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The Defense Industry's Economic Impact on the Charlottesville Region



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THE CHAMBER 
Charlottesville Regional
Chamber of Commerce

 UNIVERSITY
of VIRGINIA

Weldon Cooper Center
for Public Service
Center for Economic and Policy Studies

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EXECUTIVE SUMMARY

This study examines the size, growth, features, and economic impacts of the defense industry for the Charlottesville Region. Charlottesville's defense industry has grown over the last decade and includes more than 100 local entities involved in defense intelligence and research, military education, and defense contracting. Statistics from public data sources indicate that Department of Defense (DoD) military and civilian employment grew by 15 percent from 2011 to 2021. These publicly available figures, however, vastly underestimate the size and actual growth of DoD employment in the region because employment for two major military employers is excluded from the regional data. When estimated employment figures for these entities are added, the tabulated growth rate increases to 67 percent. Federal employment data on defense industry procurement is not available. However, using public procurement data, the Weldon Cooper Center estimates that, over the same period, employment grew an estimated 50 percent in work related to contracts and research grants. Lastly, DoD and Veterans Administration (VA) expenditures connected to the presence of retired military veterans, Armed Forces students, and DoD-funded university spinoffs also suggest that the defense industry's regional economic footprint is growing.

For purposes of this study, the "defense industry" is understood to encompass several major entities and components that account for DoD and military veteran spending in the region, including: (a) Rivanna Station, (b) The US Army Judge Advocate General's Legal Center and School, (c) Veterans, (d) the University of Virginia, (e) Defense contracts made with other private businesses and non-profit organizations in the region, (f) Virginia National Guard and Reserves, and (g) A residual category referred to as "Other sources" consisting of smaller spending and employment items not included elsewhere. The study region consists of the area encompassing the City of Charlottesville, Albemarle County, and Greene County in Virginia.

This study uses input-output analysis to gauge the contribution of the defense industry to the region. Input-output analysis produces industry economic multipliers that show how changes in employment or expenditures affect a regional economy. Defense industry expenditures made in the region are counted as direct injections into the local economies. All the expenditures from the DoD and VA budgets accounted for in this study originate from outside the community. Linkages with other industries in the area means this initial injection has further stimulative effects that result from the purchases of goods and services and payments to employees. The stimulus causes a "multiplier effect" that results when money is re-spent in the local economy. The impact analysis for this study used IMPLAN™, an industry standard input-output model that has been used in many state and regional studies of the defense industry and individual military installations.

Results are presented for four different economic measures (employment, labor income, value-added, and output) and one fiscal measure (local government revenue) in 2021. The total economic impact is also disaggregated into three parts that describe the sources of the

economic impact: a “direct effect,” “an indirect effect,” and an “induced effect.” The direct effect or impact consists of economic activity, such as employment, output, and income directly attributable to the expenditures of the DoD. The “indirect effect” consists of impacts attributable to purchases of production inputs (such as services and supplies) by defense industry entities within the region. The final component of total impact (the “induced effect” or “induced impact”) is attributable to worker household, veteran household, and active-duty military student household income and spending.

Economic impact results indicate that the defense industry directly accounts for 3,972 jobs, \$421 million in labor income, \$501 million in value-added, and \$642 million in output. When indirect and induced impacts stemming from this activity are accounted for, the total regional economic impact is 7,347 jobs, \$618 million in labor income, \$831 million in value-added and \$1.2 billion in output. This represents 5.9 percent of Charlottesville region employment, 7.5 percent of labor income, 6.2 percent of value-added, and 5.7 percent of output.

A breakdown of economic impacts by regional defense industry component shows that Rivanna Station is the largest single component, accounting for approximately half of the total regional defense industry employment impact. Its total regional economic impact is 3,790 jobs, \$395 million in labor income, \$513 million in value-added, and \$643 million in output. Next in order is DoD contracts for military equipment and services with businesses, such as Northrop Grumman and over 70 other area businesses, representing 18 percent of the total economic impact. The total economic impact of DoD contracting is 1,307 jobs, \$101 million labor in income, \$139 million in value added, and \$278 million in output. The University of Virginia is the third largest economic impact component, representing 14 percent of the total employment impact. Its regional economic impact is 946 jobs, \$57 million in labor income, \$74 million in value-added, and \$131 million in output. After UVA, veterans and the Judge Advocate General’s School and Legal Center had the fourth and fifth largest economic impacts respectively. Veteran spending accounts for 8 percent of the total defense regional economic impact. Its total regional economic impact is 553 jobs, \$52 million in labor income, \$57 million in value added, and \$90 million in output. The JAG Legal Center and School and Center accounts for 6 percent of the total defense industry regional impact. The final two components of economic impact by regional defense industry are Reserves and National Guard (4 percent of the total regional employment impact) and a miscellaneous category that includes military recruitment stations (less than 1 percent). The former has a total economic impact of 289 jobs, \$8 million in labor income, \$9 million in value-added, and \$9 million in output while the latter produces a total economic impact of 32 jobs, approximately \$3 million in labor income, \$4 million in value-added, and \$5 million in output.

An ongoing Rivanna Station capital project is another source of regional economic impact. It will provide a temporary boost to area economic activity during the 2022-2024 period. The project is estimated to create a direct economic impact of 523 jobs, \$29 million in labor income, \$35 million in value added and \$68 million in output. Once indirect and induced effects are

accounted for, the total regional economic impact is 687 jobs, \$39 million in income, \$53 million in value-added, and \$96 million in output.

The regional defense industry also may have an impact on the local community through improved safety, increased volunteerism, better social and economic distributional outcomes, and greater innovation. Some research suggests that military members exhibit high rates of community engagement. Several examples from the largest defense industry organizations illustrate the range and depth of military members' commitment to sponsored community activities, including community service activities undertaken by the JAG School as part of a 15-week course; Rivanna Station personnel involvement in local school science and technology education activities; and ROTC program volunteer activities for veterans and disadvantaged residents. Several academic studies indicate that federal military facilities improve community perceptions of safety and decrease regional crime rates. One recent study also found that DoD spending has a positive effect on local social outcomes, such as lower rates of poverty, divorce, health insurance, disability, and mortality; and an increase in homeownership and job quality. Lastly, DoD-funded university patent activity has increased in the last two decades and is associated with an increase in university startups.

INTRODUCTION

The purpose of this study is to evaluate the size, growth, characteristics, and economic impacts of the defense industry on the Charlottesville Region. The defense industry encompasses the following: employment at area defense-related facilities (i.e., Rivanna Station, The Judge Advocate General's Legal Center and School), Department of Defense (DoD) contract and grant expenditures (including spending on military equipment manufactured by Northrop Grumman at its Seminole Trail facility), spending attributable to DoD and Veterans Administration (VA) pensions and other benefit payments, Reserves and Virginia National Guard employment, DoD funded university research and education and military/veteran student enrollment, and other activities. The study region consists of Albemarle County, Charlottesville City, and Greene County.

The study has two components. The first part examines the defense industry's regional economic impact, which includes the direct injection of defense-related expenditures into the region as well as the consequent chain reaction of spending and re-spending. The second part examines additional social and economic benefits that result from the presence of the defense industry, including increased volunteerism and charitable activities, quality of life, community safety, and innovation.

This study is divided into four sections. The first section describes the various components of the regional defense industry. The second section describes the regional economic impact model and input data used to estimate the defense industry's economic impact. The third section presents the results of the economic impact analysis. The fourth section examines other qualitative and quantitative social and economic impacts of the defense industry.

SECTION 1

CHARLOTTESVILLE REGION DEFENSE INDUSTRY CHARACTERISTICS

This section describes the history, size, growth, and features of the Charlottesville region defense industry. The region, which has two major military facilities established more than 50 years ago (Rivanna Station and U.S. Army Judge Advocate General Legal Center & School), has experienced rapid growth and is poised to grow further in the future. It also describes the major entities of the area defense industry, which includes Rivanna Station, the Judge Advocate General Legal Center and School, military veterans, defense contractors, the University of Virginia, Reserves and National Guard, and other entities (see **Figure 1.1**).

