has seen an increase in the number of companies entering the market. In the 2016 IBISWorld report on Autonomous Underwater Vehicle Manufacturing, only 15 companies were identified within the industry. The number of hardware manufacturers in Mississippi alone (from those listed in the GOTF report) is 11, with 27 others associated with other aspects of the UMS industry. As component parts become more affordable and easily prototyped, more companies will likely enter the market as new uses for these systems are identified.

BARRIERS TO ENTRY CHECKLIST:

Competition	**Medium/Increasing**
Concentration	**Low**
Life Cycle Stage	**Growth**
Capital Intensity	**High/Decreasing**
Technology Change	**High/Increasing**
Regulation and Policy	**Low/Will Get Heavy**
Industry Assistance	**Medium**

One of these barriers, regulation and policy, will most likely change at a rapid pace in the near future. At present, regulations for the use of airborne UMS is highly regulated by the FAA. For water-based UMS, regulations are currently being debated. As more UMS enter the market (and the environment), policies and regulations will be forthcoming. Expanded policies and regulations will become even more complicated as different types of systems are used together or multiple systems are used in swarms.

INDUSTRY GLOBALIZATION

Many foreign countries have quickly adopted the use of unmanned systems within their defense organizations, as well as in industry. Globalization continues to increase, and the industry is rapidly being adopted in many countries for a variety of purposes. As new applications are developed, international trade will increase as well.

For example, China is developing all classes of UMS (satellite, airborne, and water-based) to improve long-distance targeting, surveillance and reconnaissance, and other military purposes.[11] Other identified non-military uses include border surveillance, communications relay, humanitarian missions, and disaster relief. Multiple Chinese systems are under various stages of development, and include underwater towed systems, gliders, drones, and delivery systems. UMS are also being used to monitor industrial polluters, with studies looking into the distribution of chemicals to freeze or disperse pollutants. Drone-delivery systems are also being studied. Support for UMS development and use is heavily supported by the Chinese government, and their use is expected to expand dramatically in the next several years.

Also of note is the use of UMS by hobbyists.[12] As airborne systems became miniaturized and affordable, drones operated for pleasure became popular—it is possible that water-based systems may see a similar progression.

The UMS market is a global marketplace, with large market shares in the U.S. and other countries. There are a number of foreign companies that sell UMS products in the U.S, as well as a growing number of U.S. companies selling to foreign markets. Industry in both the U.S. and foreign markets will increase as UMS are expanded for use in other industries.

[11] https://www.rand.org/content/dam/rand/pubs/research_reports/RR900/RR990/RAND_RR990.pdf
[12] https://www.ijser.org/researchpaper/A-Review-Paper-on-Autonomous-Underwater-Vehicle.pdf

MAJOR COMPANIES

In Mississippi, there are several satellite offices or wholly-owned subsidiaries of large companies that design and manufacture UMS, deploy and operate UMS, and/or handle the data from UMS. These include Lockheed Martin, General Atomics, General Dynamics, Leidos, VT Halter Marine, Vencore Services and Solutions (recently purchased by DXC), and The Boeing Company.

Lockheed Martin's Mississippi Space and Technology Center at Stennis Space Center manufacturers major components for nearly any type of satellite launched, including those with sensors that monitor the ocean environment.

Leidos, in partnership with U.S. Marine, is currently designing and building unmanned surface ships for the Navy. VT Halter Marine is building survey ships for the Navy, the latest of these designed specifically for the easier deployment of unmanned underwater systems.

Boeing, like many other larger companies, often relies on smaller companies for the next technology leap in UMS, then purchases the company that continues to operate as a wholly-owned subsidiary. Two of the UMS companies owned by Boeing and located in Mississippi are Aurora Flight Services and Insitu.

General Atomics is working with the University of Mississippi to begin an on-campus collaborative effort focusing on acoustic sensing and navigation technologies for water-based UMS to aid DoD operations in deep-sea areas.

General Dynamics's Information Technology division and Vencore Services and Solutions currently support the use of data from UMS within Navy environmental support tools, products, maps, and forecasts/predictions.

Several additional Mississippi-based companies are poised to support UMS, if the opportunity arose. In the recent Governor's Ocean Task Force, 29 companies were identified as ready and eager to join those companies already supporting UMS. These include large companies such as Huntington-Ingalls Shipbuilding, BAE Systems, GE Aviation, Raytheon, and Tyonek.

SUMMARY

In Mississippi, there are 38 companies currently identified as supporting the UMS industry. As it is difficult to determine whether a company supports UMS or not without directly contacting them, it is probable that more companies are supporting the industry than listed herein. A survey of the UMS companies in the State was conducted, with nearly 40% responding. Using this data, estimates of the economic impact of the industry in the State exceed $1B. However, revenues from companies only relate part of Mississippi's UMS industry story, as federal agencies in the State also work in UMS, purchasing, operating, maintaining systems and handling the data.

This extrapolation to an indicated $1B economic impact has significant implications for the larger defense-related Blue Economy and the more-encompassing Blue Economy in Mississippi. UMS, although indicated as an industry for the purposes of this report, is really a sector of the Blue Economy. To realistically capture the scope of this industry in Mississippi, significant efforts must be applied to collecting data directly from those companies, federal and state agencies, universities, and other entities working in the industry.

The UMS industry is growing in the State of Mississippi, in the U.S., and globally. Two of the 38 companies in Mississippi were pre-revenue in 2017, suggesting the industry is growing in the State. Additionally, 64% of survey responders indicated they expect to grow in 2018. Of those expecting flat revenues, the majority were federal contractors with already-negotiated revenues. This is expected to change in future years as Navy plans for increased UMS are purchased and are used in operational missions as well as surveys. NOAA also plans for more UMS in their inventory. Both at present and in the near future, federal spending (and Navy spending in particular) will drive the industry in the State.

UMS developed for commercial use is expanding in Mississippi. UMS for commercial applications are designed and engineered in smaller companies, some then bought out by larger companies and operated as wholly-owned subsidiaries. With the expense of R&D for these systems already covered by the DoD and the Oil & Gas industry, more affordable and customized systems are emerging.

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