



Commonwealth of Virginia
Unmanned Systems Commission

Final Report, September 2016

Fostering Economic and Societal Benefits

UMS Commission Final Report

Letter of Transmittal

To: Governor McAuliffe

From: Dr. John Langford Chair, Virginia Unmanned Systems Commission
Nicole Barranco Vice-Chair, Virginia Unmanned Systems Commission

Subject: 2016 Report of the Virginia Unmanned Systems Commission

The Unmanned Systems (UMS) industry offers tremendous opportunity for the New Virginia Economy in terms of economic growth, high-skill jobs, and improvements in quality of life. The industry is in its formative years with potential for impact and growth not unlike the early days of the cell phone. Commercial applications for unmanned aerial systems are expected to grow exponentially with the recent release of FAA regulations for commercial operations. Services will span agriculture, critical infrastructure inspection, lifesaving missions, and package delivery. Automated, self-driving automobiles will improve highway safety and improve mobility for entire segments of the population that may no longer be able to drive themselves. Autonomous maritime systems will improve port safety, monitor natural resources, and assist our military's maritime mission. There is no better place in the nation than Virginia to bring all these opportunities together. We are well poised to benefit with a highly educated workforce, diversity of terrain for UMS testing, an excellent policy and regulatory environment, proximity to Washington, DC, and many UMS assets in place.

In July 2015 Virginia was the site of the first FAA-approved UAS delivery of medical supplies to a patient. In the last year, Virginia has

- Hosted Cyber-Unmanned Systems Technology Showcase (Sept 30 - October 1, 2015)
- Hosted Education and Workforce Development Summit (March 2016)
- Signed HB454 Motor vehicles equipped with television and video.
- Signed HB412 Local regulation of certain aircraft – no locality may regulate the use of UAS.
- Signed Budget Bill HB30, Item 256 E.1; Out of the research allocations for Virginia Tech, \$950,000 the first year is designated for radar equipment to enhance the unmanned aircraft test range.
- Signed SB30, Item 428 #3s for the establishment of an Unmanned Aerial Systems Commercial Center of Excellence and business accelerator.
- Developed first responder UAS training and held the inaugural class at Piedmont Virginia Community College in May, 2016.
- Begun actively developing means to rapidly deploy UAS for first responders.
- Received FAA approval of 4800 square mile UAS test area for maturation of technologies for linear infrastructure inspection and beyond line of sight operations in the national airspace system. Led by Mid-Atlantic Aviation Partnership (MAAP). Currently attracting private investments made possible via Virginia investments in MAAP and the central Virginia corridor.
- Designated the Virginia Automated Corridors - More than 70 miles of urban interstates and rural arterials including northern Virginia (HOT Lanes).

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- Seen autonomous maritime vehicle testing in James River and lower Chesapeake Bay.
- Assisted in expansion of UAS operations by Textron at Blackstone, including May 9, 2016 opening of the Textron Systems Unmanned Systems Service and Support Center in preparation for future growth.

The Unmanned Systems Commission, which you created with EO-43, has worked to develop the recommendations to further advance the UMS industry in Virginia. While much has been done there is much more to be done. The recommendations provided will make Virginia the easiest and most attractive location to develop and conduct commerce with unmanned systems, and will develop the organizational constructs to sustain Virginia's UMS efforts, eliminate silos, and market its brand.

Therefore, we hereby transmit to you sixteen specific recommendations to expand Virginia's UMS leadership by improving educational opportunities and alignment to industry needs, effectively leveraging, integrating and marketing the many assets that Virginia currently offers, connecting the communities of highly innovative entrepreneurial and startup firms, capital, workforce, and customers, and maintaining a policy and regulatory environment conducive to the UMS industry.

The evolution of this industry is accelerating with the recent release of FAA regulations that enable commercial UAS operations and the introduction of the first generation of self-driving vehicles onto our roadways in progress today. Time is of the essence. Recommendations for immediate action are identified.

On behalf of all the Members of the Commission, we express our thanks for the opportunity you have given us to work with you on this important issue.

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Executive Summary

The Unmanned Systems industry offers tremendous opportunity for the New Virginia Economy in terms of economic growth, high-skill jobs, and improvements in quality of life. An economic impact report prepared by the Association for Unmanned Vehicle Systems International (AUVSI) concluded that during the 11-year period 2015-2025, the Unmanned Aerial Systems integration into the U.S. airspace is expected to contribute \$82.1 billion to the nation's economy and create 103,776 new jobs. Virginia is included in the top 10 states predicted to see the most gains in terms of job creation and additional revenue as production of UAS increases, with an estimated \$463M in economic impact, \$4.47M in tax revenue, and 2380 jobs created. This study understates the potential economic impact as it did not consider the potential for related fields such as the cyber-security of these systems, nor did it address maritime systems or automated automobiles, both of which are highly significant to the Commonwealth of Virginia. Unmanned systems will touch every aspect of life from package delivery, inspections of energy and transportation infrastructure, public safety, disaster response, communications, natural resources, and agriculture.

The Virginia Unmanned Systems Commission was established by Governor McAuliffe via Executive Order 43 to chart Virginia's path forward. The Commission found extremely high potential in Virginia with the Commonwealth's combination of assets, geography and location. The Commonwealth offers a convergence of business-friendly policies, topographic diversity, existing Unmanned Systems (UMS) infrastructure and a skilled and high-tech workforce, making the Commonwealth fertile ground for the rapidly growing UMS industry. Virginia has a demonstrated track record of fostering businesses of all types, ranging from small start-ups to Fortune 100 companies through its low taxes, financial incentives, and pro-business regulatory environment. Emerging UMS companies benefit from Virginia's strong military ties and proximity to Washington D.C., as well a robust infrastructure of UMS research and development laboratories and test facilities. In addition to many existing UMS-related companies in the cyber, aerospace, data and technology fields, Virginia is home to the nationally renowned Virginia Tech Transportation Institute, Wallops Research Park for aerial and rocket research, excellent maritime facilities in Hampton Roads, and one of six FAA UAS test sites. UMS companies in Virginia also take advantage of diverse topography conducive to testing aerial, land-based, and marine unmanned systems.

The Commission has identified barriers to realizing the Commonwealth's potential and has recommended immediate and longer-term actions to mitigate these barriers and foster the UMS industry. Key needs include the need to organize for sustained success, including a public-private consortium to maintain industry intelligence, professionally market Virginia to the UMS industry, and integrate Virginia assets and capabilities to create and capture opportunity. Stage-appropriate incentives, financial and non-financial, are needed to attract an evolving industry in large part characterized by small firms that are the innovation engine for this industry and that are not able to take full advantage of Virginia's available incentives. Also, there is a need to leverage the Commonwealth's significant leadership and investments in cyber fields as software, cyber security, and data analytics which will be major components of the unmanned systems industry across air, land, and maritime domains.

The Commission recommends specific actions to make it easier and more attractive for UMS firms to work in Virginia, to coordinate the resources and assets that Virginia possesses, to make Virginia's capabilities visible and easy to find, and to aggressively pursue and sustain the effort.

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Introduction

The Unmanned Systems (UMS) industry offers tremendous opportunity for citizens of Virginia in terms of economic growth, high skill jobs, and improvements in quality of life and mobility. An economic impact report prepared by the Association for Unmanned Vehicle Systems International (AUVSI)¹ concluded that in the aerial domain alone, during the 11-year period 2015-2025, Unmanned Aerial Systems integration into the airspace is expected to contribute \$82.1 billion to the nation's economy and create 103,776 new jobs. Virginia is included in the top 10 states predicted by AUVSI to see the most gains in terms of job creation and additional revenue as production of UAS increases, with an estimated \$463M in economic impact, \$4.47M in tax revenue, and 2380 jobs created.

Fostering this industry within Virginia is in the interest of the New Virginia Economy. Other industries that stand to benefit include energy, transportation, construction and agriculture. Virginia's citizens will benefit from quality-of-life improvements, including increased mobility, and from the creation of jobs in UMS-related industries, including cyber security, software, data analytics, business services, and education. The UMS industry can both reduce the negative effects of defense spending reductions (leveraging the defense sector's increasing reliance on UMS) and increase diversification of Virginia's economy (leveraging the civil sector's increasing use of UMS).

The Commonwealth is well suited to promote the growth of this industry. It offers a convergence of business-friendly policies, topographic diversity, existing unmanned systems infrastructure and a skilled and high-tech workforce. UMS companies can benefit from Virginia's strong military ties and proximity to Washington D.C., as well a robust infrastructure of UMS research and development facilities that include one of only six FAA UAS test sites in the country. UMS companies also can take advantage of the Commonwealth's diverse topography conducive to testing aerial, land-based, and marine unmanned systems. Very few places offer such a dynamic combination of industry-specific resources and business-friendly policies—making Virginia an ideal location for UMS businesses.