Figure 1.1 Charlottesville Region Defense Industry

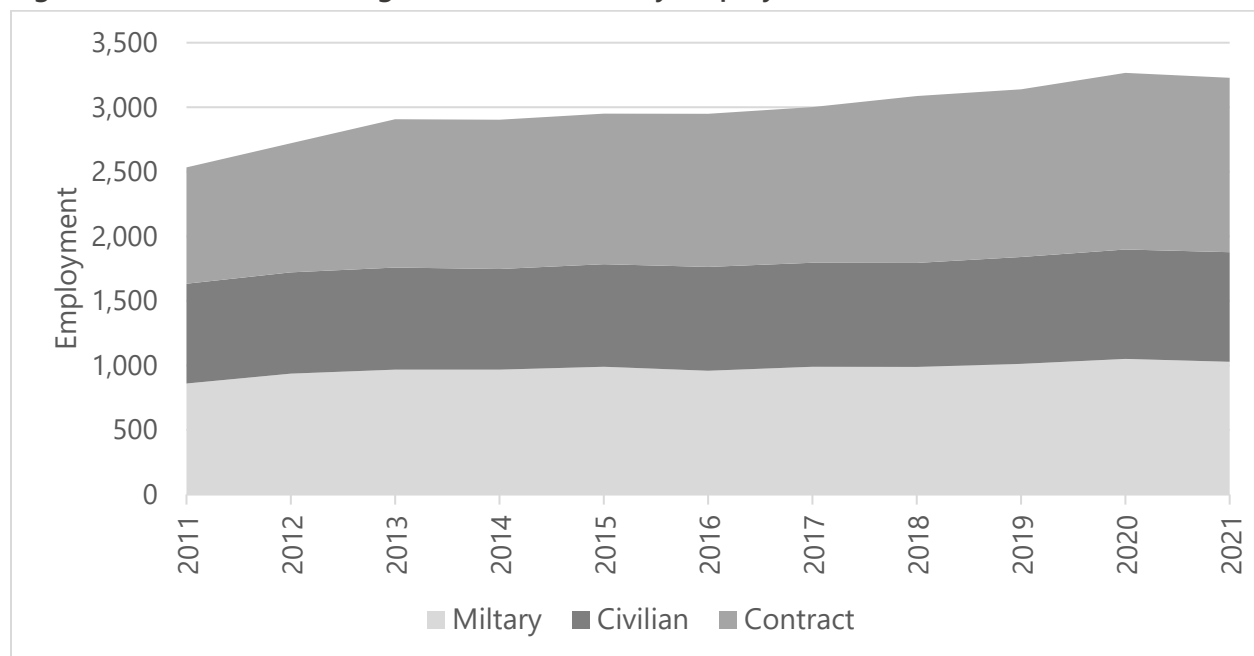


Clockwise from upper right: (a) Rivanna Station's Nicholson Building, (b) The Judge Advocate General's Legal Center and School, (c) Northrop Grumman Seminole Trail Facility, (d) University of Virginia's Thornton Hall (School of Engineering and Applied Science), and (e) TSG Frank D. Peregory U.S. Army Reserve Center

REGIONAL DEFENSE INDUSTRY EXPANSION

Charlottesville's defense industry has grown over the last decade and includes more than 100 local entities involved in defense intelligence and research, military education, and defense contracting. Statistics from the Bureau of Economic Analysis and the Bureau of Labor Statistics indicate that Department of Defense (DoD) military and civilian employment, mostly connected with Rivanna Station expansion, grew by 15 percent from 2011 to 2021 (see **Figure 1.2**). These publicly available figures, however, vastly underestimate the size and actual growth of DoD employment in the region because federal civilian employment from two Rivanna Station tenants (the Defense Intelligence Agency and National Geospatial-Intelligence Agency) are not reflected in the regional totals. When these estimated employment figures are added, the tabulated growth rate increases to 67 percent. Defense procurement employment cannot be identified from federal employment statistics because many industries that provide defense equipment, materials, supplies, and services produce goods and services for civilian use.¹ However, statistics on federal contracting attributable to the DoD (presented later in this report) suggest that DoD contract employment is also expanding. The Weldon Cooper Center estimates that, over the same time period, employment grew an estimated 50 percent in work related to contracts and research grants. Lastly, data on DoD and Veteran Administration (VA) expenditures, income, and employment connected to retired military veterans, Armed Forces students, and DoD-funded university spinoffs (presented later in this report) also suggest that the defense industry's regional economic footprint is growing.

Figure 1.2 Charlottesville Region Defense Industry Employment, 2011-2021



Source: Bureau of Economic Analysis (BEA) State Personal Income and Employment; Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages; and Weldon Cooper Center estimates of contract employment using USAspending.gov and IMPLAN^{TM,2}

COMPONENTS OF THE REGION'S DEFENSE INDUSTRY

RIVANNA STATION

Rivanna Station is the largest DoD entity in the Charlottesville region. This military-intelligence facility traces its origin to the U.S. Army Foreign Science and Technology Center (FSTC) which moved to the City of Charlottesville in 1970 (see **Table 1.1**). The largest single agency within Rivanna Station is the National Ground Intelligence Center (NGIC), which was a merger of the U.S. Army Intelligence and Threat Analysis Center with the FSTC. In 2001, NGIC moved from downtown Charlottesville to its present location in Rivanna Station with the completion of the LTC Arthur D. Nicholson Building (see Figure 1.1(a)). After the BRAC Commission recommendations in 2005, the decision was made to colocate approximately 800 employees of the DoD-funded Defense Intelligence Agency (DIA) with NGIC beginning in 2011. The National Geospatial-Intelligence Agency (NGA) was relocated to Rivanna Station around the same time.

Table 1.1 Rivanna Station Timeline

YEAR	EVENT
1970	U.S. Army Foreign Science and Technology Center (FSTC) headquarters moved to Charlottesville
1994	National Ground Intelligence Center (NGIC) was established by merging FSTC and U.S. Army Intelligence and Threat Analysis Center
2001	NGIC moved from downtown Charlottesville to the Nicholson Building at Rivanna Station
2005	Base Realignment and Closure (BRAC) Commission recommended Defense Intelligence Agency (DIA) colocation with NGIC at Rivanna Station
2010	James Nicholas Rowe Building Joint-Use Intelligence Analysis Facility opened
2011	DIA relocated 800+ employees to Rivanna Station
2016	Child Development Center that can host approximately 100 children opened
2022	Nicholson Building Addition and 250 space parking deck construction commenced

The three tenant organizations in the Rivanna Station have complementary missions. NGIC is part of the U.S. Army Intelligence and Security Command (INSCOM), which is headquartered in Fort Belvoir. It serves as the Army's principal military, scientific, and technical intelligence-gathering center on foreign military ground forces to support U.S. Army and DoD planning, operations, and decision-making. The DIA is a defense intelligence agency for the DoD and is headquartered at Joint Base Anacostia-Bolling in Washington, D.C. Its operations at Rivanna Station also focus on military, scientific, and technical analysis. The smallest of the three agencies is the NGA, which is headquartered at Fort Belvoir. Its operations at Rivanna Station focus on providing geospatial intelligence for NGIC and DIA.

Rivanna Station is one of the largest employers in the Charlottesville area. The three agencies directly employ a total of 2,100 civilian and military personnel. Average wages and salaries are in

the neighborhood of \$100,000. In addition, the agencies contract with a dozen locally domiciled firms located in the region for services related to information technology, scientific analysis, intelligence, and translation, among others. For example, Booz Allen Hamilton provides tech support and core intelligence support for Rivanna Station and employs 150 people locally. Some of these firms have satellite locations at Rivanna Station or at nearby sites, such as the North Fork Research Park. In addition, Rivanna Station attracts over 10,000 visitors, on average, each year. Approximately 85 percent of visitors are from outside of central Virginia and most are from the D.C. region. An estimated 20 percent of visitors stay overnight in area lodging.

Within the timeframe of this analysis, Rivanna Station embarked on a major capital project to enhance security and facility quality. This project involved the construction of an 80,800-foot Secure Operations and Administration Facility (SOAF) addition to the Nicholson Building and the erection of a 250-space two-level parking garage. The \$73.6 million capital project is currently in progress. The anticipated project cost is approximately \$90 million, which includes outfitting the Nicholson Building Addition with furniture and equipment.

THE JUDGE ADVOCATE GENERAL'S (JAG) LEGAL CENTER AND SCHOOL

The Judge Advocate General's Legal Center and School has been located in the Charlottesville region for more than 70 years (see **Table 1.2**). Prior to that, a JAG school that offered specialized legal training in military law had been established at the University of Michigan Law School in Ann Arbor, Michigan during World War II (U.S. Army 1985). It was deactivated briefly after the war but reopened at a temporary location in 1950 at Fort Myer, Virginia. In 1951, JAG found a permanent home at the University of Virginia, first in Clark Hall, then in 1975 in the UVA Law School, and finally in 1991 in a newly constructed building where it currently resides.

