UAS WORKFORCE NEEDS SURVEY RESULTS:

VIRGINIA STATEWIDE REPORT

Richard Bland College of William & Mary

Virginia Space Grant Consortium

Virginia Tech

magnolia consulting

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ACKNOWLEDGEMENTS

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ABOUT THE UAS WORKFORCE NEEDS SURVEY

With funding support from *GO Virginia,* the Richard Bland College of William & Mary (RBC)— in partnership with the Virginia Space Grant Consortium (VSGC), Virginia Tech and the Virginia Unmanned Systems Center at the Center for Innovative Technology (CIT)— conducted the Unmanned Aircraft Systems (UAS) Workforce Needs Survey to help inform future workforce development and education programs to train the UAS workforce.

The UAS Workforce Needs Survey focused on gathering data on workforce needs from all Virginia organizations that currently have or plan to hire and train a workforce with UAS-related tasks and duties. Because this survey was distributed during COVID-19, survey respondents were asked to consider a more typical environment for their organization when completing the survey.

Magnolia Consulting, an independent research firm, administered the survey during April and May of 2020 and had a total of 131 respondents. Respondents' primary positions or titles were most often leadership positions, including chief (e.g., chief executive office, chief technology officer or chief operating officer), president or vice president, owner or founder, or executive director. Other common positions or titles included directors, instructors (e.g., faculty), managers, administrators, or coordinators.

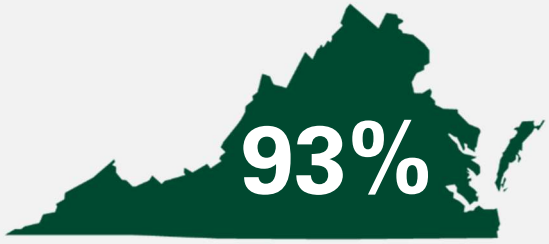
Survey respondents represented 125 unique organizations. In some instances, there were multiple respondents for the same organization. If it was deemed that these respondents represented separate departments in the same organization (i.e., they likely had different hiring and budgeting needs and would likely have different survey responses), each department was considered a unique organization. For example, different departments within a university were considered separate organizations because their workforce needs would be specific to their department. Similarly, an economic development department was considered different from a fire and safety department even though both were under the same local government. If it was deemed that these respondents were not in separate departments (i.e., they likely had similar hiring and budgeting needs and would be expected to have similar survey responses), the responses were weighted to ensure each organization was equally represented in the overall sample.

This report presents the findings for the 125 organizations represented by the survey results. It describes UAS workforce positions and vacancies, current UAS workforce training needs, duties and tasks of the UAS workforce, and the UAS workforce credentials and development for organizations. For this report, "UAS positions" is a general term that refers to any positions that include UAS tasks and duties.

ABOUT THE ORGANIZATIONS

Nearly all of the organizations were located in Virginia (93%) and were spread across 58 of the 111 localities in Virginia (Figure 2; see Appendix B). Although the remaining organizations conducted work in Virginia, they were located in seven other states: Florida, Maryland, Massachusetts, Montana, New York, Ohio and Washington, D.C.

Nearly three-quarters of the organizations were private or for profit (41%) or a municipal government (32%; Figure 1). Other types of organizations included educational institutions (11%), state governments (6%), not-for-profits (3%) or federal government agencies (2%). Six other organizations (5%) can be described as county governments, local or economic development authorities, or a higher education consultant.[1]



OF ORGANIZATIONS WERE LOCATED IN VIRGINIA ACROSS 58 LOCALITIES

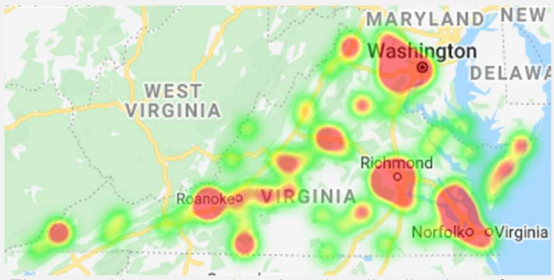


Figure 1. Heat map showing the distribution of organizations' locations (n = 125).

NEARLY THREE-QUARTERS OF ORGANIZATIONS WERE PRIVATE/FOR PROFIT OR MUNICIPAL GOVERNMENTS

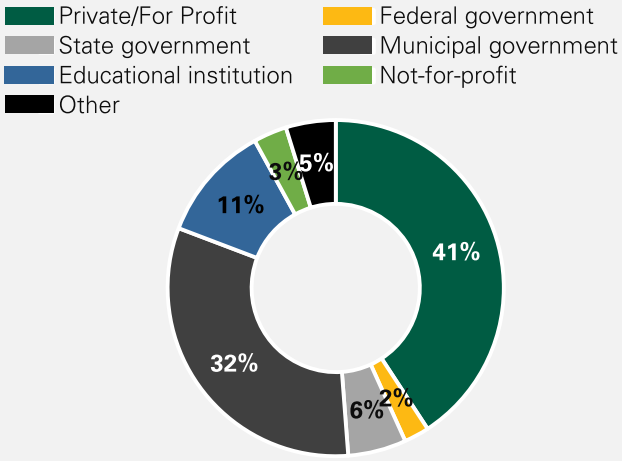


Figure 2. Types of organizations (n = 125).

The organizations and their provided services represented many different sectors or types of services, with almost half of the organizations involving UAS services (46%; Figure 3). This was followed by consulting (31%), and education (27%). Eighteen percent of respondents described their organizations as other, most often noting economic development, state level entity or government, airports, workforce development, small business development, and imagery (e.g., orthophotogrammetry or film).

[1] Given the specificity in many of the textbox responses, the qualitative findings in this report will not present exact sample sizes to protect anonymity.