The UMS industry is rapidly evolving. This industry is enabled by recent advances in software and hardware leading to high levels of automation driving increasingly capable vehicles. Although many early advances were provided by major defense programs, UMS have opened entirely new doors in the commercial markets with rapidly maturing automotive automation (e.g., self-driving cars), aerial systems that can autonomously fly routes from takeoff to landing, and robotic maritime systems for both defense and for commercial/scientific purposes. These systems open entirely new opportunities for business models and services, create opportunity for lower cost and more effective public services, and create entirely new supply and support chains. The fact that the industry is rapidly evolving implies evolving supply chains, technical challenges, and business opportunities. Given this rapid evolution Virginia must put in place dedicated, industry-savvy expertise to aggressively and proactively engage with the industry and adapt Virginia's responses.

The Virginia Unmanned Systems Commission was established by Governor Terry McAuliffe on June 12, 2015 with Executive Order 43.² The Commission brought public and private sector experts together to make recommendations on how to make Virginia a national leader in unmanned systems. It was created as a key asset in charting the way forward to grow this industry and create jobs and economic opportunities across the Commonwealth. This report represents both the Commission's annual and final report called for in the Executive Order.

¹ The Economic Impact of Unmanned Aircraft Systems Integration in the United States, AUVSI, March 2013

² Executive Order 43 Press Release: <http://governor.virginia.gov/newsroom/newsarticle?articleId=8593>

Acronyms

Beyond Visual Line of Sight (BVLOS)

Center for Innovative Technology (CIT)

Center of Excellence (COE)

Certificate of Authorization or Waiver (COA)

Commonwealth Commercialization Research Fund (CRCF)

Education (EDU); a work group of the Unmanned Systems Commission

Federal Aviation Administration (FAA)

Federal Aviation Regulations (FAR)

Innovation and Business Environment (IBE); a work group of the Unmanned Systems Commission

Information Technology (IT)

Internet of Things (IoT)

Marketing (MA); a work group of the Unmanned Systems Commission

Mid-Atlantic Aviation Partnership (MAAP)

Policy, Regulation, and Culture (PRC); a work group of the Unmanned Systems Commission

Unmanned Aerial System (UAS)

Unmanned System (UMS)³

Virginia Department of Motor Vehicles (DMV)

Virginia Department of Transportation (VDOT)

Virginia Economic Development Partnership (VEDP)

Virginia Tech Transportation Institute (VTTI)

Current State

The Unmanned Systems industry offers tremendous opportunity for citizens of Virginia, in terms of economic growth, high skill jobs, and in improvements in quality of life and mobility. The Association for Unmanned Vehicle Systems International (AUVSI) produced an economic impact report⁴ for UAS in 2013. The AUVSI economic impact study concluded that during the 11-year period 2015-2025:

- UAS integration is expected to contribute \$82.1 billion to the nation's economy by agriculture, public safety and other activities;
- 103,776 new jobs will be created, with 844,741 job years worked over the time period;
- UAS integration is expected to contribute \$75.6 billion economic impact by agriculture, \$3.2 billion by public safety and \$3.2 billion by other activities; and
- The manufacturing jobs created will be high paying (\$40,000) and require technical baccalaureate degrees.
- Virginia is included in the top 10 states predicted to see the most gains in terms of job creation and additional revenue as production of UAS increase, with an estimated \$463M in economic impact, \$4.47M in tax revenue, and 2,380 jobs created. However, a variety of factors—state laws, tax incentives, regulations, the establishment of test sites and the adoption of UAS technology by end users—will ultimately determine where jobs flow.

³ "Unmanned Systems" refers to marine, land, and aerial vehicles that can operate absent a human operator on board. These vehicles are ultimately under human control at the mission level but may be highly automated or perform with various degrees of autonomy. Examples include robotic maritime vehicles, unmanned aerial systems, and land vehicles that are unmanned or that may carry occupants that are not required to perform primary control of the vehicle.

⁴ The Economic Impact of Unmanned Aircraft Systems Integration in the United States, March 2013, http://robohub.org/_uploads/AUVSI_New_Economic_Report_2013_Full.pdf

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This study, conducted in 2012 and reported in early 2013, did not foresee the growth of UAS for linear infrastructure (e.g., power line) inspections and geospatial imaging already being explored within Virginia. Nor did the study consider the huge potential for related needs such as the cyber-security of these systems. The study addressed only unmanned aerial systems; it did not address maritime systems and automated ground vehicle systems, both of which are highly significant to the Commonwealth of Virginia.

The UMS industry is currently in an early stage of development. The systems and the business models are undergoing rapid experimentation and evolution in all domains: air, land, and sea. The industry includes many entrepreneurs and small firms that provide the engine for innovation. UMS innovation and commercialization requires an environment of connectivity between academia, entrepreneurs, workforce, capital, large firms, and customers.

In the aerial domain, commercial applications of UAS have been extremely limited since they have required exemptions to Federal Aviation Regulations (FAR). Regulations specific to the commercial application of small UAS (gross weight less than 55 pounds) were published by the FAA on June 21, 2016 as FAR Part 107; they became effective on August 29, 2016. While this new regulation is expected to open significant commercial UAS opportunity, Part 107 does not permit many UAS operations of commercial significance including flight beyond visual range of the pilot, nighttime operations, operations over people, a single pilot operating multiple UAS simultaneously, nor fully autonomous operation.

While attention is often given to the vehicles, whether UAS, automated automobiles, or unmanned maritime vessels, the UMS industry consists of diverse networks in the supply chains and supporting industries. The supply chain includes applied research and development, test and evaluation services, hardware and software engineering, components such as sensors, batteries, actuators, and electric motors, manufacturing, and services provided by UMS. Supporting industries include fields such as cyber-security, data analytics and services, communications, modeling and simulation, education and training, maintenance, venture capital and incubator services, legal, and insurance. Many skills apply to all domains of UMS: air, land, and sea.

Virginia Capabilities and Assets

Virginia has a plethora of capabilities and assets of high value to the UMS industry.

Aerial Domain Assets

In the aerial domain, Virginia is home to the Mid-Atlantic Aviation Partnership (MAAP), one of six FAA-designated UAS test sites in the nation. The MAAP has established and operates testing locations across the Commonwealth and beyond. The MAAP has been proactive in enabling growth of firms within Virginia, in enabling the first ever FAA-approved medical package delivery by UAS, in supporting first responders in active searches, in enabling research operations for Beyond Visual Line of Sight (BVLOS) long-distance energy infrastructure flights by UAS, and training news crews in the use of UAS. The MAAP has recently established a 4,800 square mile area in central Virginia up to an altitude of 7000 feet that overlies extensive energy infrastructure, quarries, railroads and highways. The MAAP has received an FAA Certificate of Waiver or Authorization (COA) that enables UAS operations in this area. The fiscal 2017 Virginia budget provides \$950,000 for mobile equipment to support BVLOS UAS research anywhere in the Commonwealth, the next major technical and regulatory hurdle preventing widespread commerce with UAS. A consortium of energy firms has begun research within this COA. Virginia is also home to two NASA facilities, Langley Research Center and Wallops Flight Facility. These installations conduct research in the fields of autonomy and advanced UAS and are capable of hosting operations of any size UAS, including Global Hawks that have been based at

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NASA Wallops Flight Facility for Atlantic hurricane science studies. A 3000-foot runway dedicated to UAS operations is under construction at Wallops Island adjacent to the Mid-Atlantic Regional Spaceport. Virginia has maintained a regulatory environment friendly to UAS commerce. UAS businesses are not required to satisfy Virginia-specific aviation regulations; they must only comply with FAA regulations. In 2016, the Commonwealth passed legislation prohibiting localities from regulating the use of privately owned, unmanned aircraft systems. Virginia's effort to avoid a complex patchwork of regulations creates a competitive advantage over states that have passed restrictive regulations.

Ground Domain Assets

In the ground vehicle domain, the Virginia Tech Transportation Institute (VTTI) is the second-largest university-level transportation institute in the U.S. with more than 475 employees. VTTI has effected significant change in public policies for driver, passenger, and pedestrian safety and is advancing the design of vehicles and infrastructure to increase safety and reduce environmental impacts, including automated automobiles.