Table 1.2 The Judge Advocate General's Legal Center and School Timeline

YEAR	EVENT
02.1942	Judge Advocate coursework was created by the U.S. Army at National University School of Law
08.1942	JAG School moved to University of Michigan Law School
1946	JAG School deactivated after World War II demobilization
1950	Another temporary school was established in Fort Myer, VA
1951	JAG School was established at University of Virginia
1955	JAG School was accredited by American Bar Association
1975	JAG School moved to University of Virginia North Grounds
1991	Building Addition was completed
2003	JAG School became the Legal Center and School
2004	NCO Academy moved to the JAG school

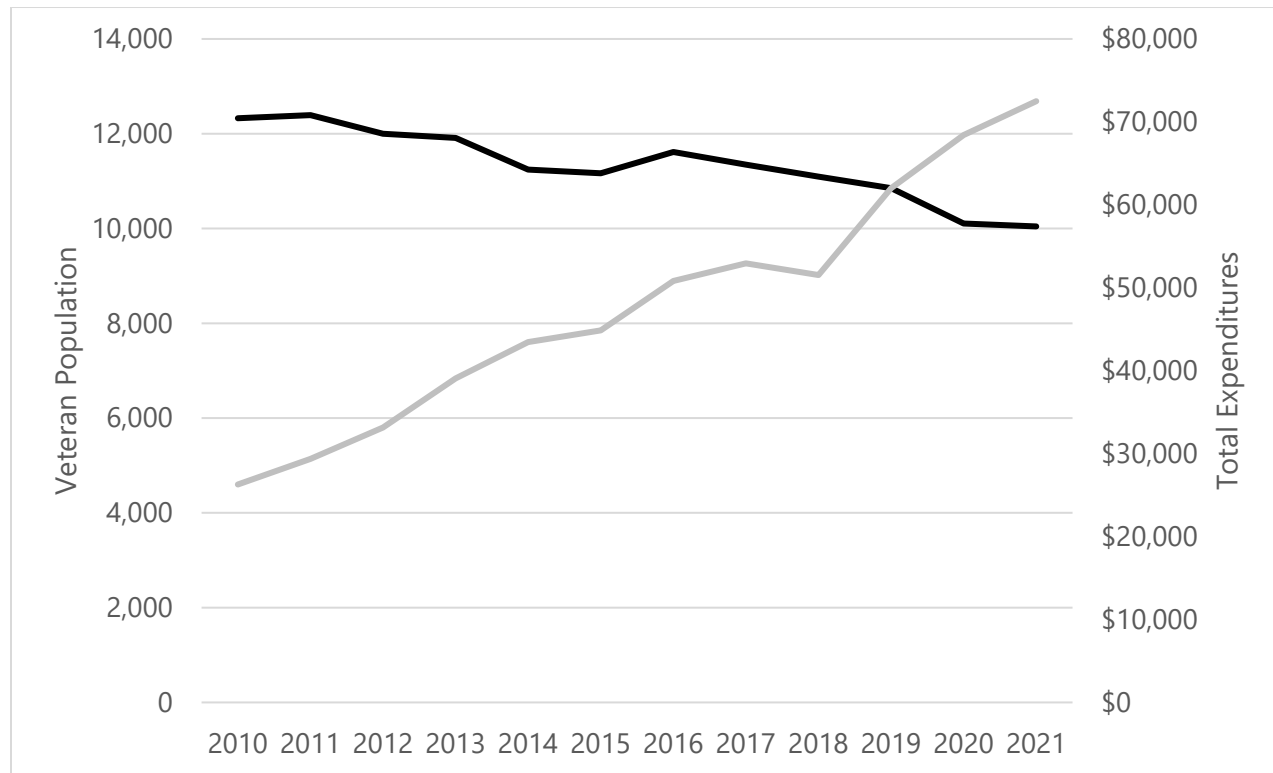
The Judge Advocate General's Legal Center and School (see Figure 1.1(b)) contains three sections: the Judge Advocates Legal Center, the JAG School, and NCO Academy. The Legal Center provides legal research, education program development, and analysis for the U.S. Army. The JAG School is the principal U.S. Army academy for military legal education for Judge Advocates who serve as legal advisors in military commands, newly commissioned officers, and other army personnel. The School offers several types of coursework in furthering its mission. It offers a 10-month graduate program (Masters of Law or LL.M) that provides specialized coursework in military law to prepare military attorneys for service as senior Judge Advocates. The program, which enrolls officer-lawyers from other services and some international students, has an annual enrollment of 120 students each year. The School also offers a Judge Advocate Officer Basic Course and Advanced Course that runs for 10.5 weeks and is offered three times per year; it covers core legal practice areas and more specialized areas and has an annual enrollment of 350 officers. Senior Officer and General Officer Legal Orientation courses provide a 4.5-day orientation (offered seven times per year) on basic administrative, criminal, and civil law topics for officers who are not attorneys to better prepare them for administrative responsibilities. The School also offers coursework on military law office management and related topics, and coursework for Congressional staff and court reporters. Finally, the school provides approximately 50 short courses in various specialized subjects. The School's NCO Academy provides paralegal coursework with an annual enrollment of 240 noncommissioned officers. The JAG School is reportedly planning for future expansion to accommodate an additional 3,000 students.

The Judge Advocate General's Legal Center and School directly employs 122 military and civilian staff and in FY2021, enrolled 6,250 students (88 percent of whom were registered for short courses). The estimated income in the form of military pay and per-diem for the enrolled students was \$26,295,306.

MILITARY VETERANS

The Charlottesville region hosted over 10,000 military veterans in 2021.³ This is a decrease of nearly 19 percent since 2010, a trend similar to the rest of the nation as large cohorts of veterans from WWII and the Korean War pass away. However, VA expenditures attributable to these veterans (retirement, disability, health care, etc.) have actually increased over the period. This reflects a higher rate of annual growth in budget appropriations for VA programs by the federal government and an increase in the number of veterans receiving VA medical care.⁴ Retiring military members can elect to choose between VA and DoD benefits based on their VA and military disability ratings, length of service, and other factors. In Federal Fiscal Year 2021, VA payments to regional veterans for compensation, pension, insurance, and indemnities totaled \$40.6 million. However, DoD retirement payments for 1,237 area military retirees represent an additional \$51.8 million in area income. This brings the total retirement spending attributable to military veterans in the region to approximately \$92.4 million.

Figure 1.3 Charlottesville Region Veteran Population and VA Spending, FY2010-FY2021



Source: U.S. Department of Veteran Affairs

Table 1.3 Department of Defense Military Retirement Payments

NUMBER OF RETIRED SERVICE MEMBERS					
Locality	Army	Navy	Marine Corps	Air Force	Total
Albemarle County	396	223	68	196	883
Charlottesville City	62	23	5	16	106
Greene County	132	53	12	51	248
Total	590	299	85	263	1,237