OVERALL, THE ORGANIZATIONS, AND THE SERVICES THEY PROVIDE, REPRESENTED MANY DIFFERENT SECTORS WITH NEARLY HALF IN UAS

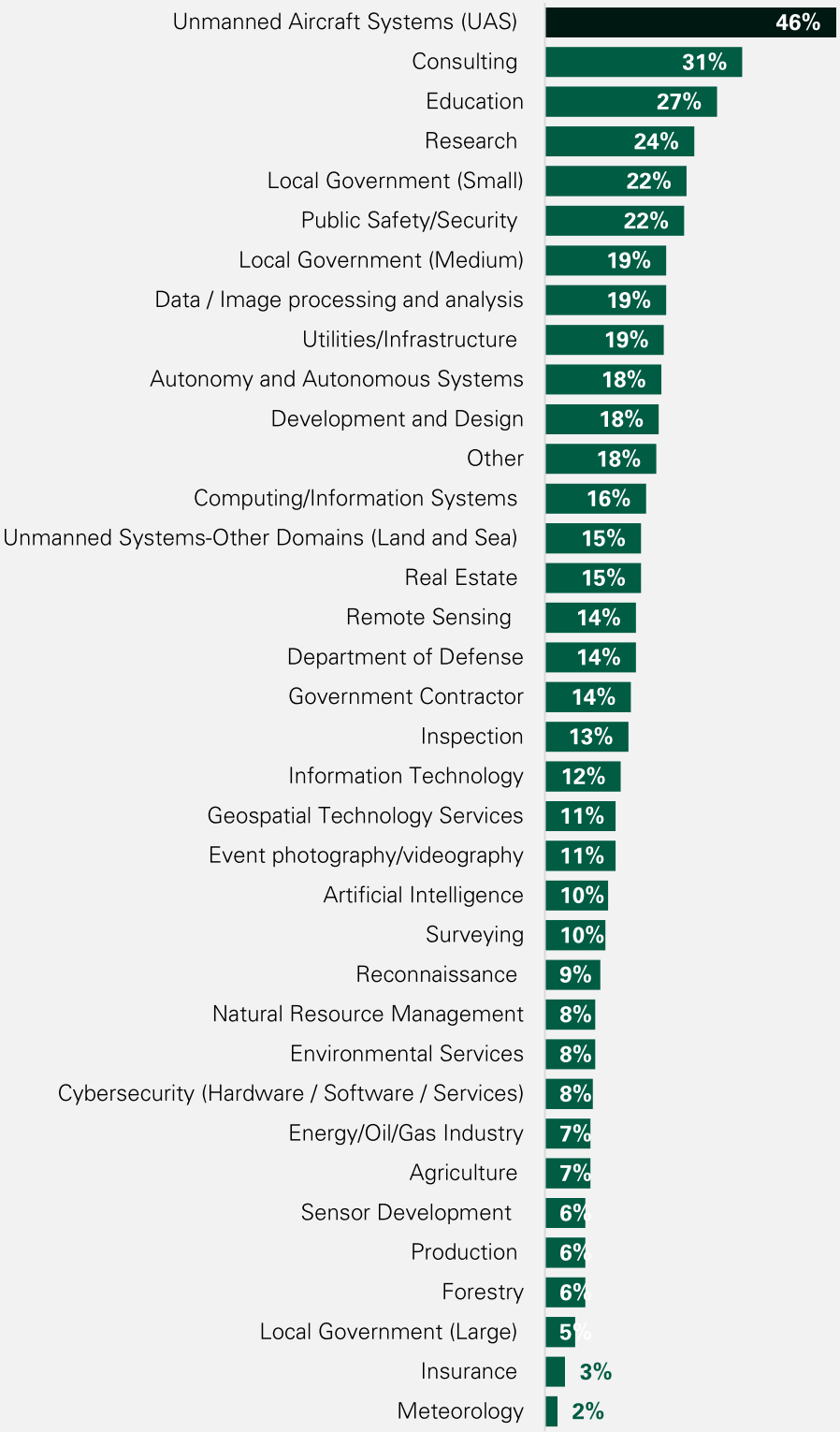


Figure 3. Categories that describe the organizations and their provided services (n = 125).
Note. Organizations can be represented by more than one category because organizations can work across multiple sectors.

UAS WORKFORCE POSITIONS & VACANCIES

Nearly half of organizations employed UAS positions (46%), 39% did not employ these positions, and 14% do not employ UAS positions now, but plan to in the future (Figure 5). Of the organizations that employed UAS positions, 31 provided hiring data, which showed the number of UAS positions they hired in a typical year ranged from 0 to 100 with a median of 2 positions (M = 6.50, SD = 18.07). Of the 32 organizations that employed UAS positions and provided vacancy data, 62% had no current vacancies. For the organizations with current vacancies, these vacancies ranged from 1 to 40 with a median of 1.50 positions (M = 4.50, SD = 8.30).

The survey collected annual salary data for 26 organizations that employed UAS positions. The lowest annual salary for UAS positions, ranged from $6,000 to $120,000 with a median of $40,000 ($M$ = $49,377, SD = 25,367.99). The highest annual salary for UAS positions ranged from $35,000 to $300,000 with a median of $90,000 ($M$ = $101,665, SD = 59,869.22).

Demand for employees in UAS positions was expected to increase in the near future (1-3 years) at 41% of all organizations. The projected demand at these organizations ranged from 1 to 150 positions with a median of 3 positions (M = 7.63, SD = 17.86). Demand was not expected to increase at 31% of these organizations. Twenty-eight percent of respondents indicated they were not sure about future demand.

NEARLY HALF OF ORGANIZATIONS EMPLOYED UAS POSITIONS

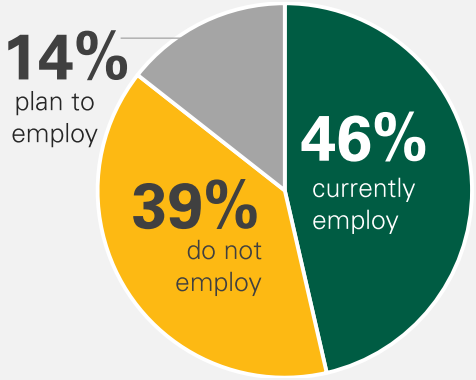


Figure 5. Percent of organizations that employ any UAS workforce positions (n = 125).

ORGANIZATIONS HIRED A MEDIAN OF 2 UAS POSITIONS IN A TYPICAL YEAR

ORGANIZATIONS HAD A MEDIAN OF 1.5 VACANT UAS POSITIONS

ANNUAL SALARIES FOR UAS POSITIONS RANGED FROM A LOW MEDIAN OF $40,000 TO A HIGH MEDIAN OF $90,000

DEMAND FOR EMPLOYEES IN UAS POSITIONS WAS PROJECTED TO INCREASE AT 41% OF ORGANIZATIONS BY 3 UAS POSITIONS (MEDIAN)

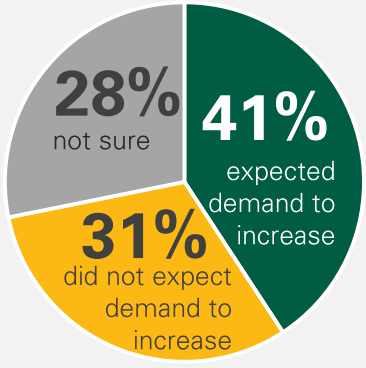


Figure 5. Respondents' projections about their organizations' future demand for employees in UAS positions (n = 119).

CURRENT UAS WORKFORCE TRAINING NEEDS

This section describes organizations' current UAS workforce training needs. These findings do not include 35 respondents who selected not sure for these questions about their organization. Only 18% of all organizations need training that adds UAS tasks and duties to existing positions for their current workforce. The number of UAS positions that need this add-on training at these organizations ranged from 1 to 22 with a median of 3 UAS positions (M = 5.63, SD = 5.73). These positions were described as safety and security, emergency services, UAS pilots or operators, software and hardware developers, instructors, engineering, inspections, enforcement (e.g., law or code) or all positions.