The Virginia Smart Road⁵, located at VTTI, is a unique, state-of-the-art, 2.2-mile closed test-bed research facility managed by VTTI and owned and maintained by the Virginia Department of Transportation (VDOT). The Smart Road includes the Smart Road Bridge (the highest state-maintained bridge in Virginia), lighting and weather system controls, roadside equipment units that facilitate connected-vehicle communications, a connected-vehicle-compatible intersection controller model, and seventy-five weather-making towers. Precipitation and fog can be produced including artificial snow production of up to four inches per hour (in suitable weather conditions) and differing intensities of rain with varying droplet sizes. Transportation scientists and product developers have spent more than 20,000 hours conducting research on this high-tech highway.

The Virginia Automated Corridor was developed in answer to Virginia Governor Terry McAuliffe's 2015 Governor's Proclamation⁶ declaring Virginia "open for business" in the realm of automated vehicles. The automated corridor allows the testing of any automated vehicle on Virginia roads, covering more than 70 miles of interstates and arterials in the Northern Virginia region, under the guidance of VTTI. The Virginia Department of Motor Vehicles (DMV) will support research efforts performed by VTTI in accordance with the proclamation. In addition to VTTI, firms such as Blacksburg-based TORC Robotics and defense installations such as Naval Surface Warfare Dahlgren are advancing the state of the art in robotic ground vehicles for industrial, road, and defense applications. As is true for unmanned aerial systems, Virginia has exercised regulatory discipline and remained a friendly environment for automated ground vehicle testing. In 2016, the Commonwealth passed legislation permitting the viewing of visual displays in motor vehicles while the vehicle is being operated autonomously.

Maritime Domain Assets

In the maritime domain, the waters of the Chesapeake Bay, Atlantic Ocean, the Hampton Roads harbor, and rivers and marshes provide a rich and diverse testing environment actively in use primarily by the defense industry and contributing academic institutions such as Penn State and Virginia Tech. Firms have traveled from New England to test autonomous underwater vehicles, and the Office of Naval Research and the Naval Surface Warfare Center Carderock have utilized these assets for autonomous surface boat development. Several firms resident in Hampton Roads are active in maritime unmanned systems development. Virginia Tech's Autonomous Systems and Controls Laboratory conducts research activities that range from fundamental issues in systems and control to the practical art of designing and deploying advanced autonomous robots for maritime applications. Unlike the aerial and ground

⁵ <http://www.vtti.vt.edu/facilities/virginia-smart-road.html>

⁶ <https://governor.virginia.gov/newsroom/newsarticle?articleId=8526>

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vehicle domains, Virginia currently has no organization or function focused on facilitating the testing and development of maritime vehicles.

Cross-Domain Assets

While significant research and development activity is taking place within each domain of UMS, these domains call upon common sets of skills and technologies. For example, a skilled software engineer will find relevance whether the subject is an automated automobile, unmanned underwater vehicle, or an aerial vehicle. Innovation in these platform agnostic areas will grow in importance as unmanned systems mature and move into increased commercial deployment. Growth opportunities will develop in areas including education, software, cyber security, data analytics, sensors, system integration, control logic, autonomous systems, communications, advanced materials and advanced manufacturing, and business services.

Barriers

Multiple barriers to the growth of UMS industry and commerce within Virginia have been identified by the Commission. The barriers fit into five categories:

1. Lack of a focal point or resources dedicated to UMS to focus and integrate our efforts
2. Barriers to development and deployment
3. Limited pull for products and services
4. Public perception and associated policy and regulatory environment
5. Availability of adequate workforce

Focal Point

Several states have a dedicated organization to foster their position in the UMS industry, with most states focusing on the aerial domain. These include:

- The Northern Plains UAS Test Site works directly with the State of North Dakota and the Grand Sky Business Park to market North Dakota to the UAS industry. The North Dakota Department of Commerce recruits businesses, the Grand Sky Business Park houses the businesses, and the Test Site provides the space for research and development.
- The Northeast UAS Airspace Integration Research (NUAIR) Alliance is a multiple state-funded not for-profit organization that manages a coalition of public and private entities and educational institutions, and operates UAS test ranges in New York, Massachusetts and Michigan. NUAIR works with three different economic development entities to promote the UAS industry within the region.
- SOAR Oregon is a statewide, state-funded not-for-profit organization focused on the economic development of the UAS industry in Oregon.
- The Nevada Institute for Autonomous Systems is a state-funded nonprofit organization that serves as a consortium for educators, businesses and government entities, for the purpose of promoting the research and development of UAS in the State of Nevada.

Virginia lacks a focal point, or a focused team or office, to understand the ever-changing dynamics of this evolving industry, integrate assets and efforts across the Commonwealth, and actively facilitate growth within Virginia. This is critical at this time due to several attributes of this industry. The UMS industry is evolving quickly. At this moment, with freshly released FAA UAS regulations and maturation of automated automobile technologies, it is poised for rapid growth. Other states are aggressively pursuing this industry. Once dominate firms are established in the supply chain and related service fields, the time for action will have passed. North Dakota has invested more than

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\$34 million to develop one of only six national UAS test sites, to develop Grand Sky business and aviation park infrastructure, and to advance UAS research and development. The Central New York Regional Economic Development Council is expecting to invest \$250M over 5 years to make the region a global center for Unmanned Systems and Cross-Connected Platforms⁷, with both UAS and ground vehicles in mind leading to economic leadership in the Internet of Things (IoT). As noted in their “CNY Rising” plan “No region has secured the level of funding, coordination and strategic partnerships required to solve this national and international challenge and unlock the large-scale economic benefits of unmanned aerial systems, until now.” During the work of the UMS Commission, a Commissioner working for a major aerospace firm in Virginia received a package from the governor’s office of another state. The package contained a small toy drone and a letter inviting that company to contact that state’s economic development office to discuss ways that they can help them take off. Such aggressive outreach is not yet taking place from Virginia. The industry also requires a focus and domain knowledge because of the rapidly evolving technology, use cases, and customer base.

There is no singular voice for the emerging and rapidly evolving UMS industry in Virginia that is (1) proficient in industry knowledge and trends across air, land, and maritime domains and is singularly focused on this industry, (2) familiar with assets and capabilities across the Commonwealth, (3) able to integrate assets and efforts across the Commonwealth, (4) able to effectively market the Commonwealth, and (5) otherwise fosters the growth of the UMS industry across the breadth of domains and assets that Virginia has to offer. Deliberations within the UMS Commission, industry, and a market survey conducted by Capital Results, have unanimously concluded that such a focal point is essential. While the term “singular voice” is used here, the recommendations below suggest a lean private-public construct to carry out the necessary functions.

Barriers to development and deployment

Several most-cited barriers to attracting new firms to Virginia or assisting firms in Virginia to prosper or remain in Virginia have been access to stage-appropriate incentives or capital for small firms, the need to break down silos and facilitate connections between various segments of the technology and capital/business communities and between education and industrial communities, and the need for easier and/or lower cost testing of UMS.

The industry is characterized at this time not only by major aerospace firms providing systems for defense, but to a much greater extent many small, entrepreneurial firms and evolving networks of research labs, venture capital, component suppliers, software houses, and business models. Many of these firms may have 5 to 25 employees and cannot expect to rapidly grow in number of employees. Yet these firms provide the innovation and anchors with which to develop economic impact and attract related services and firms. These startups provide the potential for some to become highly successful and become major players in the industry. The major incentive options that exist within the Virginia Economic Development Partnership (VEDP) are appropriate for large firms making significant capital investments and offering job growth beyond that which a small firm entering the UMS market can produce. The Commonwealth Opportunity Fund, for example, requires 50 new jobs with \$5 million capital investment or 25 new jobs with \$100 million capital investment (25 new jobs with \$2.5 million capital investment in areas with above average unemployment or poverty). The Center for Innovative Technology (CIT) provides seed stage and early stage investments in technology firms with high growth potential through the Commonwealth Commercialization Research Fund (CRCF) and the GAP Fund. There are suited for small and early stage innovative firms but are limited by the investment funds available and a \$50K cap for commercialization funds. The fiscal year 2016 selections total \$3.4M

⁷ “CNY Rising”; https://www.ny.gov/sites/ny.gov/files/atoms/files/CNYREDC_URI_FinalPlan.pdf

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across 48 awards spanning multiple technology areas⁸. Four awards were in the field of unmanned systems totaling \$215K. The CRCF awards must further the goals set forth in the Commonwealth Research and Technology Strategic Roadmap.⁹ Although unmanned vehicles and robotics are mentioned within the strategic roadmap, they are a subset of Advanced Manufacturing, one of eleven sectors identified as research and technology strengths and opportunities that represent high-priority industries, subsectors, and research disciplines with promising out-year growth. The CIT funds are also limited in their agility as opportunity arises by virtue of a single annual competition cycle. Feedback from small firms has suggested that improved access to capital, perhaps awards or loans in the range of \$50K to \$300K, could be a very substantial tool for developing the industry and are more available in other states.