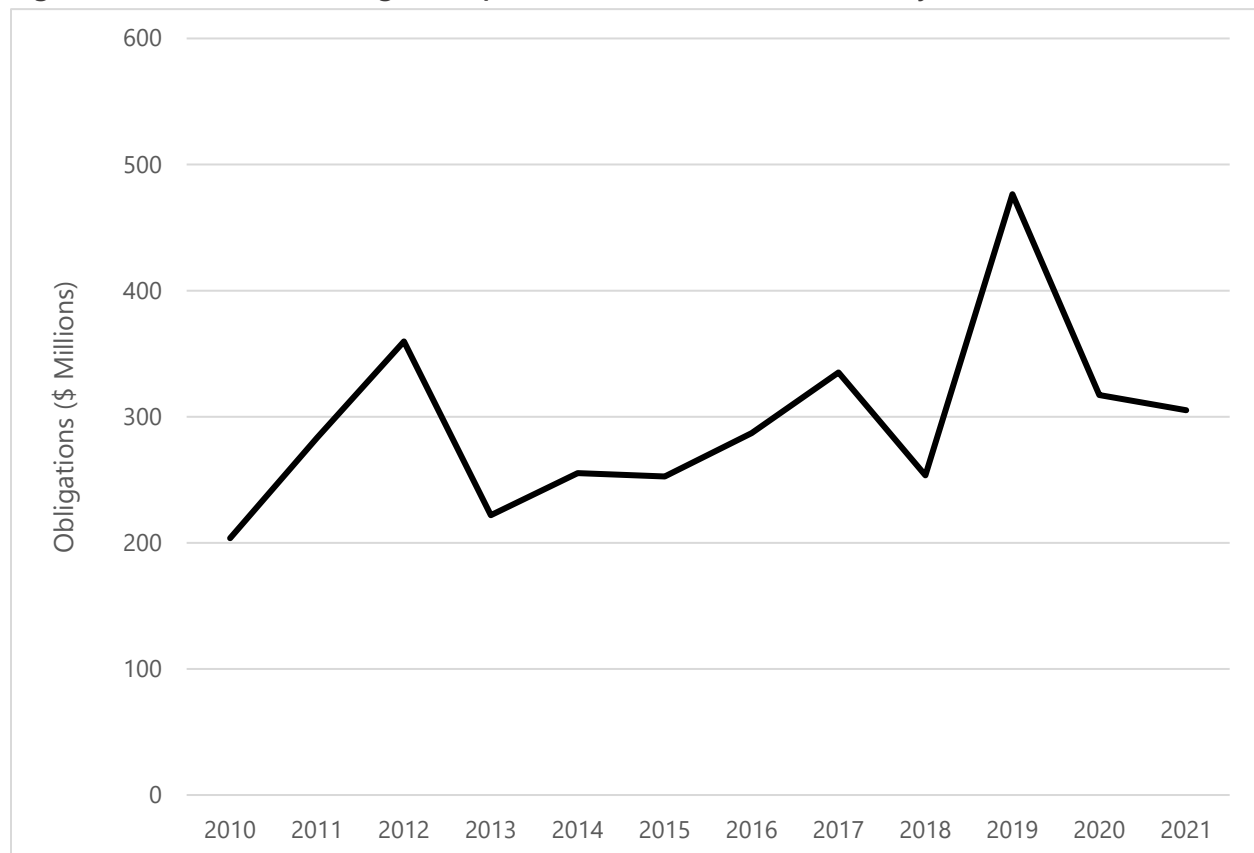
RETIREMENT PAYMENTS					
Locality	Army	Navy	Marine Corps	Air Force	Total
Albemarle County	\$17,289,683	\$9,912,577	\$2,819,713	\$8,770,045	\$38,792,018
Charlottesville City	\$2,442,113	\$1,004,093	\$173,321	\$673,803	\$4,293,330
Greene County	\$5,153,008	\$1,615,612	\$319,216	\$1,639,235	\$8,727,071
Total	\$24,884,803	\$12,532,282	\$3,312,250	\$11,083,084	\$51,812,419

Source: Department of Defense, Office of the Actuary

DEPARTMENT OF DEFENSE CONTRACTS

Outside of the three major entities, described elsewhere in this report (i.e., Rivanna Station, The Judge Advocate General’s Legal Center and School, and UVA), the Charlottesville region benefits from DoD spending via contracts awarded to local companies that provide products and services to the military. According to estimates developed by the Weldon Cooper Center, there were approximately 100 Charlottesville-based companies that received DoD procurement contracts of at least \$50,000 during the FY2012-2021 period. DoD contracts for all regional entities averaged \$295 million in the 2010-2021 period and were approximately \$300 million in FY2021. Of this total, \$198.7 million went to approximately 70 businesses and organizations, and the remaining \$62 million for construction of the Rivanna Station Secure Operations and Administration Facility.

Figure 1.4 Charlottesville Region Department of Defense Contracts by Fiscal Year



Source: USAspending.gov

Many of these companies would qualify as small businesses. However, others, such as Northrop Grumman (NG), are part of major defense conglomerates. In terms of direct employment, Northrop Grumman is the largest single entity, employing approximately 480 workers, 360 professional staff with college degrees, and 120 skilled laborers in engineering and manufacturing (See Figure 1.1(c)). Their research, engineering, and manufacturing location at Seminole Trail is awarded \$100-\$200 million in new contract awards each year. Approximately

70 percent of NG's total contractual activity is derived from the DoD (i.e., Navy). An additional 20 percent of activity is connected to Homeland Security (i.e., the Coast Guard), and the remaining 10 percent are contracts with international clients.

SBIR/STTR Awards

One relatively small area of DoD contract activity, but important from the vantage point of regional innovation and entrepreneurship, are awards to small businesses through DoD Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR). SBIR/STTR are competitive grant programs coordinated by the Small Business Administration designed to encourage small business R&D that has potential for commercialization. STTR awards are distinguished from SBIR awards by requiring a small business to partner with a nonprofit research organization, such as a higher education institution. The DoD funds projects through the program that contribute to critical technology development as part of an overall research and development road map.⁵

The Charlottesville region hosts 18 businesses that received 81 SBIR/STTR grants over the FY 2012-FY2021 period (see **Appendix A**). One company, Barron Associates, Inc., accounted for slightly over 40 percent of the awards and total amount awarded. Several of these businesses received funding in FY2021 and are represented in public spending data as DoD contracts rather than financial assistance (e.g., grants).

UNIVERSITY OF VIRGINIA

DoD spending affects the University of Virginia through several different channels: 1) DoD contracts and sponsored research grants, 2) tuition assistance for veteran students provided by the GI Bill, 3) Reserve Officer Training Corps (ROTC) programs at UVA, 4) household income of students who are active-duty military, and 5) the generation of university startups resulting from DoD-sponsored research.

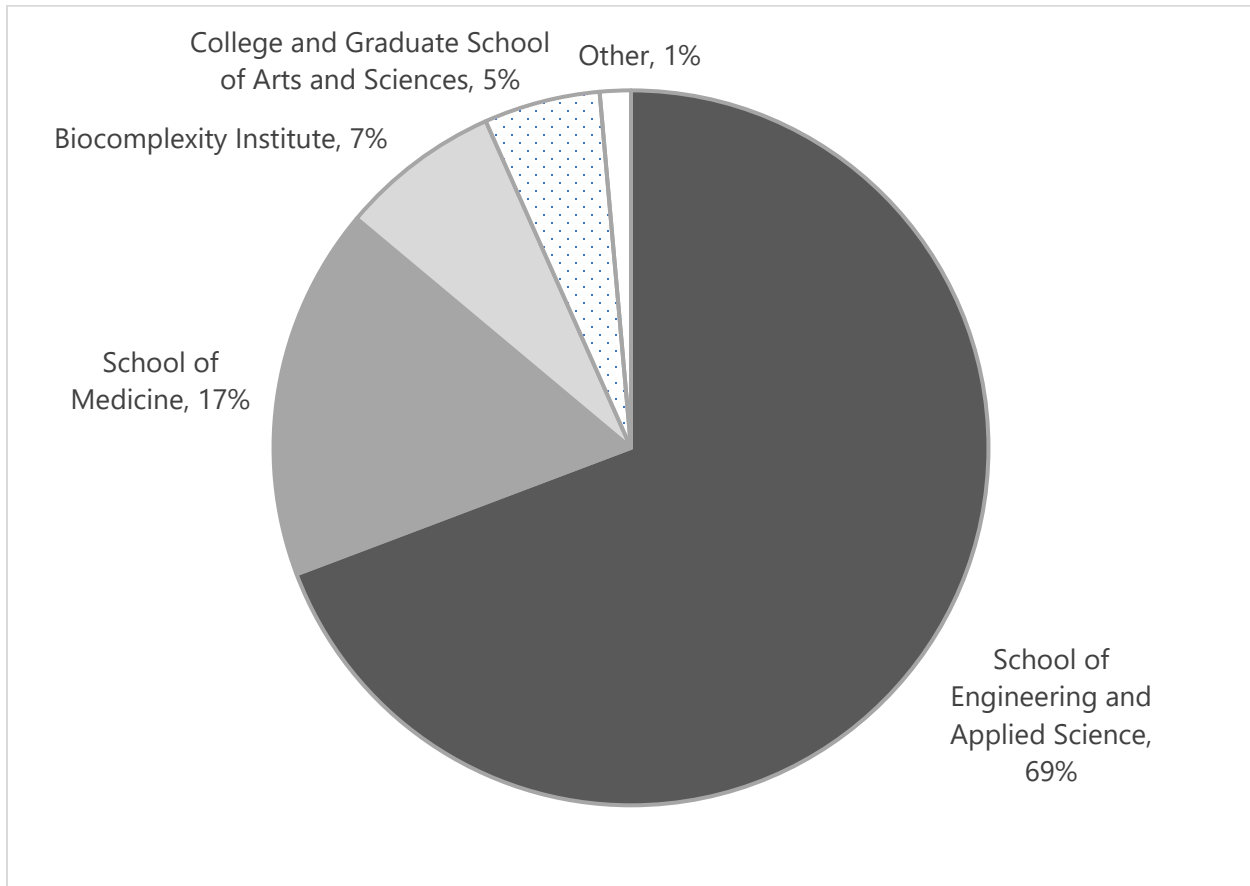
Contracts and Grants

The University of Virginia received an estimated \$35.7 million in FY2021 in defense contracts and grants. This total does not include tuition assistance funding for ROTC programs (covered below). Federal contracts, in order of contractual value, were the following: 1) R&D services (e.g., a subcontract from Applied Research Associates, Inc. for the Defense Threat Reduction Agency at Ft. Belvoir for data processing, analysis, and modeling and simulation related to biological agent and infectious disease threats), 2) education and training services (e.g., Darden School training coursework for military leaders on Strategic Thinking), and 3) tuition and fees for DoD personnel.