Fifty-two percent of the organizations that employ UAS workforce positions need training for their current workforce to stay up to date in their UAS tasks and duties. There was a wide variety of UAS tasks and duties that the current workforce at 22 organizations need training in to stay up to date (see Appendix B for full list). The most common areas of training included current regulations and requirements (e.g. Federal Aviation Administration [FAA]), emerging and advancing UAS technologies, Part 107 remote pilot certification, inspections (e.g. procedures) and imaging.

All of the organizations that employ UAS positions have been able to sufficiently (70%) or *somewhat* sufficiently (30%) meet their UAS workforce's training needs. These organizations have provided this training most often in-house (80%). Other ways of providing training have been online trainings (49%) and attending conferences (45%). Few organizations have used community colleges and other two-year programs (6%) or four-year institutions (2%). Thirteen organizations (27%) provided other professional development and training, including training service providers, specific programs or organizations (e.g., NASA, NISS, GeoTEd-UAS, FAA), or literature and research.

FEW ORGANIZATIONS NEED TRAINING TO ADD UAS TASKS OR DUTIES TO THEIR CURRENT WORKFORCE

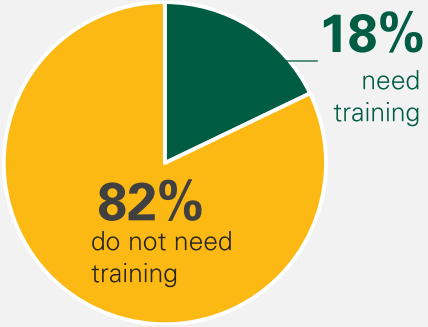


Figure 6. Percentage of organizations that need training to add UAS tasks and duties to existing positions in their current workforce (n = 84; not sure = 35).

HALF OF ORGANIZATIONS NEED TRAINING FOR THEIR CURRENT WORKFORCE TO STAY UP TO DATE IN UAS TASKS & DUTIES

Figure 7. Percentage of organizations that need trainings for their current UAS workforce to stay up to date in their UAS tasks and duties (n = 45; not sure = 10).

ORGANIZATIONS HAVE BEEN ABLE TO GENERALLY MEET THEIR TRAINING NEEDS IN-HOUSE

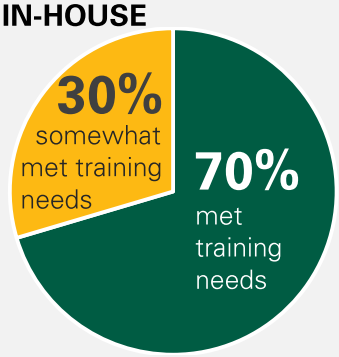


Figure 8. Percent of organizations who have been able to sufficiently meet their UAS workforce's training needs (n = 49; not sure = 5).

UAS WORKFORCE TASKS AND DUTIES

Many types of positions currently a part of these organizations' workforce include or could include UAS-related tasks and duties. The positions that most often involve these tasks and duties were small UAS (sUAS) operator or remote pilot (53%), followed by geographic information system (GIS) or geospatial technician (33%). Sixteen percent of organizations had other types of positions, including data analyses, marketing, fire/EMS, inspections, UAS operation and maintenance, water and wastewater distribution, airfield and test range operations, consulting, department of defense, parks and recreation, and other types of management. Two survey respondents indicated none of these position types represented their organization.

MANY TYPES OF POSITIONS INCLUDE OR COULD INCLUDE UAS-RELATED TASKS AND DUTIES. ORGANIZATIONS MOST OFTEN SELECTED sUAS OPERATOR OR REMOTE PILOTS.

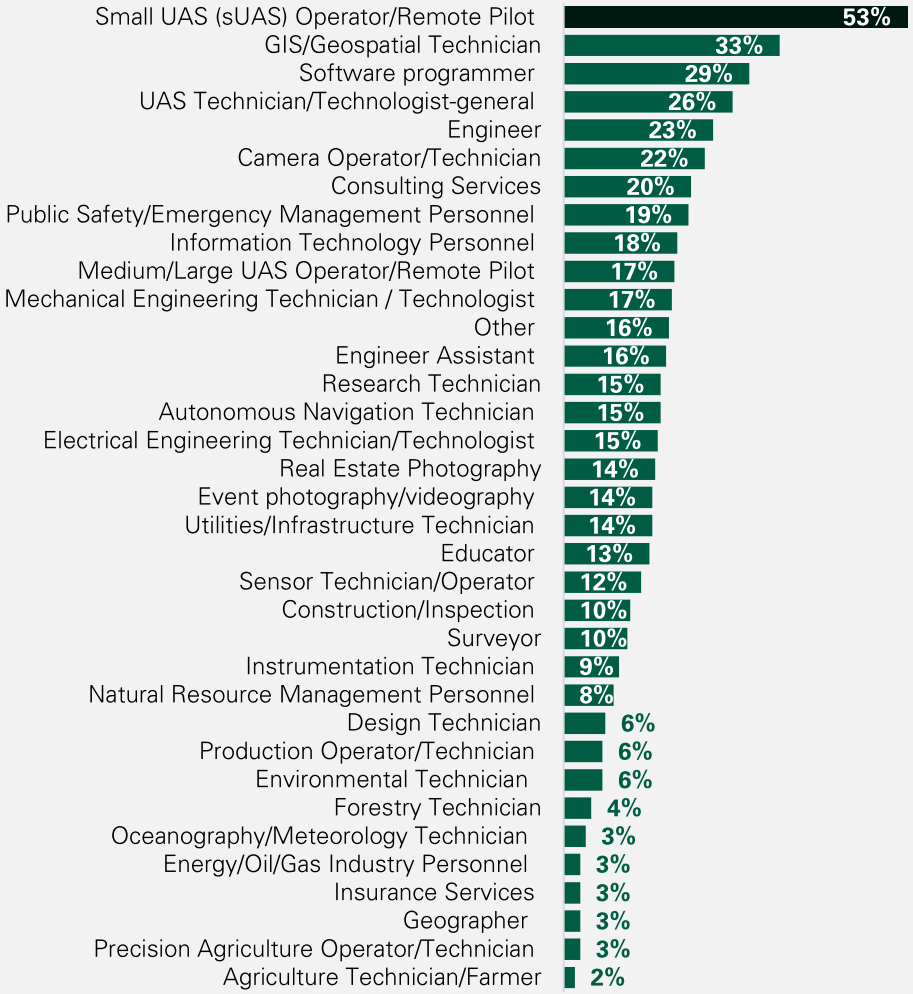


Figure 9. General categories of positions that include, or could include, UAS related duties and tasks that are currently part of organizations' workforce (n = 117).
Note. Organizations can have more than one type of position.