Since incentives can take both financial and non-financial forms, the availability of rapid, fast-turn, inexpensive testing of UMS is also a factor in the attractiveness of Virginia for UMS firms. The maritime community in Hampton Roads has articulated the incredible diversity of maritime environments, the attractiveness of the location as a place to live, and the large number of maritime related defense and federal installations as system users, and numerous companies in the region developing maritime systems including autonomous systems. This community has suggested the value of a service to assist smaller firms in navigating the labyrinth of permissions, permits, and logistics needed for autonomous maritime testing and the value of low-cost and low-bureaucracy testing with close proximity to customers. In the UAS domain, the MAAP services can be limited by the bandwidth of a small organization.

What is missing from these incentives are those that can support small firms experimenting in this evolving sector, and that can attract or retain promising firms that currently have and may well have a small workforce (5 to 25 for example) for several years or which might be the anchor to attract a community of additional researchers, suppliers, and users. Availability of incentives is applied only on a case-by-case basis to individual entities seeking aid, as opposed to a system approach of attracting a symbiotic community of which individual firms may succeed or fail. Virginia has required the MAAP to become self-sustaining. This is in contrast to, and in competition with, states that are investing significantly in research and business parks adjacent to test facilities, and in some cases using state funds to assist enabling technology R&D and testing, to attract the necessary communities of academia, technology and system developers, and suppliers.

Limited pull for products and services

Prior to June 2015, FAA regulations did not provide a general basis for authorizing commercial services using UAS. Commercial services that were allowed were approved by the FAA on a case-by-case basis under exemptions to or waivers of existing regulations. This situation has limited the market for commercial UAS services and the associated supply chain. Even in this challenging environment, approximately 70 firms in Virginia have been provided the needed FAA regulatory exemptions. The majority of these commercial UAS services are aerial photography for real estate, advertising, mapping, or infrastructure inspection. As in the case of the evolution of the internet, new and innovative uses of UAS are just beginning to evolve. For example, recent news has disclosed an interest by the energy sector to use UAS for inspection in confined spaces, a very hazardous duty for humans to provide. Until the pull for services increases, the growth of service providers and the supply chain will not take off. As one Commissioner observed, an incentive for firms to locate in Virginia is to provide commerce. An element of the Commission recommendations therefore proposes means of encouraging (not mandating) the use of UAS services by Commonwealth agencies where a business case exists. Commonwealth utilization of UAS for functions such as

⁸ Fiscal Year 2016 CRCF awards; <https://governor.virginia.gov/newsroom/newsarticle?articleId=15591>

⁹ <http://www.cit.org/initiatives/research-and-technology-strategic-roadmap/>

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bridge and other infrastructure inspection, natural resources monitoring, mapping surveys, search and rescue, and others offers a win-win potential for improved services at lower cost and potentially reduced risk and in providing the environment of commerce to attract service providers, data analytics, maintenance facilities, training programs, and other aspects of the UMS industry.

Public perception, policy, and regulatory environment

Realization of the tremendous promise of positive benefit from unmanned systems is challenged by negative public perceptions, primarily in privacy and safety. Multiple news stories indicate that the mere presence of a small UAS is often interpreted as an invasion of privacy, even when a person in the same location with a hand-held camera or aerial photography from a crewed aircraft would not generate such concern. Small UAS used by commercial roof inspection services have been shot out of the air by neighbors.

In the 2016 Virginia legislative session, eight bills were introduced in an attempt to define trespassing by a UAS, prohibit photography over private property, or to define ownership of airspace above private property. All eight bills were tabled for future study after numerous technical issues were identified and numerous organizations testified that the bills would interfere with their legitimate business cases. Unintended negative consequences were probable, including the prohibition of existing and required aerial photography from manned aircraft as is performed for updating geographic information system data bases, defining private property as extending into the airspace 500 feet above ground and hence setting up a preemption issue with Federal Aviation Administration regulation of airspace operations and flight patterns¹⁰, and providing landowners with the ability to prohibit UAS operations over their land without having a means for UAS operators to be informed about those prohibitions. More significant than the technical issues is the potential for an evolving patchwork of regulations which could have a seriously detrimental effect on commerce. For example, if individual landowners can prohibit UAS flight over their land the potential exists for a patchwork of no-fly zones inhibiting proposed package delivery services.

In the ground vehicle domain, other states have passed regulations in an attempt to ensure safety but which require specific technical solutions or require extensive data gathering and reporting that has stymied firms wishing to conduct automated automobile development in those states. Many people who work in the field believe that regulating prematurely – before a technology is sufficiently mature – discourages innovation and development. Likewise, laws that require a specific technical solution to an issue, for example geofencing, risk significant damage to innovation.

Availability of adequate workforce

There is robust need for a skilled workforce in the UMS arena. The needs span engineering, software, data analytics, cyber security, logistics, operators, maintenance, and more. While Virginia has an excellent education system and a highly skilled workforce, the lack of suitable quantities of the right skills in the right place has been a barrier to growth. Multiple firms and a defense research installation have suggested that further growth or gaining additional projects are limited by the number of qualified employees that they can recruit. An education forum held by the UMS Commission in March 2016¹¹ brought together a dozen university and community colleges as well as industry representatives to share their experiences and programs related to UMS. Gaps were found in a lack of collaboration

¹⁰ FAA Fact Sheet for State and Local Regulation of Unmanned Aircraft Systems;
http://www.faa.gov/uas/resources/uas_regulations_policy/media/UAS_Fact_Sheet_Final.pdf

¹¹ <http://vus.virginia.gov/ums-commission/ums-education-summit/>

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and standardization of training standards across the Commonwealth (with respect to UMS) and in the collaboration between industry and academia to match programs and students with jobs. These gaps may be partially closed by the recent FAA release of remote pilot certificate standards¹² and the Virginia “Open Data, Open Jobs” challenge to identify new ways to connect Virginians to jobs by creatively using workforce data.¹³

Multiple institutions are developing curricula for training UAS operators, including mission specific skills such as emergency services. The curricula are currently being developed independently by various institutions (although with the aid of excellent subject matter experts). Prior to July 2016, there were no FAA standards for certification of UAS operators and there still are no standards for airframe and powerplant mechanic certification. Currently there are too few examples of close connection between academia and industry, although there are notable exceptions of excellent and productive partnerships. Overall there is room for improvement.

Recommendations

The Unmanned Systems Commission developed recommendation in response to these barriers. The high-level vision behind these recommendations is: ***Make Virginia the easiest and most attractive location to develop and conduct commerce with unmanned systems, and to develop the organizational constructs to sustain Virginia’s UMS efforts, eliminate silos, and market its brand.***

Recommendations were developed by the four work groups formed within the Commission. These work groups were: 1) Innovation and Business Environment (IBE), 2) Marketing (MA), 3) Education (EDU), and 4) Policy, Regulation, and Culture (PRC). The recommendations are numbered by these abbreviated work group names, but frequently address more than one barrier. Two categories of recommendations were developed: one that proposes an organizational construct, and one that proposes specific actions. The mapping of organizational and action recommendations to barriers is presented in table 1, below. As an example of the mapping, the first table row indicates that recommendations MA-2, PRC-3, and PRC-4 may be considered subsets of recommendation MA-1. In turn the action specified by MA-1 would be executed by the consortium defined by recommendation IBE-1. This partnership addresses the barriers of a lack of a focal point for UMS and the public perception of UMS.

The full text of the Commission’s recommendations is contained in Appendix A. This section provides a summary of the recommendations that address each barrier.