The School and Department of issuance was not available from the federal procurement data. However, sponsored research funding data available from the University of Virginia's Office of the Vice President for Research provide a window into the beneficiaries of DoD funding. For research contracts in which the DoD was the original sponsor, over 66 percent of the awards

went to the School of Engineering and Applied Sciences (see Figure 1.1(d) and **Figure 1.5**), 17 percent to the School of Medicine, 7 percent to the Biocomplexity Institute, 5 percent to the College and Graduate School of Arts and Sciences, and the remaining one percent to other schools.

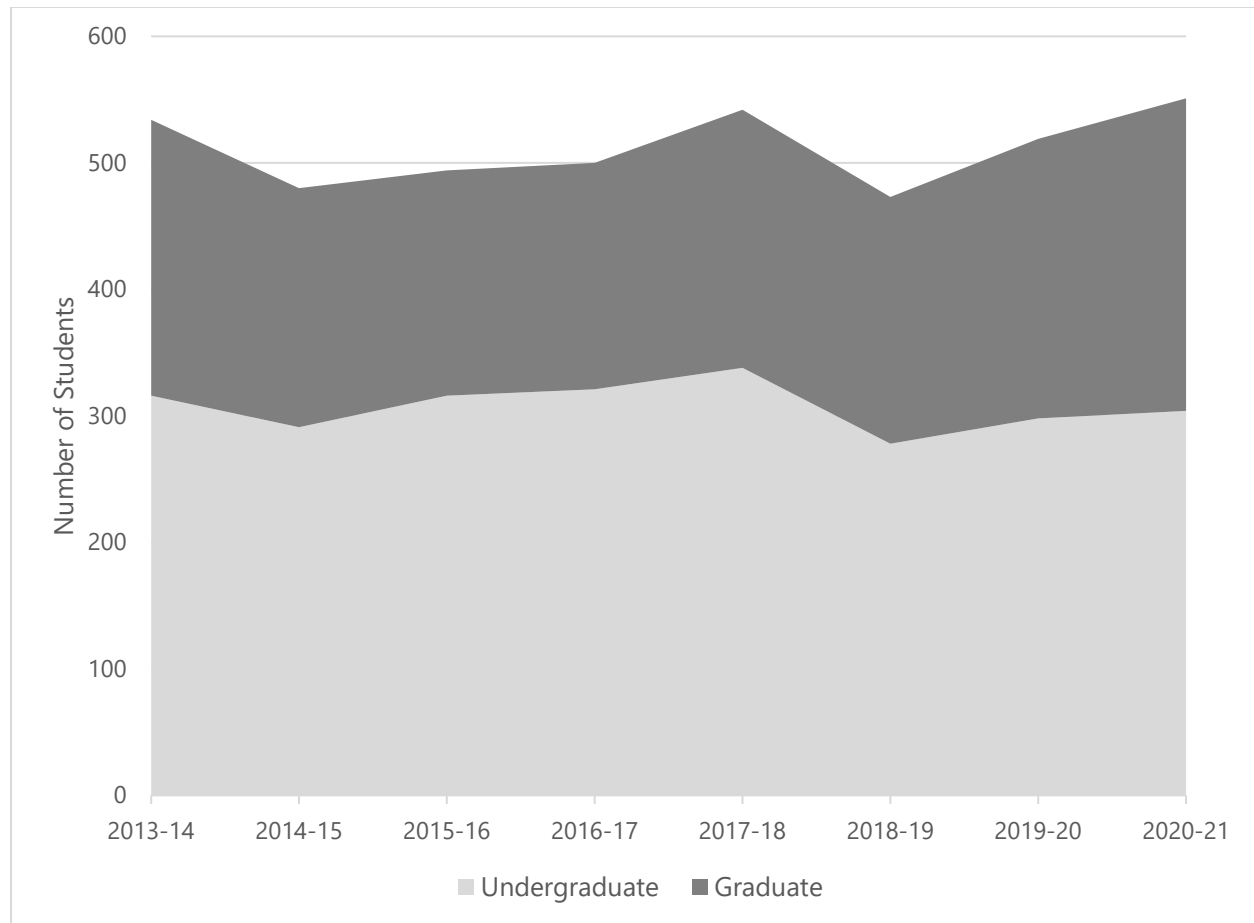
Figure 1.5 University of Virginia Department of Defense Awards by School, FY2021



Source: University of Virginia, Office of the Vice President for Research, ResearchUVA (Juice); awards having Department of Defense as original sponsor (based on total award amount of \$32.6 million).

Veteran Students (GI Bill)

Several hundred veterans attend UVA with financial assistance from the GI Bill. The GI Bill is a long-standing educational assistance program created after World War II to reward military members for their service and ease their transition into the civilian economy. The benefit, which can also be used by military spouses and children, has been re-authorized on several occasions to improve military recruitment and retention (Dortch 2021). The most recent legislation was the post-9/11 GI Bill, which went into effect in 2009 and provides benefits to veterans and service members who served at least 90 days on active duty on or after 9/11. Financial assistance may be used for tuition, fees, housing, books and supplies, and other educational expenses. During the 2020-21 Academic Year, a total of 551 UVA students (304 undergraduate students and 247 graduate students) received GI Bill funds totaling \$16.6 million.

Figure 1.6 University of Virginia GI Bill Enrollment

Source: National Center of Education Statistics (NCES) Integrated Post-Secondary Education Data System (IPEDS) and University of Virginia

ROTC Programs

The University of Virginia offers three ROTC programs: Army, Naval, and Air Force. ROTC provides college and university students officer training opportunities and merit-based scholarships to cover tuition and fees, assistance with books and supplies, and a living stipend (Kamarck 2021). The students, referred to as “cadets,” enroll in an undergraduate degree program while also undertaking training to become commissioned military officers. Students who accept scholarships incur a service obligation. ROTC operations, personnel, and cadet financial assistance are funded through federal military expenditures.

UVA’s ROTC history is long. The university’s Naval ROTC program, established in 1940, was the nation’s 10th. The Army ROTC detachment was created in 1948. During the 2020-21 academic year, UVA’s ROTC programs enrolled 167 cadets on scholarships who received financial assistance totaling \$4.7 million. This was higher than an average of approximately 136 students enrolled during the previous 9-year period. The programs employed 24 staff in total.