The typical tasks and duties that best described the organizations that currently employ UAS positions were most often performing UAS missions and flight operations (69%) and maintaining UAS and related equipment and sensors (64%). However, there was not much variation as each of the other tasks and duties were typical in about half of these organizations (Figure 10). Nine organizations did not have any typical tasks and duties selected. Results suggest that organizations were able to employ a workforce that can effectively perform the requisite UAS tasks and duties for their positions. Based on a 5-point scale, most tasks and duties were rated between *a little challenging* and *somewhat challenging* to employ (see Figure 10). The most challenging tasks for these organizations, on average, were analyzing (M = 3.15, SD = 1.35) and processing (M = 3.03, SD = 1.20) data collected from UAS. These findings do not include respondents who selected *I am not in a position to rate this item*.

EACH TASK AND DUTY WAS TYPICAL OF UAS POSITIONS FOR ABOUT HALF TO TWO THIRDS OF THE ORGANIZATIONS. IT WAS CONSIDERED *A LITTLE* TO *SOMEWHAT CHALLENGING* TO EMPLOY A WORKFORCE WHO CAN EFFECTIVELY DO THEM.

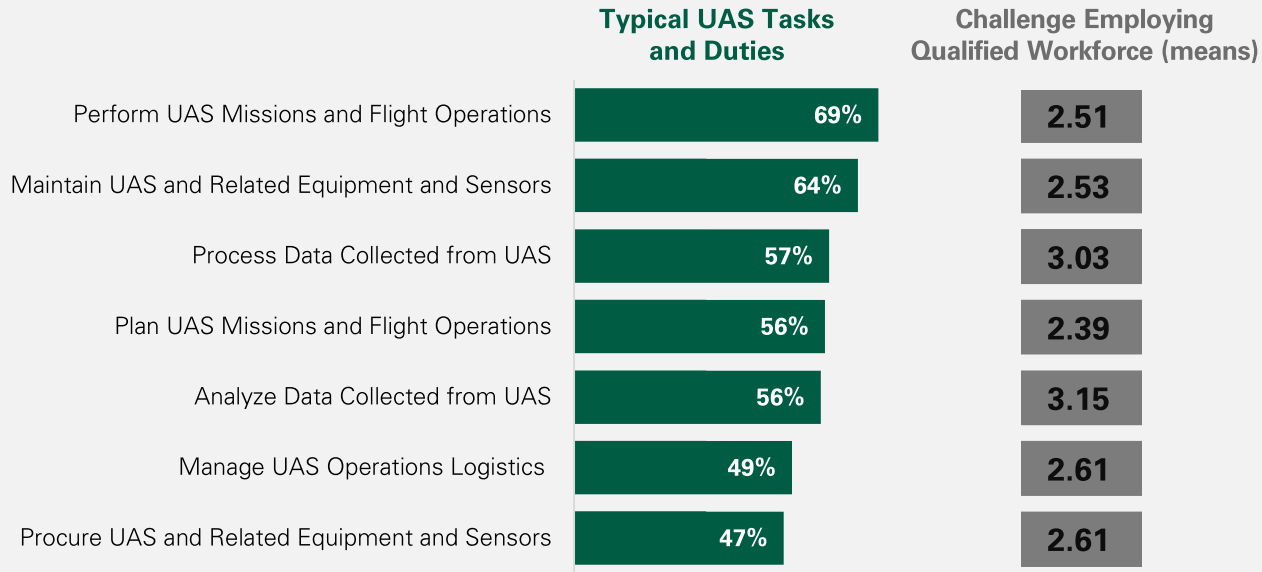


Figure 10. Typical tasks and duties of UAS positions at these organizations (n = 54) and the extent to which it is challenging to employ a workforce who can effectively do these tasks and duties (see appendix B for sample sizes).

Note a. Organizations can have more than one task and duty in their UAS positions.
Note b. The scale was 1= *not at all challenging*, 2 = *a little challenging*, 3 = *somewhat challenging*, 4 = *challenging* and 5 = *very challenging*.

UAS WORKFORCE CREDENTIALS & DEVELOPMENT

This section describes the credentials organizations desire in employees and contributions they would be willing to make to help develop or recruit a workforce. These findings do not include any respondents who selected *I am not in a position that can provide this information*. Organizations that currently have UAS positions most often look for employees who have either an FAA Part 107 remote pilot certificate (77%), a bachelor's degree (63%), or both, when filling these positions (Figure 11). It is less typical for organizations to look for employees who have an associate degree (20%), Certified Geographic Information Systems Professional (13%) or any of the AUVSI Trusted Operator Levels (2-4%). Thirteen percent of organizations look for other industry certifications or credentials, including private pilots, a Master of Science degree, prior military experience, Occupational Safety and Health Administration credential, or an FAA airframe and powerplant credential.

ORGANIZATIONS TYPICALLY LOOK FOR EMPLOYEES FOR UAS POSITIONS WHO HAVE A REMOTE PILOT CERTIFICATE AND/OR A BACHELOR'S DEGREE.

Figure 11. Credentials organizations typically look for in employees for UAS positions (n = 45; none of the above = 0; I am not in a position that can provide this information = 8).
Note. Organizations can look for more than one credential.

Of all the organizations who provided information, 79% would be willing to provide offerings to develop the UAS workforce or to recruit a qualified workforce. Fifty-seven percent of these organizations were willing to offer service-learning projects in partnership with education institutions to allow students to participate in real-world projects and missions that support the needs of a customer. This was followed by classroom visits (44%) and paid internships for high school or college students (44%). Sixteen percent shared comments or other offerings they were willing to provide, including site visits, unpaid internships, connections to employers who can provide these offerings and partnering on grants or facilitating joint projects. Additional survey comments included that these offerings depended on company growth, market requirements and help from local educational institutions.

ORGANIZATIONS WERE MOST OFTEN WILLING TO OFFER SERVICE-LEARNING PROJECTS, CLASSROOM VISITS OR PAID INTERNSHIPS.

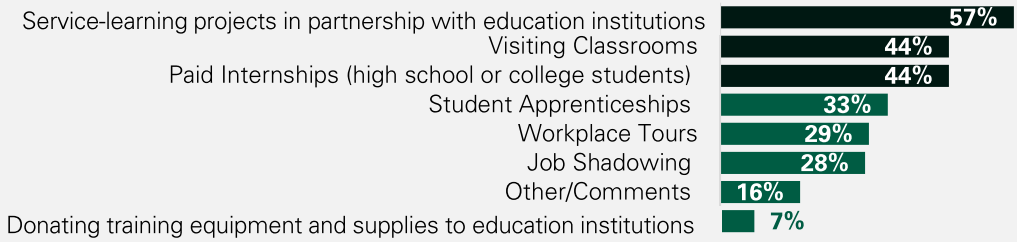


Figure 12. Offerings organizations were willing to make as a way to develop the UAS workforce or recruit a qualified workforce (n = 68; none of the above = 18; I am not in a position that can provide this information = 28).
Note. Organizations can be willing to provide more than one offering.