¹² FAA Remote Pilot – Small Unmanned Aircraft Systems Airman Certification Standards, July 2016: https://www.faa.gov/training_testing/testing/acs/media/uas_acs.pdf

¹³ Open Data, Open Jobs: <https://governor.virginia.gov/newsroom/newsarticle?articleId=15819>

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Organizational	Specific Actions	Barrier
(IBE-1) A Private-Public Partnership for UMS consisting of: <ul style="list-style-type: none"> • UMS Advocate • UMS Marketing Office • Trade Association • Incentives 	(MA-1) develop a comprehensive marketing strategy (MA-1) <ul style="list-style-type: none"> • Marketing Materials (MA-2) • Educate Legislators and Public (PRC-3) • Promote positive image (PRC-4) 	1 – Lack of Focal Point 2 – Barrier to development & deployment 4 – Public perception 5 – Workforce
Automated Automobile Work Group (IBE-2)		2 – Barrier to development & deployment 3 – Pull for services
	Accelerate Commercial Pull (IBE-5)	3 – Pull for services 4 – Public perception
University Robotics COE (IBE-3)		2 – Barrier to development & deployment
PPA Center for Certification (IBE-6)		2 – Barrier to development & deployment
A convened body of education institutions for collaborative programs in UMS (EDU-1)	<ul style="list-style-type: none"> • Virginia-wide UAS training standards (EDU-2) • Integrated Messages (EDU-3) • Strengthen elementary and high school programs (EDU-4) 	5 – Workforce
	IT environment for UMS (IBE-4)	2 – Barrier to development & deployment
	Avoid premature regulation (PRC-1)	2 – Barrier to development & deployment
	VA/FAA work group for proactive look at jurisdictional issues (PRC-2)	2 – Barrier to development & deployment 4 – Public perception

Table 1 – Mapping of Recommendations to Barriers

Recommendations for the focal point

Recommendation IBE-1 defines a public-private organizational construct to address the need for a focal point and sustainable focus for the UMS industry in Virginia.

A Commonwealth position to integrate and influence efforts to stay the economic development course is recommended in the UMS Advocate, synonymous with the singular voice or focal point. This position is an integrator of the various UMS initiatives and should be singularly focused on this industry and proficient in industry knowledge and trends. The advocate must be familiar with assets and capabilities across the Commonwealth, able to integrate assets and efforts across the Commonwealth, facilitate partnerships and collaboration, and effectively speak for Virginia.

No single entity has the full picture and all the tools to identify and execute on Virginia’s opportunities. It is absolutely essential to develop closer linkages between Virginia’s marketing and economic development engine, the incentive structures, incubators, capital, academia, industry, and our existing UMS test sites (the MAAP and the

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VTTI). Each of these organizations possesses deep knowledge and unique tools but in different aspects of the total picture. A primary duty of the UMS Advocate is to facilitate the trust and connectivity between these organizations to develop integrated Commonwealth approaches to opportunity identification and capture.

A focus must be brought to the use of professional marketing research and outreach tools and methods by staff that understand and are focused on this unique and ever-changing industry, and are highly innovative and proactive in tracking developments across the nation and in attracting industry. Hence an element of the construct is a recommendation that the Commonwealth establish a small but highly-proactive marketing office dedicated solely to the UMS industry.

An industry led and funded trade association is recommended and can best advocate for the industry and best understands the barriers, opportunities, and the needs of industry at any given time. It will also bring private resources to bear in the efforts to advance UMS in Virginia. However, dependency on the trade association alone to foster this industry is not suggested. A trade association carries a risk of becoming inwardly focused, as opposed to economic development that will bring in additional firms, and gradually losing its economic development focus.

These organizations within the private-public construct must cooperate to fulfil the recommendations to develop and execute a comprehensive marketing strategy (MA-1), specific marketing materials (MA-2), provide stage appropriate incentives (IBE-1), educate legislators and the public (PRC-3), and promote a positive image (PRC-4). Elements of these recommendations are already in execution with a baseline marketing strategy having been developed, marketing materials in hand, and legislator outreach begun in the 2016 session.

Recommendations for barriers to development and deployment

Several recommendations from the Commission address current barriers or gaps that affect the development or deployment of UMS. These are the lack of appropriate financial incentives for the small and startup firms critical to innovation in the UMS space (IBE-1), Automated Automobile Work Group (IBE-2), a University Robotics COE (IBE-3), a Public-Private-Academic Center for Certification (IBE-6), an IT environment for UMS (IBE-4), avoid premature regulation (PRC-1), and a Virginia/FAA work group for proactive look at jurisdictional issues (PRC-2).

Stage-appropriate incentives are critical for attracting the innovators in this field. A thriving community of innovators in technology, systems, and business models would be a magnet for developing the industry in Virginia. Financial incentives to assist startup firms must be established with alignment of award metrics to this sector. Feedback from small firms has suggested that improved access to capital, perhaps awards or loans in the range of \$50K to \$300K, could be a very substantial tool for developing the industry and are more available in other states. This incentive tool set could take the form of reprioritized or a UMS set aside of existing fund programs, loans, or other seed funding options. This element should leverage the UAS commercialization center of excellence and accelerator funded in the Virginia fiscal 2017-2018 budget.

The Automated Auto Work Group should guide efforts in a portfolio that potentially spans improved testing and collaboration facilities (e.g., the VTTI Smart Village Concept and Virginia Automation Park), improved outreach to the industry, incubating startups, and pilot projects. This work group can be stood up quickly by convening the appropriate organizational representatives.

The recommendations for University Center/s of Excellence in Robotics and Public/Private Center Dedicated to Certification are put forth as means of attracting a critical mass of intellectual capital for innovation, capital, and

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company formation and acquisition, and to address the principle barrier to widespread commercial introduction of unmanned and autonomous systems. Additional study is required to determine the value proposition, feasibility, and resources needed for one or more robotics COE. The Commission recommends that Virginia examine the initiatives to establish the Humans and Autonomy Laboratory (HAL) at Duke University and the NREC in Pittsburg, and consider an initiative to establish a Virginia center. A question in this assessment is whether to establish a single cross-domain COE or specific COEs for air, ground, and maritime robotics. The assessment must also consider the relative value in promoting robotics itself and the value of the enabled industries in the cyber, application/mission software, data analytics, and related fields.

The heart of robust commercial UMS systems demands a robust capability for cyber security, data services, and trustworthy autonomy. An Information Technology (IT) environment that facilitates experimentation, commerce, and addresses the cyber challenges of autonomous systems will contribute to the list of attributes making Virginia the state of choice for this industry.

Significant concerns have been raised by manufacturers and research institutions about the strong possibility for premature regulation to stifle innovation, given the extremely fast pace of technology development. The Commission has concluded that it is premature for the Commonwealth to establish laws or regulations specific to unmanned systems development, testing, or use. Likewise, a significant issue affecting UAS regulation nationwide is the relative role and authority of states and the federal government in regulating aircraft and landowner rights. The threat of a patchwork of local regulations to limit the routes used by aerial commerce pose a potentially significant barrier. The FAA has acknowledged this issue in its State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet.¹⁴ Virginia has an opportunity to be on the forefront of the complex federal preemption issues associated with balancing federal authority with regard to air safety and the state authority with regard to privacy, property rights, land use, nuisance, and trespass; and state legislators will be better positioned to make decisions supportive of commercial UAS operations.

Recommendations for limited pull for products and services

The creation of the Automated Automobile Work Group (IBE-2), mentioned above and also the removal of barriers to deployment, and Accelerate Commercial Pull (IBE-5) both increase the pull for products and services in Virginia.

Recommendation IBE-5 directly targets commercial pull while improving services to Virginia citizens. This recommendation would bring together relevant Commonwealth agencies to identify opportunities for UAS to provide services and reduce cost. Where appropriate benefits are identified and where the agency desired to execute a pilot project with UAS, the Commonwealth would facilitate and assist in the adoption of UAS services by these agencies. Examples include lifesaving missions, highway construction and assessments, and natural resources monitoring. Use of UAS in Virginia for these services will attract UAS operators, data services, training services, and other related services. This work not only will put UAS to use in very positive and meaningful ways for the public good, it potentially will strengthen the Commonwealth's UMS product and service industries.

Recommendations for public perception, policy, and regulatory environment

Several recommendations address public perception either directly or indirectly. The most direct recommendation is contained in IBE-1 (A Private-Public Partnership for UMS) and the associated action recommendations. The

¹⁴ State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet, Federal Aviation Administration Office of the Chief Counsel, December 17, 2015, http://www.faa.gov/uas/regulations_policies/media/UAS_Fact_Sheet_Final.pdf

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beneficial use of UAS that may be enabled by Accelerate Commercial Pull (IBE-5) has significant potential to improve public perception. Indirectly, the recommended Virginia/FAA work group for jurisdictional issues (PRC-2) stands to affect public perception and has broad implications for the future governance of UAS operations. However, the impact could be beneficial or detrimental to public perception depending on whether the outcome provides for more or less perceived control by landowners, and especially in the manner that the outcome is presented along with explanation of the beneficial commerce being enabled.