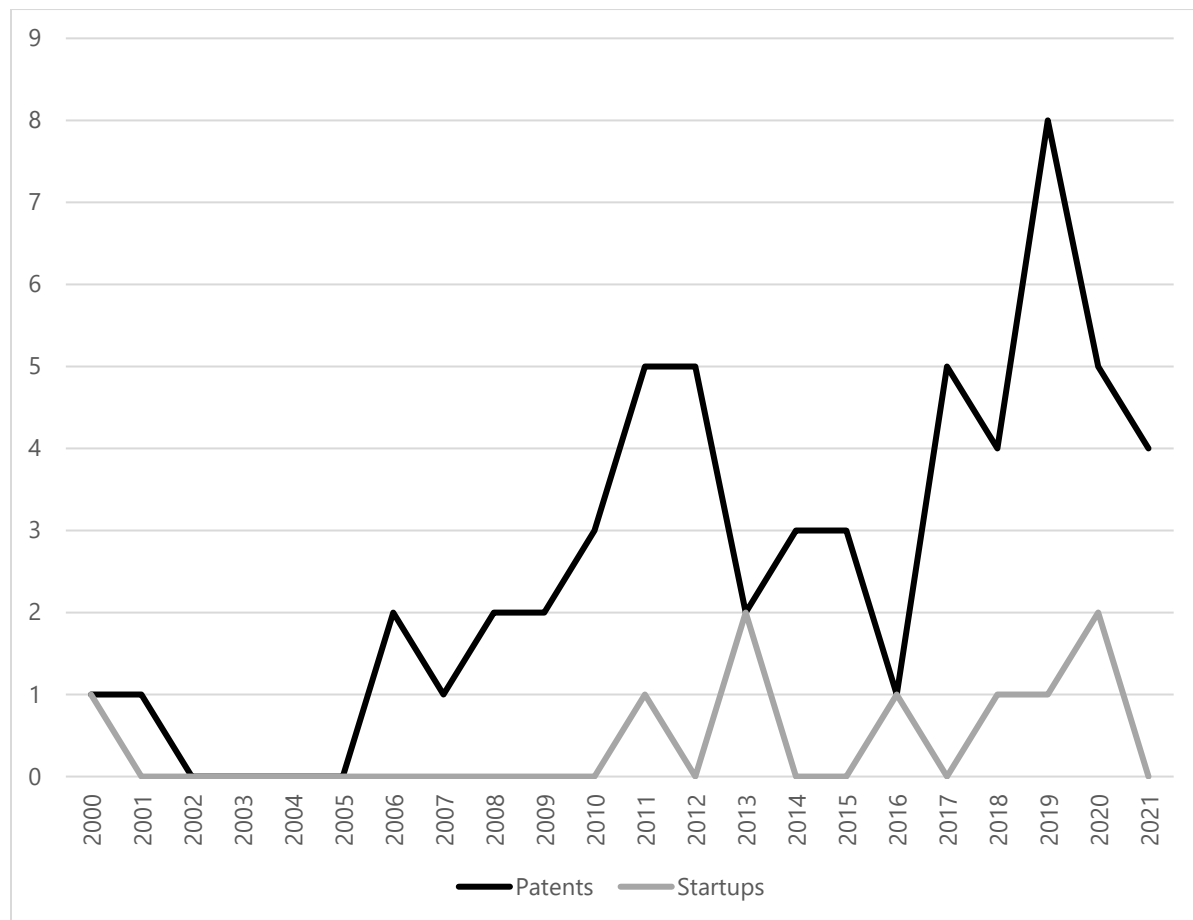
Active-Duty Military University Students

According to records from the University of Virginia's Registrar's Office, UVA enrolled approximately 200 active-duty military members during the 2020-21 academic year. Of these students, 127 students were enrolled full-time on Grounds, most of them in graduate and professional programs. The DoD pays the tuition for these active-duty students who also receive their full military salary. Their UVA assignment is considered a PCS (permanent change of station) move so that families may accompany them. These students were estimated to account for at least \$9.6 million in additional household income for the Charlottesville region.

University Startups

DoD-funded research grants have been important in facilitating the creation of intellectual property (IP) in the form of patents and licenses. In addition, several local startup businesses were established with licensed IP that resulted from DoD sponsored research (see **Figure 1.7**).⁶ Over the first decade of this century (2000-2009), approximately one UVA patent per year could be attributed to DoD funding. This ratcheted up to an average of three during the next decade. In addition, over the 2000-2021 period, eight startups based on licensed IP and funded by DoD (and sometimes jointly by other agencies and private foundations) were created. Seven of these startups are currently located in the Charlottesville region (see **Appendix B**).⁷ The startups employed an estimated 64 people in the Charlottesville region in 2021.

Figure 1.7 University of Virginia Department of Defense Sponsored Patents and Startups by Year



Source: University of Virginia Licensing and Ventures Group

RESERVES AND NATIONAL GUARD

Reserve members can be called to active duty in the military in the event of war, national emergency, community disasters, or another exigency (Kapp 2021). Virginia National Guard members are under the authority of the Governor and often respond to disasters, civil disturbances, and other regional emergencies. However, they can also be called into national military service. Reserve and National Guard members drill for two days per month and also engage in 15 days of additional annual training. However, if called up to active duty, activated members receive full compensation depending on the type and length of duty.

The Charlottesville Region hosts several Reserve and Virginia National Guard units. Two Charlottesville-based Virginia National Guard Companies are stationed at the National Guard Armory located at 165 Peregrory Lane in Charlottesville. They include (a) Charlottesville-based Alpha Company, 3rd Battalion, 116th Infantry Regiment and (b) Charlottesville-based Charlie Company, 429th Brigade Support Battalion. Four Army Reserve Units are based at the TSG Frank D. Peregrory United States Army Reserve Center located at 1634 Cherry Avenue in Charlottesville

(see Figure 1.1(e)). They include (a) 151 Judge Advocate General Legal Operations Detachment, (b) 2 Battalion, 317 Regiment Detachment 1, (c) 2300 U.S. Army Military Intelligence Group, and (d) U.S. Army Reserve Careers Group. In addition, residents often serve in reserve and guard units elsewhere in the state and sometimes outside of Virginia. According to DoD statistics, the region hosts 119 Reserve and 152 Virginia National Guard members.

OTHER SOURCES

Three additional sources that contribute to DoD's regional economic impact (not reflected in the other categories) include 1) employment at local military recruitment centers, 2) GI Bill tuition assistance for students enrolled at Piedmont Virginia Community College (PVCC), and 3) financial assistance (e.g., grants) to local private firms and non-profit organizations. The Charlottesville Region hosts military recruitment stations for the Army, Navy, and Marines at adjacent offices located at the Albemarle County Square shopping plaza. These offices collectively employ 14 Armed Forces members. PVCC enrolled 91 veterans who received \$241,209 of GI Bill student tuition assistance during the 2020-21 academic year. Lastly, one area private business and two non-profit organizations received grants from the DoD that totaled approximately \$1 million during FY2021.

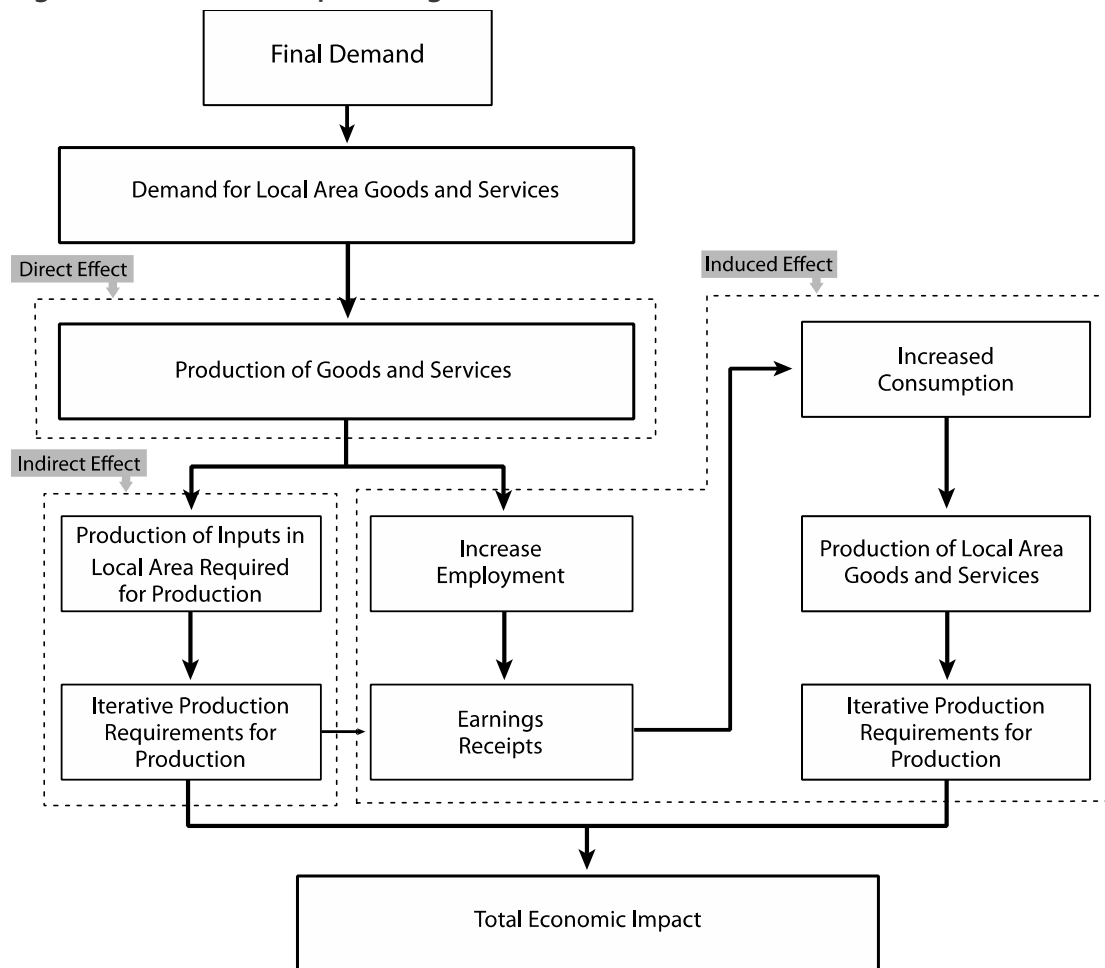
SECTION 2

MEASURING DEFENSE INDUSTRY ECONOMIC IMPACT

This study uses input-output analysis to gauge the defense industry's economic contribution to the region. Input-output analysis produces industry economic multipliers that show how changes in employment or expenditures affect a regional economy. Defense industry expenditures made in the region are counted as direct injections into the local economies. All the expenditures from the Department of Defense (DoD) and Veteran Administration (VA) budgets accounted for in this study originate from outside the community. Linkages with other industries in the area means this initial injection has further stimulative effects that result from the purchases of goods and services and payments to employees. The stimulus causes a "multiplier effect" that results when money is re-spent in the local economy.