FINAL REMARKS

Forty-four respondents provided additional information that was important for strengthening current and future UAS education and/or any additional UAS training needs at their organizations. These responses reflected a wide variety of themes, including these five major themes:

- **Ensure specific topic areas are included in UAS education and/or training**: Several specific topic areas were noted, including UAS building and maintenance, cybersecurity, skilled machinists, implications of UAS on economic development (e.g., supply or value chains), UAS flying (e.g. classic UAS pilot training), data management and analyses, and using a UAS in the field effectively and safely.
- **Incorporate key approaches in UAS education and/or trainings:** UAS coursework should be hands-on and follow current trends (e.g., from the Department of Defense). Awareness of UAS careers should begin in elementary school and reach people with relevant skills (computer science, GIS) who may not consider UAS as a career yet.
- **Address important skills for new hires when possible:** There was information about what organizations looked for in their new hires, including demonstrated flight experience, being knowledgeable about cyber-influence and flight area laws, and having senior-level experience.
- **Consider how to support all the different ways UAS is used at organizations:** Several of the organizations were not specifically in the UAS field and either had staff in other positions whose responsibilities included UAS (e.g., fire/rescue and law enforcement) or contracted out UAS needs. Moreover, some of the organizations primarily provide support to the UAS industry by working with UAS companies (e.g. emerging technologies), providing UAS training, encouraging more people to learn about UAS, or sharing they may be able to provide testing locations and classroom space.
- **Provide targeted support:** Some organizations need specific information or support, for example, more information about state or local financial incentives, a public list of UAS applications, easily accessible information about flight legalities, a liaison between the FAA and businesses, marketing (e.g., UAS services) and resources to provide unpaid internships.

"Data management is increasingly becoming a challenge and a training consideration with the increasing file sizes per UAS mission coupled with the volume of missions."

"Begin awareness of UAS related career pathways in elementary school. This is done in other states and Virginia has to do this to stay competitive on developing workforce pipeline prepared to meet employer demand."

"Having the classical UAS pilot and technical training as well as Part107 certification is critical. However, nothing beats flight experience in the field. These flight hours and learning the nuances of UAS operations would give us the confidence in a new employee to start flying with us early in their employment.

"We have autonomous technology companies in our County that need talent. We need resources to better market these opportunities and provide a subsidy to trainees that take unpaid internships with these companies."

SUMMARY OF KEY FINDINGS

1. **SURVEY RESULTS REPRESENT A WIDE RANGE OF ORGANIZATIONS CONDUCTING WORK IN VIRGINIA.**
   The organizations represent 52% of the localities in Virginia. Although the most common types of organizations were private/for profit and municipal governments (73%), all available types of organizations were represented in this sample. Additionally, these organizations represent many different sectors, most notably the UAS sector.

2. **ORGANIZATIONS TYPICALLY HIRE A FEW UAS POSITIONS EACH YEAR, BUT DEMAND IS PROJECTED TO INCREASE IN AT LEAST 49 ORGANIZATIONS.**
   Forty-six percent of organizations currently employ UAS positions. Most of these organizations hire fewer than six UAS positions each year, but there are a few organizations that hire greater numbers, between 25 and 100 UAS positions. Combined, these organizations hire a median of 2 UAS positions per year. Only 38% of the organizations that employed UAS positions currently have vacancies and are looking for a median of 1.50 UAS positions. Demand for employees in UAS positions was expected to increase in the next 1-3 years in at least 41% of all organizations, anticipating a median of 3 additional UAS positions. O*Net describes bright outlook occupations as ones that are projected to grow faster than average, showing an employment increase of 7% or more. This would suggest considerable growth in UAS positions is anticipated (O*NET OnLine, 2020).

3. **UAS POSITIONS HAVE POTENTIAL TO EARN A HIGH ANNUAL SALARY IN VIRGINIA.**
   The U.S. Bureau of Labor Statistics showed that the annual mean wage for all occupations in Virginia is $56,740 (May 2019). The lowest annual salary for UAS positions averaged slightly below this wage $49,377 but the highest annual salary for UAS positions averaged significantly more at $101,665.

4. **ORGANIZATIONS NEED TRAINING TO HELP THEIR CURRENT WORKFORCE STAY UP TO DATE IN UAS TASK AND DUTIES. HOWEVER, ORGANIZATIONS HAVE GENERALLY BEEN ABLE TO PROVIDE REQUIRED TRAINING, PRIMARILY IN-HOUSE.**
   More than half of organizations (52%) that employed UAS positions need training for their current workforce to stay up to date in their UAS tasks and duties. More specifically, organizations needed training in current regulations and requirements (e.g. FAA), emerging and advancing UAS technologies, the remote pilot certification, inspections (e.g. inspection procedures) and imaging. However, the majority of organizations (70%) that employed UAS positions were able to sufficiently meet their training needs, and the rest (30%) indicated they were somewhat able to meet their needs. Organizations typically provided this training in-house (80%). Moreover, most organizations (82%) do not need training to add UAS tasks and duties to existing positions. These findings suggest that organizations may not need substantial support in training their current workforce in UAS. However, while these organizations are currently meeting their workforce's training needs, these organizations may still be open to other avenues of training support. For example, organizations may have rarely used community colleges or four-year institutions to meet their UAS training needs because they lack awareness of existing UAS training offerings at colleges and universities.

This suggests a need to further connect with organizations about their training needs. There may be opportunities to support or supplement in-house trainings that will help keep their UAS workforce up to date on UAS tasks and duties. Organizations may be most interested in trainings that cover current regulations and requirements (e.g. FAA), emerging and advancing UAS technologies, the remote pilot certification, inspections (e.g. inspection procedures) and imaging.

5. **MANY TYPES OF POSITIONS CAN INCLUDE A VARIETY OF UAS TASKS AND DUTIES.**
   Many types of positions at these organizations include or could include UAS-related tasks and duties, but the positions that most often involve these tasks and duties were sUAS operator or remote pilot (53%). There was not much variation in the typical tasks and duties of UAS positions, but organizations showed a slightly higher need for UAS positions to perform UAS missions and flight operations (69%) and maintain UAS and related equipment and sensors (64%). Findings suggest it is not particularly challenging for organizations to employ a workforce who can effectively do the UAS tasks and duties.

6. **ORGANIZATIONS TYPICALLY NEED EMPLOYEES WHO HAVE A REMOTE PILOT CERTIFICATE AND/OR A BACHELOR'S DEGREE TO FILL UAS POSITIONS.**
   Organizations that employed UAS positions, predominately look for employees who have their FAA Part 107 remote pilot certificate (77%) or a bachelor's degree (63%) or both. Findings suggest that this emphasis on the remote pilot certificate and bachelor's degree indicate that educational programs could best meet employer needs by providing pathways to these credentials.