Recommendations for availability of adequate workforce

A convened body of education institutions for collaborative programs in UMS (EDU-1) and the associated action recommendations Virginia-wide UAS training standards (EDU-2), integrated messages (EDU-3), and strengthen elementary and high school programs (EDU-4) all address the limitations of availability of workforce for the UMS industry. Together these recommendations strengthen the cooperation between educational institutions, strengthen the connection between academia and industry, improve the ability of highly trained vets to transition to UMS work, and increase the ability of Virginia to market our educational capabilities. The education recommendations are expected to increase awareness of Virginia's education capabilities, create additional demand for those capabilities, and increase the available workforce for the industry. Recommendation EDU-4 would also use UMS to strengthen our STEM programs, inspire youth to pursue high-tech careers in UMS, and improve the flow of high school students into UMS and cyber fields. The UMS Advocate and/or UAS center of excellence is a potential convener between industry and academia.

Areas for Further Work

Future work is defined in three categories: 1) near-term (calendar year 2016), 2) Longer-term (2017), and 3) conditional.

Near-Term (Calendar 2016)

Several recommendations are very time sensitive and action on them should occur immediately. Major drivers for the urgency are the pace of industry developments and the need to prepare for the 2017 Virginia legislative session. This preparation will require:

1. The next level of detail for the private public consortium integrating the UMS Advocate, UMS marketing, a trade association, incentives, and the UAS Commercialization Center of Excellence and Business Accelerator. Immediate identification of responsible organizations, resources required, and the interactions and collaboration mechanisms for these separate groups is required. Overall responsibility for defining this detail resides with the Office of the Secretary of Technology.
2. Immediate and continued execution of recommendations that fall in the "just do it" category. Steps are already being taken by the Secretary of Transportation with respect to automated automobiles, effectively executing on recommendation IBE-2. A private industry group is in the process of forming the trade association and the Office of the Secretary of Technology has developed a marketing strategy and initial marketing materials. A series of roundtable events were held in August 2016 to gain the regional inputs needed to define priorities for the UAS center of excellence that will be most beneficial to the Commonwealth at large. Establishment of the UAS COE should take place as soon as feasible.

Longer-Term (Calendar 2017)

The priority in 2017 is to stand up the private-public consortium described above and begin aggressive implementation of the functions contained within. Some elements can be instantiated early, such as the trade association. Other elements will require decisions to be made in the 2017 legislative session with budget available in July 2017. Overall responsibility for defining and instantiating this partnership resides with the Secretary of Technology with the specific functions to be assumed by the appropriate partnership organization.

Among the functions that are required in 2017:

1. Effective outreach to industry, system users, media, and others as described in the marketing strategy.
2. Sponsorship of appropriate forums, summits, and other industry/defense/academia networking events. Gain national visibility in collaborative projects with defense, DARPA, NASA, and others.
3. Steps to connect elements of the value chain including large to small firms, capital, jobs to job seekers, and academia to industry. These will include incubator and accelerator programs, incentives in the form of subsidies testing of systems in Virginia, and online, searchable data bases of Virginia firms and Virginia incentives tailored to the needs of the small firms that are the innovation engine for this industry.

Conditional

Several recommendations made by the Commission require further assessment. These include centers of excellence for robotics, for autonomy, and for certification. In part the vision to be refined in the near-term will prioritize the value of these recommendations. All COEs have tremendous potential to attract a community of leading researchers, small innovative firms, and larger firms that find value in that environment. However significant resources will be required to define, focus, and build a truly world-class center.

The next update of the Commonwealth Research and Technology Strategic Roadmap¹⁵, last published on November 1, 2014, should consider strengthening the emphasis on unmanned systems and robotics. This document is a comprehensive planning tool used to identify research areas worthy of economic development and institutional focus. It provides elected and other officials with priorities in key industry sectors that have commercial promise, that will drive economic growth in Virginia, and that will be eligible for Commonwealth Research Commercialization Fund (CRCF) awards. Although mentioned in the current roadmap, unmanned systems are a subcategory under the major category of Advanced Manufacturing. UMS warrants being a major category.

¹⁵ Commonwealth Research and Technology (R&T) Strategic Roadmap: <http://www.cit.org/file.aspx?DocumentId=738>

Appendix A - Executive Order 43



*Commonwealth of Virginia
Office of the Governor*

Executive Order

NUMBER FORTY THREE (2015)

ESTABLISHMENT OF THE UNMANNED SYSTEMS COMMISSION

Importance of the Issue

The Commonwealth of Virginia is home to the eighth largest concentration of unmanned system firms in the nation at a time when the use of unmanned systems is rapidly expanding. Unmanned systems could provide Virginia with numerous practical benefits: crops could be inspected and maintained using unmanned aerial technologies; traffic jams could be ameliorated by self-driving ground vehicles; and, Virginia's waterways could be protected from contamination with advanced unmanned marine systems. As these new and exciting possibilities emerge, Virginia is in a highly competitive position to take the greatest advantage of the industry's development and reap benefits from it.

Virginia has already succeeded in winning a test-site designation from the Federal Aviation Administration to develop unmanned aerial technologies through the Mid-Atlantic Aviation Partnership. In addition, a number of Virginia's higher education institutions are focused on studying and developing the industry. The sector's development will align nicely with areas in which the Commonwealth is already a leader, such as data industries, manufacturing, and military/civilian government sectors.

Virginia stands poised to leverage its unique resources to create an innovation ecosystem that will not only underpin industry development and support the advancement of beneficial applications of unmanned systems of today, but also to provide a foundation for the technologies, cyber security, big data, and manufacturing facilities necessary to create a highly reliable unmanned systems industry for the future. Virginia should be doing all it can to obtain the economic development benefits of this industry's growth, and the creation of this Commission will bring needed focus to how Virginia can strengthen its position in growing the unmanned systems industry.

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Composition of the Commission

The Commission will consist of the Secretaries of Technology, Commerce and Trade, Education, Veterans and Defense Affairs, two Representatives from the Virginia Congressional Delegation, and (11) citizen members whose background shall include relevant expertise to be appointed by the Governor and serve at his pleasure. The Governor shall designate a Chairman and Vice Chairman from among the appointed members. The Governor may appoint additional persons to the Commission at his discretion.

Establishment of the Virginia Unmanned Systems Commission

Accordingly, by virtue of the authority vested in me as Governor under Article V of the Constitution of Virginia and under the laws of the Commonwealth, including but not limited to § 2.2-J 34 and § 2.2-135 of the Code of Virginia, and subject to my continuing and ultimate authority and responsibility to act in such matters, I hereby establish the Virginia Unmanned Systems Commission.

Responsibilities of the Commission

The Commission shall:

1. Identify the state of all unmanned systems industries in Virginia. This review should look comprehensively at the industry, including the supply chain from pre-competitive research and development through production and operation.
2. Identify challenges and needs of the unmanned system industry that may be met with Virginia assets for each domain of unmanned systems (aerial, land, maritime) including but not limited to workforce, research and engineering expertise, testing facilities, manufacturing facilities, and economic development opportunities within the Commonwealth.
3. Provide recommendations that will encourage the development of the unmanned systems industry in Virginia.
4. Develop the value proposition for Virginia that will provide a basis for marketing Virginia to the current unmanned systems industry and that will position Virginia for emerging needs and applications within that industry.

The Commission shall provide an interim report to the Governor of recommendations by November 30, 2015.

The Commission shall also submit an annual report giving its findings, as well as any other reports as either the Commission or the Governor deem necessary.

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Commission Staffing and Funding

Necessary staff support for the Commission's work during its continued existence shall be furnished by the Office of the Secretary of Technology and other such agencies and offices as designated by the Governor. An estimated 300 hours of staff time will be required to support the work of the Commission.

Necessary funding to support the Commission and its staff shall be provided from federal funds, private funds, and state funds appropriated for the same purposes as the Commission, as authorized by 2.2-135 of the Code of Virginia, as well as any other private sources of funding that may be identified. Estimated direct costs for this Commission are \$5000. Commission members shall serve without compensation and shall receive reimbursement for expenses incurred in the discharge of their official duties.

The Commission shall serve in an advisory role, in accordance with 2.2-2100 of the Code of Virginia and shall meet upon the call of the chairman at least three times per year.

Effective Date of the Executive Order

This Executive Order shall be effective upon its signing and shall remain in force and effect until June 12, 2016, unless otherwise amended or rescinded by further executive order.

Given under my hand and under the Seal of the Commonwealth of Virginia, this 12th day of June, 2015.