The total impact of this activity consists of three parts: a "direct effect," "an indirect effect," and an "induced effect" (see **Figure 2.1**). The "direct effect" refers primarily to the economic impact of DoD funded firms and organizations in the region. The "indirect effect" refers to the economic impact that results when these entities purchase goods and services in the region. The indirect effect measures the cumulative change as a result of DoD-funded firms and organizations purchasing goods and services within the region as well as the subsequent rounds of firm goods and service purchases needed to supply other local producer. For example, Northrop Grumman may purchase janitorial and waste collection services from Charlottesville area businesses, which causes a "ripple effect" on the local economy when money is re-spent by these businesses on equipment, supplies, business services, and other goods and services from local businesses. These businesses spend a portion of their sales revenues on their supplies and services from other local firms which, in turn, purchase a portion of their supplies and services from other local firms. This cascading sequence of spending continues until the subsequent rounds of spending dissipate due to leakages as a result of saving or spending outside the area. The sum of these cascading rounds of inter-industry purchases constitutes the "indirect effect." The final component of total impact (the "induced effect" or "induced impact") is attributable to worker household, veteran household, and active-duty student household income and spending. For instance, businesses in the supply chain pay workers from local households for their labor. These households then purchase goods and services from area firms who, in turn, receive a portion of their labor, material, and service inputs from within the region. Again, leakages occur at each round due to purchases of goods and services outside the state. The "induced effect" is the sum of the industry impacts associated with these household purchases.

Figure 2.1 Economic Impact Diagram



IMPLAN (Impact analysis for PLANning) is used for the input-output economic impact analysis part of this study. It is an industry standard input-output model that has been used in many economic impact studies, including state and regional studies of the defense industry and individual military installations (Harpel and Romitti 2021; Virginia Secretary of Veterans and Defense Affairs 2020; Nathalie P. Voorhees Center 2012).⁸

The first stage of estimating economic impact was to obtain information on defense-related spending, household income, and employment in the Charlottesville region. The next stage involved mapping these inputs onto appropriate IMPLAN sectors using multi-regional input-output (MRIO) analysis with IMPLAN Online software (release 6.9). The third stage involved running the IMPLAN model and generating the economic impact and local government revenue results.

Results are presented for four different economic measures (employment, labor income, value-added, and output) and one fiscal measure (local government revenue) in 2021. Employment is measured in terms of person-years of employment. A person-year of employment is a job of

one year in duration. Employment includes full-time and part-time employment as well as the self-employed and is measured by place of work. Total sales or industry output, which is the total value of industry production during a period, measures sales of intermediate inputs for use in production as well as sales of products to final consumers. Value-added is a subset of total industrial output and is the most commonly used measure of economic activity. It reflects only sales to final consumers and therefore avoids the double counting that occurs when intermediate inputs are included. Value-added is the concept behind gross domestic product (GDP) and can be compared to the GDP numbers provided by the Bureau of Economic Analysis for states, metropolitan areas, and counties. It can also be represented as total factor income plus taxes on production and imports. Labor income represents the component of value-added that flows to workers and business owners in the form of employee compensation and proprietary income. Local government revenues include taxes, fees and fines, and charges for service.⁹

The study area is the Charlottesville region, which is defined as the area encompassing the City of Charlottesville, Albemarle County, and Greene County in Virginia.

For purposes of this study, the “defense industry” includes (a) the defense, military, intelligence, cyber, and security agencies (i.e., DoD, Department of the Army, Department of the Navy, Department of the Air Force, Department of the Marine Corps, and Department of the Space Force), (b) private sector companies and nonprofits engaged in contract, grants, or other work for or on behalf of these federal entities, and (c) military veterans. The regional defense industry is understood to encompass the entities and components introduced in the previous section, including: (a) Rivanna Station (NGIC, DIA, and NGA), (b) The US Army Judge Advocate General’s Legal Center and School, (c) Veterans, (d) the University of Virginia, (e) Defense contracts made with other private businesses and non-profit organizations in the region, (f) Virginia National Guard and Reserves, and (g) a residual category referred to as “Other sources” consisting of spending and employment not included elsewhere (i.e., military recruitment activities, PVCC GI Bill tuition, and DoD grants to private businesses and non-profit organizations).¹⁰ The method for assembling the input data for these components is described in further detail in **Appendix C**. The manner in which these data inputs were mapped onto IMPLAN events are described in **Appendix D**.

SECTION 3

CHARLOTTESVILLE REGION DEFENSE INDUSTRY ECONOMIC IMPACT

This section reports the results of the economic impact analysis of the defense industry for the Charlottesville region in 2021. It reports on each of the economic metrics (employment, labor income, value-added, output, and local government revenue) described in the previous section by type of economic impact (direct, indirect, induced, and total). Next, economic impacts are disaggregated by major component described previously. Finally, the economic impacts are disaggregated by major (2-digit) North American Industrial Classification System (NAICS) industry. It also reports the statewide economic impacts of local Department of Defense (DoD) activity. Finally, a regional economic impact analysis of the ongoing Rivanna Station Nicholson Building Addition and Parking Deck construction project is presented separately.

The total economic impact of the defense industry in the region is summarized in **Table 3.1**. It shows that the defense industry directly accounts for 3,972 jobs, \$421 million in labor income, \$501 million in value-added, and \$642 million in output. When indirect and induced impacts stemming from this activity are accounted for, the total economic impact is 7,347 jobs, \$618 million in labor income, \$831 million in value-added, and \$1.2 billion in output. For reference purposes, the Charlottesville region economy had an estimated 123,994 jobs, \$8.3 billion in labor income, \$13.5 billion in value added, and \$21.5 billion in output in 2021.¹¹ Therefore, the defense industry represents 5.9 percent of Charlottesville region employment, 7.5 percent of labor income, 6.2 percent of value-added, and 5.7 percent of output.

Table 3.1 Charlottesville Region Defense Industry Economic Impacts

	EMPLOYMENT	LABOR INCOME	VALUE ADDED	OUTPUT
Direct	3,972	\$420,785,710	\$501,005,934	\$642,650,090
Indirect	1,353	\$93,263,966	\$127,231,903	\$249,579,577
Induced	1,994	\$104,024,709	\$203,048,535	\$326,022,800
Total	7,347	\$618,074,385	\$831,286,372	\$1,218,252,468

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Table 3.2 and **Figure 3.1** show a breakdown of the regional economic impacts into individual components. It shows that Rivanna Station is the largest single component, accounting for approximately half of the total regional employment impact related to the defense industry. Rivanna Station organizations directly employ approximately 2,100 civilian and military personnel. Its total regional economic impact is 3,790 jobs, \$395 million in labor income, \$513 million in value-added, and \$643 million in output. Next in order is DoD contracts for military equipment and services with businesses, such as Northrop Grumman and over 70 other area

businesses, representing 18 percent of the total employment impact (Northrup Grumman accounting for slightly over half of this contract spending employment impact). The total economic impact of DoD contracting is 1,307 jobs, \$101 million labor in income, \$139 million in value added, and \$278 million in output.