7. **ORGANIZATIONS WERE MOST WILLING TO OFFER SERVICE-LEARNING PROJECTS, CLASSROOM VISITS AND PAID INTERNSHIPS.**
   Most organizations were willing to make offerings as a way to develop the UAS workforce or to recruit a qualified workforce (79%). This means there is an opportunity for greater collaboration between organizations and education institutions, especially for developing service-learning projects (57%) and offering classroom visits (44%) and paid internships (44%).

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APPENDIX A
SURVEY VALIDITY, RELIABILITY & LIMITATIONS

VALIDITY

Validity examines the extent to which an instrument measures what it is intended to measure. The UAS Workforce Needs Survey exhibits two types of validity: content validity and face validity. Survey content validity was established by engaging content experts in the survey development process and reviewing the content of existing workforce needs surveys. The extensive UAS experience of content experts ensured that the survey included the types of questions that would yield relevant data to inform project development. Additionally, the survey incorporated feedback from project partners, including Virginia Space Grant Consortium, Richard Bland College of William and Mary, and Virginia Unmanned Systems Center at the Center for Innovate Technology. This further ensured the survey was comprehensive and aligned to the needs of the field and the intended users.

The instrument also established face validity in two ways. First, Magnolia Consulting provided expertise on the survey logistics and administration to ensure questions were clear and appropriately structured. Second, a small sample of intended survey recipients reviewed and provided feedback on survey organization, clarity, and ease of completion.

RELIABILITY

Reliability refers to the extent to which an instrument produces similar results under consistent conditions. Given that the survey structure includes several checklists and open-ended responses, as opposed to rating scales, its structure does not lend itself to calculating the internal consistency of its items. However, evaluators were able to examine the absolute agreement between multiple recipients within the same organization for checklist items and other categorical variables. This allowed evaluators to generally determine if different respondents representing the same organization agreed in their responses. Through this approach, evaluators compared six pairs of surveys from organizations represented by more than one survey respondent by calculating the number of times raters agreed on a response and then divided by the total number of responses (Graham, Milanowski & Miller, 2012). Evaluators did not include respondent's selection of *other*, *not applicable*, or *not sure* in these calculations. A general rule of thumb for determining sufficient reliability is a minimum agreement level of 75%. An agreement level of 90% would be considered high inter-rater reliability.

Table 1. and Table 2 show the results. Across questions, most organizations showed an acceptable level of agreement, though organization 3 was slightly below the 75% benchmark. Q7, which asks about whether an organization employed any UAS workforce positions, and Q17, which asks about the typical tasks and duties of UAS positions, were slightly below the 75% benchmark. Q13, which asks about training needs for current workforce to stay up to

date in their UAS tasks and duties, was below the benchmark likely because its results are based on two organizations and one pair of respondents from one organization did not show absolute agreement. Q20 showed the lowest level of inter-rater reliability as it showed the least absolute agreement. There could be several reasons that might account for these differences in responses. One, this question is more speculative in nature and did not ask about what organizations currently offer but asked them to speculate what their organization would be willing to offer as a way of developing the UAS workforce or recruiting a qualified workforce. Two, this question also included a mutually exclusive "none" option, meaning when selected, no other response options could also be selected. Thus, if only one of the two respondents selected "none," there will be 0% agreement.

Table 1. Inter-rater reliability analyses for categorical survey items.

	Q5	Q6	Q7	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q19	Q20	All
Company or Organization 1	**100%**	**100%**	**100%**	**100%**				-	**82%**	-	-	**75%**	**93%**
Company or Organization 2	**100%**	**83%**	**100%**	0%			50%	**80%**	**79%**	**86%**	**88%**	**75%**	**74%**
Company or Organization 3	**100%**	69%	0%					-	**97%**	-	-	0%*	67%
Company or Organization 4	**100%**	**83%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**82%**	**86%**	**75%**	0%*	**93%**
Company or Organization 5	**100%**	**100%**	**100%**	**100%**		0%	**100%**	**80%**	**79%**	29%	**75%**	63%	**75%**
Company or Organization 6	**100%**	**89%**	0%		**100%**			-	**88%**	-	-	0%*	**75%**
Average	**100%**	**87%**	67%	**75%**	**100%**	50%	**83%**	**87%**	**85%**	67%	**79%**	35%	**76%**

For the Likert scale questions, only one organization had both respondents provide information. Because this question had more than 4 rating levels, the percentage of exact and adjacent agreement was used to determine agreement. Table 2 shows a high level of reliability, but this should be interpreted with caution because results are based on only two respondents from one organization.

Table 2. Inter-rater reliability analyses for Likert scale survey items.

Q18	Company or Organization 5
Plan UAS Missions and Flight Operations	**100%**
Perform UAS Missions and Flight Operations	**100%**
Process Data Collected from UAS	**100%**
Analyze Data Collected from UAS	**100%**
Maintain UAS and Related Equipment and Sensors	**100%**
Manage UAS Operations Logistics	**100%**
Procure UAS and Related Equipment and Sensors	**100%**
Average	**100%**

These results should be viewed with caution for a few reasons. One, absolute agreement is a less stringent measure of inter-rater reliability, because it does not correct for the likelihood that agreement could happen by chance (Graham, Milanowski & Miller, 2012). Two, evaluators were not able to calculate absolute agreement for continuous variables, such as salary range. Three, due to survey skip logic (that is, respondents receive some survey questions depending on how

they answer certain prior survey questions), evaluators could not conduct inter-rater reliability analyses on all questions for all raters because of logically missing data (that is, some respondents do not have answers to questions, because they did not receive the question due to skip logic). This was especially the case if responses differed on Q7, which asks about whether an organization employed any UAS workforce positions, because this question determined most skip logics and thus, respondents would not see all the same subsequent questions. Four, it should also be noted that not all respondents would be expected to have the same information about their organization and thus, responses may naturally vary. For example, if someone in human resources completed the survey, they may be able to provide information about hiring compared to someone in another position. Five, the samples were very small, and some questions only included only two respondents from one organization.

LIMITATIONS

The study is limited by the extent to which findings are generalizable to entire organizations. For the majority of organizations, survey results are based on only one representative of the organization who may not have had all the information about their organization. This caused several challenges: reaching the appropriate representatives, missing organizational data, and weighting responses. To help ensure the survey went to the appropriate representatives in an organization, recipients received details about who should complete the survey. To ensure the accuracy of the data, each question allowed respondents to opt out if they were unable to provide the required information (e.g., salary data or hiring information) for their organization. To ensure organizations were equally represented in the findings, weighting was used for six organizations that had survey data based on two representatives at each organization.

A second limitation of the study is the generalizability of results to all types of organizations represented in the survey sample. For example, some respondents represented postsecondary education institutions, which may not hire a UAS workforce directly. However, since it is possible to hire faculty that require UAS tasks and duties, these respondents were included in the findings. A third limitation is the generalizability to all organizations in the state. A total of 124 organizations were represented in the statewide report and 17 organizations in the *GO Virginia Region 4* report. Thus, these findings only represent a fraction of the organizations in the state.

APPENDIX B

This appendix provides additional tables to support the findings in the body of the report.