Terence R. McAuliffe, Governor

Attest:

Levar M. Stoney, Secretary of the Commonwealth

Appendix B – Commission Meeting Dates

The Virginia Unmanned Systems Commission met at the following dates and locations:

Inaugural meeting: September 18, 2015
George Mason University - Arlington Campus
3351 Fairfax Drive, Founders Hall, Arlington, VA 22201

Meeting 2: November 5, 2015
George Washington University - Science & Engineering Hall
800 22nd St. NW, Washington, DC 20052

Meeting 3: February 12, 2016
Offices of McGuireWoods, Gateway Plaza
800 E Canal St, Richmond, VA 23219

Meeting 4: June 7, 2015
Virginia Tech Executive Briefing Center
900 N. Glebe Road
Arlington, VA 22203

Additionally the following work group meetings were held:

November 5, 2015: All Work Groups met following the full Commission meeting
George Washington University - Science & Engineering Hall
800 22nd St. NW, Washington, DC 20052

January 27, 2016: The Policy, Regulatory and Culture Work Group
Offices of Williams Mullen
8300 Greensboro Dr, Suite 1100, 11th Floor
Tysons Corner, VA 22102

February 12, 2016: The Innovation and Business Environment Work Group and the Marketing Work Group
Offices of McGuireWoods, Gateway Plaza
800 E Canal St, Richmond, VA 23219

March 29, 2016: The Policy, Regulatory and Culture Work Group
Offices of Veracity Engineering
425 3rd St SW, Suite 600
Washington, DC 20024

Appendix C – Full text of the Commission’s recommendations

The recommendations are listed by work group. The four work groups are 1) Innovation and Business Environment (IBE), 2) Marketing (MA), 3) Education (EDU), and 4) Policy, Regulation, and Culture (PRC). The mapping of recommendations to barriers is presented in table 1.

Innovation and Business Environment

Recommendations:

The Commission recommends initiatives to aggressively increase focus and effectiveness of the development of the UMS industry in Virginia.

IBE-1: Establish a Public/Private Partnership to aggressively increase focus and effectiveness of UMS economic development in Virginia. Establish a partnership for sustained leadership to carry the mission forward and improve alignment of other Virginia organizations. The Commission recommends that:

- (1) A senior UMS Advocate position, reporting directly to the Secretary of Technology, should be created with the express mandate of carrying this mission forward and to facilitate coordination across Virginia assets for the benefit of the New Virginia Economy¹⁶, including all organizations suggested below. The Commission also recommends that a UMS Work Group be established led by the UMS Advocate and including the UMS office (defined below), the UMS trade association (see below), Virginia Associate Director for the Mid-Atlantic Aviation Partnership (MAAP), Director of Virginia Tech Transportation Institute (VTTI), and representatives from appropriate cabinet offices. The UMS Work Group should meet regularly to develop and update the Virginia UMS growth strategy, review market developments and opportunity, identify opportunities to leverage all Virginia fund sources for opportunity capture, and prioritize marketing efforts or proposal development.
- (2) A marketing/economic development office (hereafter referred to as the UMS Office) be created focused solely on the nascent UMS industry and to create functional connections between the expertise and deep industry knowledge of our UMS test assets (VTTI and MAAP) and economic development. Economic development is an inherently government function and will conflict with internal business goals if solely held within a university or within a privately funded trade group. An office that possesses the expertise and tools for professional marketing, leveraging all Virginia assets and available economic incentives and the deep industry intelligence resident in the VTTI and MAAP, offers significant opportunity for Virginia.
- (3) The UMS Advocate and the UMS Office should collaborate with a Virginia UMS trade association that is currently emerging. The trade association is expected to bring a unified voice to advocacy efforts, Virginia representation at national and international trade shows, and conferencing or networking events with significant potential to connect entrepreneurs, venture capital, technologists, manufacturers, and end users. Collaboration between this trade association, the Virginia UMS Advocate, and the UMS office, and by extension the other parties to the UMS Work Group, will provide a powerful voice for Virginia.
- (4) The UMS Advocate and the UMS office should facilitate integration of existing incentives and additional incentives targeted at the startup firms that are crucial to this nascent industry. Both financial and non-financial incentives should include vouchers for low to no-cost UMS testing and incubator support leveraging Virginia incubators and a Virginia UAS Commercialization Center of Excellence established in the Virginia

¹⁶ New Virginia Economy, <https://commerce.virginia.gov/media/3501/new-virginia-economy-12052014.pdf>

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fiscal year 2017 budget. The new UMS incentives should be available for UMS firms in the aerial, surface, and maritime domains. Selection criteria should be developed for these incentives considering Virginia residency or relocation, matching funding by other investors, and market viability of the technology under development.

This integrated ecosystem will provide the ability to market and promote the unmanned systems industry, represent the interests of the unmanned systems industry in Virginia before federal, state and local legislators, provide financial and business support to entrepreneurial firms via Virginia's existing incubators and accelerators, and facilitate beneficial connections between the unmanned systems industry, its supply chain, product users, educational and research institutions, and investors through seminars, forums, educational publications and other means.

IBE-2: Establish an Automated Automobile Work Group to evaluate and recommend options for strengthening Virginia's posture in the automated automobile industry. This Work Group should focus on autonomous technology and leverage the work already done in the Commonwealth including the VTTI Smart Road and the Virginia Automated Corridor. Virginia is well postured to attract research and development to the Commonwealth in the absence of regulations or laws that slow the industry. This Work Group should guide efforts in a portfolio that potentially spans improved testing and collaboration facilities (e.g., the VTTI Smart Village Concept and Virginia Automation Park), improved outreach to the industry, incubating startups, and pilot projects. Members of the Work Group should include Transportation, Technology, Virginia start-up companies, Original Equipment Operators (OEMs), the UMS Advocate, and other experts in the field of automation.

IBE-3: Establish University Center/s of Excellence in Robotics. At the heart of great industrial centers of technology lies a major university: MIT in Boston, Carnegie-Mellon in Pittsburgh, Stanford in Silicon Valley, etc. These universities have been built up over decades and are the product of concerted individual, private, and public support. The impact of these centers is illustrated by recent decision of Uber to locate its development center for driverless cars in Pittsburgh. This was directly due to the talent available from the National Robotics Engineering Center (NREC), itself an affiliate of Carnegie Mellon. The State of Virginia has an outstanding university system. However, we lack a concentrated and focused center of excellence of the caliber needed to attract and anchor an ecosystem in the robotics area. The Commission recommends that Virginia examine the initiatives to establish the Humans and Autonomy Laboratory (HAL) at Duke University and the NREC in Pittsburg and consider an initiative to establish a Virginia center, or possibly three such centers: one for ground robotics, perhaps built around the current VTTI; one for marine robotics, perhaps located in the Hampton Roads area; and one for aerial robotics, perhaps located in Northern Virginia or in the Hampton Roads area. The Commission notes that Virginia possesses no maritime research and test assets equivalent to the automotive and aerial assets represented by VTTI and MAAP. A Hampton Roads based robotic center of excellence offers the opportunity to create significant growth in maritime systems development, testing, and deployment.

IBE-4: Establish an IT environment within Virginia for the UMS industry. The heart of robust commercial UMS systems demands a robust capability for cyber security, data services, and trustworthy autonomy. The Commission recommends that Virginia (1) provide low-cost data services and infrastructure to Commonwealth users of UMS and commercial activities spanning testing and commercialization of UMS services and (2) establish an Autonomy Commercialization Center of Excellence to address the related challenges of high-reliability, trusted autonomous software/hardware systems and cyber security for UMS. This COE has also been recommended in the Commonwealth of Virginia Cyber Security Commission First Report, August 2015, "Threats and Opportunities" under

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their recommendation ECON-6 which says in part “Leverage existing resources with the National Institute of Standards and Technology and NASA Wallops to develop the cyber security capabilities for unmanned systems that can help create a new industry in Virginia. Establish a university-based unmanned systems cyber security Center of Excellence to support the workforce and technology development needed for this emerging area.”

IBE-5: Accelerate commercial pull for UAS services. Provide a commercial pull for UAS services while improving services to Virginia citizens via one-year dedicated funding to accelerate the use of UAS by the Commonwealth for lifesaving missions and highway construction and assessments, and other infrastructure. The use of UAS to provide search and rescue is practical today and the use of UAS for inspecting transportation infrastructure has already begun in other states. UAS can drastically reduce the cost and time to locate persons in distress, improve the safety of first responders in emergency situations, and can dramatically lower the cost while improving frequency and effectiveness of inspections for bridges and other infrastructure. Use of UAS in Virginia for these services will attract UAS operators, data services, training services, and other related services. Specifically: fund efforts to operationalize the use of UAS by first responders. This will support and expand Virginia-wide the ongoing efforts of the Albemarle County Sheriff’s Department, Virginia Department of Emergency Management (VDEM), the Piedmont Virginia Community College, and others to enable routine uses of UAS by first responders in life-saving applications. Likewise bring VDOT and the Virginia Department of Aviation (DOAV) together to explore the benefits of the use of UAS in transportation infrastructure services. This work not only will put UAS to use in very positive and meaningful ways for the public good, it potentially will strengthen the Commonwealth’s UMS product and service industries.

IBE-6: Establish a Public/Private Center Dedicated to Certification. The largest single impediment to the growth of the unmanned systems industry today is the lack of a certification and regulatory structure that gives private businesses the incentives to invest with confidence in this area. Whereas type certification of aircraft is necessary for true integration of unmanned systems to occur and to enable efficient use of the technology for challenging applications, there is no place in the United States today where companies can go and receive competent, efficient services and support for the certification of aircraft and development of operator certification requirements. Such a center in Virginia would attract businesses from around the world. With its close proximity to the FAA headquarters in Washington, and with the technical resources of NASA Langley and other groups throughout the Commonwealth, Virginia is well positioned to meet this need. In conjunction with the MAAP, academia, industry, government labs, and in collaboration with the FAA, establish a Public/Private Center for Certification to develop these processes and provide the certification services to UMS developers and manufacturers.

Marketing

Recommendations

MA-1: Develop, implement, and update a comprehensive marketing strategy. A comprehensive marketing strategy to include use of web sites, interfaces to general and trade press, road shows, trade and “reverse-trade” missions, trade show presence, use of industry days or conferences/summits, cold calls and mailings, and other venues should be developed along with resource estimates for execution. The UMS private-public consortium recommended by IBE-1 should have responsibility for tailoring and implementing the strategy in cooperation with the Office of the Secretary of Technology and local EDA officials.

MA-2: In the near term develop and update specific marketing materials targeted toward several target audiences: air, automotive, and maritime interests. These should be professionally produced, concise, and highlight

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attractive factors such as our industry friendly policy, regulations, incentives, workforce, infrastructure, geography, proximity to customers, quality of life, and successes.

Education

Recommendations

EDU-1: In the fall 2016, all universities and community colleges (all higher education institutions) that already have existing academic programs should be convened to develop collaborative programs in unmanned systems.

This group of higher education individuals should also include industry partners who can provide guidance and streamline the curriculum from community colleges into universities into the workforce. Based on the courses that are already developed, this group should work with the respective agencies to define a clear path for students to gain credit in a degree program at a Virginia community college or university.

EDU-2: Jointly develop Virginia-wide standards and curricula. Coordinate development of training curricula for UAS operators for commercial and emergency applications and for UAS maintenance technicians. This should be done in consultation with industry subject matter experts including application mission training (emergency services, construction, etc.) and in collaboration with the MAAP, DOAV, VDEM, VDOT, consensus-based standards bodies where applicable, and the FAA. As curricula develop, the Commonwealth should reverse map to military training so veterans can come into the field and be hired based on their actual skills/expertise.

EDU-3: Develop an integrated message for our UMS related educational activities. Working with the Secretary of Education, the Secretary of Technology, and the consortium described by recommendation IBE-1, the Virginia STEM Coordinator should solicit information from higher education institutions to develop an integrated description and message concerning Virginia educational capabilities and activities. This message should be provided to marketing efforts and to the educational institution community. The message should be updated as necessary. Consider production of a periodic newsletter that will be distributed to interested parties as well as be posted on the Virginia STEM website and the Virginia Unmanned Systems website.

EDU-4: Strengthen elementary and secondary education with an eye to expanding existing co-curricular activities, such as robotics and rocketry programs. As part of the legislatively mandated high school redesign, school divisions will look for opportunities to develop a summer enrichment curriculum for high school students. Opportunities may include finding grant funding in order to expand such programs that spark interest in the STEM fields, with an emphasis on unmanned systems.

Policy, Regulation, and Culture

Recommendations

PRC-1: Take no action to establish laws or regulations about the development, testing, or use of unmanned systems. Furthermore, establish a sufficient basis of data to clearly justify action before any legislation is enacted.

The Commission has considered the types of legislation passed in various states, including their impact on achieving the intended objectives as well as their impact on encouraging or stifling innovation. Although there are good intentions motivating the legislative actions, the Commission believes there are not always sufficient supporting data available to justify them. Also, significant concerns have been raised by manufacturers and research institutions about the strong possibility for such actions to stifle innovation given the extremely fast pace of technology

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development. The Commission has concluded that it is premature for the Commonwealth to establish laws or regulations specific to unmanned systems development, testing, or use.

PRC-2: Establish a Work Group to work in conjunction with the FAA to reconcile FAA and Commonwealth jurisdictional interests in the airspace. The Commission anticipates a future when commercial UAS are ubiquitous and it may become necessary to resolve jurisdictional issues between state, local, and federal authorities. The FAA has acknowledged this need in its State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet¹⁷. The Commission sees value in the Commonwealth addressing these competing interests before disputes arise and engaging early with the FAA as it addresses these issues. With knowledgeable state representatives working closely with the FAA, Virginia will be on the forefront of the complex federal preemption issues associated with balancing federal authority with regard to air safety and the state authority with regard to privacy, property rights, land use, nuisance, and trespass; and state legislators will be better positioned to make decisions supportive of commercial UAS operations. The Work Group should include expertise from the Office of the Attorney General, state lawmakers and agencies, private industry, UAS and aviation experts, the MAAAP, and the DOAV.

PRC-3: Initiate activities to educate the public and legislators regards UMS. Prepare fact sheets to describe the uses of UMS, perception and reality in issues such as privacy and federal airspace regulations, and the economic and other benefits to Virginia citizens. Update and provide these fact sheets annually to Virginia legislators and cabinet officials prior to the legislative session and also provide to the public via the Virginia UMS web site and as input to marketing/public relations efforts.

PRC-4: Include the promotion of positive public acceptance of unmanned systems in its ongoing and future marketing efforts. Include public acceptance and perceptions in marketing efforts. Unmanned systems by their very nature can become quite controversial with respect to ethics, job security, safety, and privacy. Public opinion towards UAS is being formulated daily in the media based, in many cases, on inaccurate information. Public acceptance of automation in automobiles will be highly dependent on confidence in the safety of these systems. Media handling will again be critical in obtaining positive perceptions of these vehicles. It is important that the people of Virginia understand how unmanned systems, when used appropriately, can efficiently, effectively, and safely meet critical public needs.

¹⁷ State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet, Federal Aviation Administration Office of the Chief Counsel, December 17, 2015, http://www.faa.gov/uas/regulations_policies/media/UAS_Fact_Sheet_Final.pdf

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Appendix D - Commissioner Biographies

The Honorable Mark R. Warner, Member, United States Senate

The Honorable Scott Rigell, Member, United States House of Representatives

The Honorable Karen Jackson, Secretary of Technology

The Honorable John Harvey, Secretary of Veterans and Defense Affairs

The Honorable Anne Holton, Secretary of Education

The Honorable Maurice Jones, Secretary of Commerce and Trade

The Honorable Aubrey Layne, Secretary of Transportation

Vice Admiral David Architzel USN (Ret), President, Fairlead Boat Works, Inc. (Will serve as Special Advisor to the commission)

The Honorable Jack Kennedy, Esq., Clerk of Circuit Court, County of Wise (Will serve as Special Advisor to the commission)

John S. Langford, PhD of Fairfax, Chairman and CEO, Aurora Flight Sciences (Will serve as Chair of the commission)

Nicole Barranco, Director State Government Relations, Volkswagen Group of America (Will serve as Vice Chair of the commission)

Victoria Cox, Senior Technical Advisor, Veracity Engineering

Robert E. "Bob" Dehnert, Senior Director, Raytheon Company

Tom Dingus, Director, Virginia Tech Transportation Institute

David Hamrick, Senior Technical Advisor, The MITRE Corporation

Jim Hughes, Vice President of Submarine Programs, Newport News Shipbuilding

Young Kim, CEO, Digital Harvest

Guy Sanitate, Business and Program Manager, US Air Force Airborne Intelligence Surveillance and Reconnaissance Programs, Scitor Corporation, an SAIC Company

Scott Strimple, Captain, United Airlines

Steve Weidner, National Unmanned Aircraft Systems Representative, National Air Traffic Controllers Association