Table 3. Locations of the organizations in Virginia (n = 125)

- Accomack 3%
- Albemarle 3%
- Alexandria 1%
- Alleghany 1%
- Amelia 0%
- Amherst 3%
- Appomattox 0%
- Arlington 1%
- Augusta 1%
- Bath 1%
- Bedford 2%
- Bland 0%
- Botetourt 1%
- Brunswick 1%
- Buchanan 0%
- Buckingham 0%
- Campbell 0%
- Caroline 0%
- Carroll 0%
- Charles City 0%
- Charlotte 1%
- Chesapeake 0%
- Chesterfield 5%
- Clarke 0%
- Colonial Heights 0%
- Craig 0%
- Culpeper 1%
- Cumberland 0%
- Danville 0%
- Dickenson 0%
- Dinwiddie 0%
- Emporia 1%
- Essex 1%
- Fairfax 6%
- Fauquier 0%
- Floyd 0%
- Fluvanna 1%
- Franklin 1%
- Frederick 3%
- Giles 0%
- Gloucester 2%
- Goochland 0%
- Grayson 0%
- Greene 0%
- Greensville 0%
- Greensville/Emporia 0%
- Halifax 0%
- Hampton 3%
- Hanover 1%
- Henrico 3%
- Henry/Martinsville 3%
- Highland 0%
- Hopewell 0%
- Isle of Wight 1%
- James City 1%
- King and Queen 0%
- King George 0%
- King William 0%
- Lancaster 0%
- Lee 1%
- Loudoun 5%
- Louisa 0%
- Lunenburg 1%
- Lynchburg 2%
- Madison 1%
- Mathews 0%
- Mecklenburg 1%
- Middlesex 0%
- Montgomery 5%
- Nelson 1%
- New Kent 0%
- Newport News 3%
- Norfolk 1%
- Northampton 2%
- Northumberland 1%
- Nottoway 1%
- Orange 0%
- Page 0%
- Patrick 0%
- Petersburg 0%
- Pittsylvania 0%
- Portsmouth 1%
- Powhatan 0%
- Prince Edward 0%
- Prince George 2%
- Prince William 3%
- Pulaski 1%
- Rappahannock 0%
- Richmond 0%
- Richmond City 3%
- Roanoke 2%
- Rockbridge 1%
- Rockingham 1%
- Russell 0%
- Scott 0%
- Shenandoah 1%
- Smyth 0%
- Southampton 0%
- Spotsylvania 1%
- Stafford 1%
- Suffolk 0%
- Surry 0%
- Sussex 0%
- Tazewell 1%
- Virginia Beach 3%
- Warren 0%
- Washington 1%
- Westmoreland 1%
- Wise 2%
- Wythe 1%
- York/Poquoson 3%

Table 4. In what UAS tasks and duties does your workforce need training to stay up to date?

- Flight testing
- More robust functional training opportunities for agility
- All FAA requirements; technology changes, research findings, new initiatives.
- Regulation changes, Survey/mapping

- Certification eligibility, changing legislation (waivers applications) and data collection and processing methods for photogrammetry.
- Part 107 certification, seeking FAA permissions, BLOS flights, multi-craft missions, usage of advanced and custom sensors.
- Advanced payloads, evolving user interfaces
- Various inspection SOP's ranging from operations is wired environment to internal confined space inspections
- Review of FAA Regulations, Preflight assembly and inspection procedures, Safe aeronautical decision making, Configuration management and documentation
- Thermal Imaging, mapping, crime scene and other incident 3D reconstruction, technical videography techniques
- Piloting, crew resource management
- Part 107, UAS platform, OSHA
- CPR, NISS, UAS
- Flying, regulations and application of UAS in industry
- Changing regulatory environment
- UAV model-specific training, UAV Image Processing software-specific training
- Part 107 proficiency
- FAA Regulations updates, UAS Program Management
- While we do not need to perform UAS tasks and duties, we need to understand the field well as part of our role is to support companies as an economic development authority in emerging technologies including UAS.
- Advanced concepts of design and build
- Drone inspections, drone spraying

Table 5. Please rate the extent to which it is challenging to employ a workforce who can effectively do each of the following tasks and duties (n = 52).

	n	Mean	SD	I am not in a position to rate this item
Plan UAS Missions and Flight Operations	40	2.39	1.01	12
Perform UAS Missions and Flight Operations	39	2.51	1.12	13
Process Data Collected from UAS	39	3.03	1.20	13
Analyze Data Collected from UAS	39	3.15	1.35	13
Maintain UAS and Related Equipment and Sensors	40	2.53	1.15	12
Manage UAS Operations Logistics	38	2.61	1.05	14
Procure UAS and Related Equipment and Sensors	38	2.61	1.17	14

Note. The scale was 1= *not at all challenging*, 2 = *a little challenging*, 3 = *somewhat challenging*, 4 = *challenging* and 5 = *very challenging*.

APPENDIX C

This appendix shares the UAS workforce needs survey.

The Richard Bland College of William & Mary (RBC) in partnership with the Virginia Space Grant Consortium (VSGC) and Virginia Tech are conducting this survey to help inform future workforce development and education programs to train the unmanned aircraft systems (UAS) workforce. The Virginia Unmanned Systems Center at the Center for Innovative Technology (CIT) is also a partner in this project. **This survey should only take about 5-10 minutes to complete.**

With funding support from *GO Virginia* and the RBC Foundation, this survey is targeting all companies and organizations in Virginia who currently, or plan to, hire and train a workforce that includes tasks and duties related to UAS.

We ask that you complete this survey to provide information about your company/organization's current and projected workforce needs. A statewide summary of the data will be provided to all respondents to help inform future projects.

Due to the current pandemic situation, we realize your UAS-related current and projected workforce may be impacted. In completing this survey, we ask that you consider a more typical environment for your company/organization in your responses. We also ask that you refer to work only being conducted in Virginia.

Your participation is voluntary and the responses to the survey will only be reported as a group. Please share this survey link- ADD LINK with other contacts who have similar workforce needs and wish to provide input. This survey is being hosted and administered by Magnolia Consulting, a woman-owned, small business with headquarters in central Virginia.

I. About Your Company/Organization

1. Name of your company/organization: _____

2. Your primary position/title in your company/organization: _____

3. Your Email Address: _____@_____
We request your email address so we can send you a statewide summary of the data to help inform future projects. Providing an email is not required to complete the survey.

4. Location of your company/organization:
State: [drop down list]
City/County: [select from drop down list]
Zip code:

5. What best describes your company/organization?

- o Private/For Profit
- o Federal government
- o State government
- o Municipal government
- o Educational institution
- o Not-for-profit
- o Other (please specify):_____

6. Please select all categories below that describe your company/organization and the services you provide: (check all that apply)

- ☐ Unmanned Aircraft Systems (UAS)
- ☐ Agriculture
- ☐ Artificial Intelligence
- ☐ Autonomy and Autonomous Systems
- ☐ Computing/Information Systems
- ☐ Consulting
- ☐ Cybersecurity (Hardware / Software / Services)
- ☐ Data / Image processing and analysis
- ☐ Department of Defense
- ☐ Development and Design
- ☐ Education
- ☐ Energy/Oil/Gas Industry
- ☐ Environmental Services
- ☐ Event photography/videography
- ☐ Forestry
- ☐ Geospatial Technology Services
- ☐ Government Contractor
- ☐ Information Technology
- ☐ Inspection
- ☐ Insurance
- ☐ Local Government (Small)
- ☐ Local Government (Medium)
- ☐ Local Government (Large)
- ☐ Meteorology
- ☐ Natural Resource Management
- ☐ Production
- ☐ Public Safety/Security
- ☐ Remote Sensing
- ☐ Research
- ☐ Real Estate
- ☐ Reconnaissance
- ☐ Sensor Development
- ☐ Surveying
- ☐ Unmanned Systems-Other Domains (Land and Sea)
- ☐ Utilities/Infrastructure
- ☐ Other (please specify): _____

II. Your Company/Organization's UAS Workforce Positions and Vacancies

7. Does your company/organization employ any workforce positions that include UAS as a task or duty?

- o Yes [Skip to Q8]
- o No [Show Q11, Q12, Q16, Q20, Q21?]
- o Not now, but we plan to in the future [Show Q11, Q12, Q16, Q20, Q21]

8. How many workforce positions do you hire in a typical year that include UAS tasks and duties?
If you do not know this information, please leave this question blank.

9. Please indicate the number of current vacancies in these positions at your company/organization.
If you do not know this information, please leave this question blank.

10. Please provide the annual salary range for workforce positions that include UAS tasks and duties at your company/organization:
If you do not know the annual salary range, please leave this question blank.

$ _____ (lowest) to $ _____ (highest)

11. Do you project that your company/organization's demand for employees for positions that include tasks and duties in UAS will increase in the near future (1-3 years)?

- o Yes
- o No
- o Not sure
- o If 'Yes', how many positions? _____

III. Current UAS Workforce Training Needs

12. Does your current workforce need training in UAS <u>to add</u> UAS tasks and duties to existing positions?

- o Yes
- o No
- o Not sure
- o If 'Yes', which positions?
- o If 'Yes' how many positions? _____

13. Does your current UAS workforce need training <u>to stay up to date</u> in their UAS tasks and duties?

- o Yes
- o No
- o Not sure

(If 'Yes') In what UAS tasks and duties does your workforce need training to stay up to date?

14. Have you been able to sufficiently meet your UAS workforce's training needs?

- o Yes
- o Somewhat
- o No
- o Not sure

15. If yes or somewhat- How have you been providing this training? (Check all that apply)

- □ In-house Training
- □ Online Training
- □ Attending Conferences
- □ Community College and Other Two-Year Programs
- □ Four-year Institutions
- □ Other Professional Development and Training, please list

III. Duties and Tasks of Your Company/Organization's UAS Workforce

16. Which of the following general categories of positions that include, or could include, UAS related duties and tasks are currently part of your workforce? (Check all that apply)

- □ Small UAS (sUAS) Operator/Remote Pilot
- □ Medium/Large UAS Operator/Remote Pilot
- □ UAS Technician/Technologist-general
- □ Electrical Engineering Technician/Technologist
- □ Mechanical Engineering Technician / Technologist
- □ Autonomous Navigation Technician
- □ Software programmer
- □ Instrumentation Technician
- □ Sensor Technician/Operator
- □ Engineer
- □ Engineer Assistant
- □ Camera Operator/Technician
- □ Environmental Technician
- □ Agriculture Technician/Farmer
- □ Precision Agriculture Operator/Technician
- □ Research Technician
- □ Oceanography/Meteorology Technician
- □ Real Estate Photography
- □ Surveyor

- ☐ GIS/Geospatial Technician
- ☐ Geographer
- ☐ Public Safety/Emergency Management Personnel
- ☐ Forestry Technician
- ☐ Educator
- ☐ Utilities/Infrastructure Technician
- ☐ Construction/Inspection
- ☐ Design Technician
- ☐ Production Operator/Technician
- ☐ Event photography/videography
- ☐ Insurance Services
- ☐ Energy/Oil/Gas Industry Personnel
- ☐ Consulting Services
- ☐ Information Technology Personnel
- ☐ Natural Resource Management Personnel
- ☐ Other (please specify): _____

17. Which of the following best describe the typical tasks and duties of positions that include UAS at your company/organization? (Check all that apply)

- ☐ Plan UAS Missions and Flight Operations
- ☐ Perform UAS Missions and Flight Operations
- ☐ Process Data Collected from UAS
- ☐ Analyze Data Collected from UAS
- ☐ Maintain UAS and Related Equipment and Sensors
- ☐ Manage UAS Operations Logistics
- ☐ Procure UAS and Related Equipment and Sensors

18. Please rate the extent to which it is challenging to employ a workforce who can effectively do each of the following tasks and duties.

	Not at all challenging	**A little challenging**	**Somewhat challenging**	**Challenging**	**Very challenging**	**I am not in a position to rate this item**
Plan UAS Missions and Flight Operations						
Perform UAS Missions and Flight Operations						
Process Data Collected from UAS						
Analyze Data Collected from UAS						
Maintain UAS and Related Equipment and Sensors						
Manage UAS Operations Logistics						
Procure UAS and Related Equipment and Sensors						

IV. UAS Workforce Credentials and Development

19. Which of the following credentials does your company/organization typically look for in employees for positions that include UAS as a task or duty? (Check all that apply)

- ☐ Associate's Degree
- ☐ Bachelor's Degree

- ☐ FAA Part 107 Remote Pilot Certificate
- ☐ Certified Geographic Information Systems Professional (GISP)
- ☐ AUVSI Trusted Operator Level 1
- ☐ AUVSI Trusted Operator Level 2
- ☐ AUVSI Trusted Operator Level 3
- ☐ Other Industry Certification or Credential (please list): _____
- ☐ None of the above
- ☐ I am not in a position that can provide this information.

20. Which of the following would your company/organization be willing to offer as a way of developing the UAS workforce or recruiting a qualified workforce for your company/organization? (Check all that apply)

- ☐ Service-Learning Projects (students participate in real-world projects and missions that support the need of a customer) in partnership with education institutions
- ☐ Paid Internships (high school or college students)
- ☐ Student Apprenticeships
- ☐ Workplace Tours
- ☐ Job Shadowing
- ☐ Visiting Classrooms
- ☐ Donating training equipment and supplies to education institutions
- ☐ Other/Comments
- ☐ None of the above
- ☐ I am not in a position that can provide this information.

21. Please provide any information you believe is important for strengthening current and future UAS education and workforce development programs. Please also share any additional UAS training needs for your company/organization.