The University of Virginia is the third largest economic impact component. Its regional economic impact is 946 jobs, \$57 million in labor income, \$74 million in value-added, and \$131 million in output. The employment economic impact represents 14 percent of the total defense industry regional employment impact. **Table 3.3** provides a breakdown of UVA DoD impacts into its constituent elements, including contracts and grants, ROTC, GI Bill tuition assistance, active-duty military income, and university startups. Contracts and grants account for 320 university jobs (i.e., direct employment) and approximately half of the total 946 jobs impact. It also generates a total regional economic impact of \$27 million in labor income, \$34 million in value-added, and \$62 million in output. The next largest category is GI bill tuition, which represents 23 percent of the DoD university regional economic impact, and accounts for 148 university jobs and a total regional employment impact of \$13 million in labor income, \$16 million in value-added, and \$29 million in output. UVA startups directly employ an estimated 64 workers, which has a total economic impact of 117 jobs, \$8 million in labor income, \$11 million in value-added, and \$20 million in output. The total employment impact accounts for 12 percent of the DoD university regional employment impact. The final two elements, ROTC and active-duty military income, make up the residual 15 percent of total DoD university regional economic impact.

After UVA, veterans and the Judge Advocate General's School and Legal Center had the fourth and fifth largest economic impact respectively. Veteran spending accounts for 8 percent of the total defense spending regional employment impact. It produces a total regional economic impact of 553 jobs, \$52 million in labor income, \$57 million in value added, and \$90 million in output. The Judge Advocate General's School and Legal Center accounts for 6 percent of the total defense industry regional impact. It directly employs approximately 122 military and civilian staff. An additional 140 direct jobs can be attributed to student spending on housing, food, and other products in the region. The total economic impact of the JAG Legal Center and School is 431 jobs, \$22 million in labor income, \$35 million in value-added, and \$62 million in output.

The final two economic impact components of economic impact are Reserves and National Guard (4 percent of the total regional employment impact) and a miscellaneous category including military recruitment stations, PVCC GI Bill tuition, and DoD grants to the private sector (less than 1 percent). The former has a total economic impact of 289 jobs, \$8 million in labor income, \$9 million in value-added, and \$9 million in output while the latter produces a total economic impact of 32 jobs, approximately \$3 million in labor income, \$4 million in value-added, and \$5 million in output.

Table 3.2 Charlottesville Region Defense Industry Economic Impacts by Component

RIVANNA STATION				
	Employment	Labor Income	Value Added	Output
Direct	2,111	\$291,044,193	\$349,637,466	\$350,056,040
Indirect	755	\$55,774,990	\$69,312,575	\$141,930,120
Induced	924	\$48,181,667	\$94,204,900	\$151,388,910
Total	3,790	\$395,000,850	\$513,154,940	\$643,375,070

THE JUDGE ADVOCATE GENERAL'S LEGAL CENTER AND SCHOOL				
	Employment	Labor Income	Value Added	Output
Direct	262	\$13,735,507	\$19,035,890	\$32,732,346
Indirect	63	\$3,038,062	\$5,545,406	\$11,339,041
Induced	106	\$5,525,969	\$10,915,587	\$17,555,876
Total	431	\$22,299,537	\$35,496,883	\$61,627,262

DEPARTMENT OF DEFENSE CONTRACTS				
	Employment	Labor Income	Value Added	Output
Direct	671	\$62,297,243	\$76,536,144	\$172,484,295
Indirect	380	\$25,692,539	\$36,500,620	\$63,729,237
Induced	255	\$13,327,403	\$25,981,237	\$41,768,419
Total	1,307	\$101,317,184	\$139,018,000	\$277,981,951

UNIVERSITY OF VIRGINIA				
	Employment	Labor Income	Value Added	Output
Direct	599	\$40,125,043	\$40,977,986	\$70,983,024
Indirect	168	\$7,858,604	\$14,524,326	\$30,096,100
Induced	180	\$9,398,453	\$18,336,625	\$29,438,849
Total	946	\$57,382,099	\$73,838,937	\$130,517,973

SECTION 3: CHARLOTTESVILLE REGION DEFENSE INDUSTRY ECONOMIC IMPACT

VETERANS				
	Employment	Labor Income	Value Added	Output
Direct	37	\$4,744,376	\$4,744,376	\$6,612,788
Indirect	11	\$640,756	\$957,769	\$1,732,101
Induced	504	\$26,332,710	\$51,149,153	\$81,915,906
Total	553	\$31,717,842	\$56,851,298	\$90,260,796

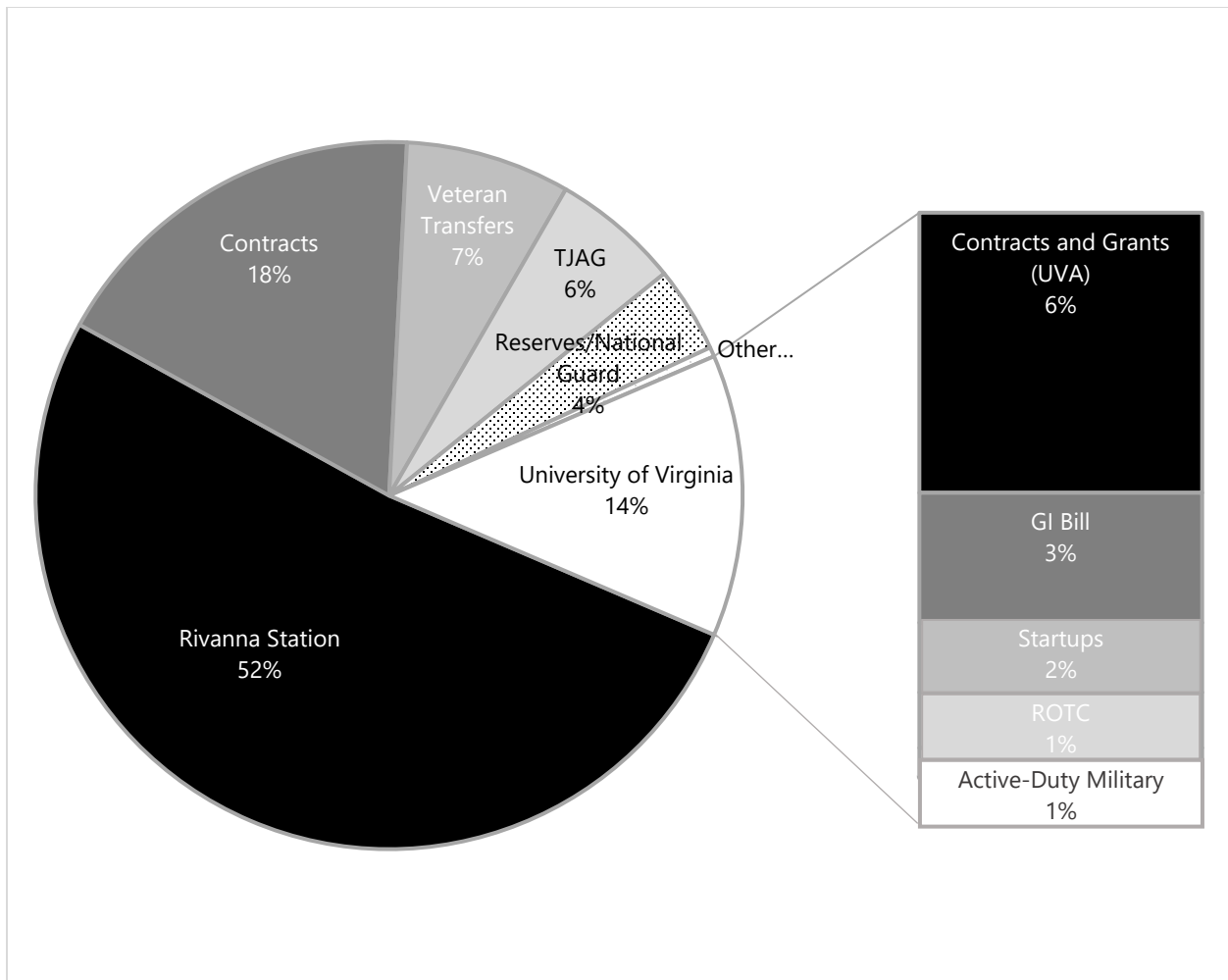
RESERVES AND NATIONAL GUARD				
	Employment	Labor Income	Value Added	Output
Direct	271	\$6,687,899	\$7,600,833	\$6,687,899
Indirect	0	\$0	\$0	\$0
Induced	18	\$921,887	\$1,803,009	\$2,897,354
Total	289	\$7,609,786	\$9,403,842	\$9,585,253

OTHER SOURCES				
	Employment	Labor Income	Value Added	Output
Direct	21	\$2,151,450	\$2,473,240	\$3,093,697
Indirect	4	\$259,016	\$391,207	\$752,978
Induced	6	\$336,620	\$658,025	\$1,057,486
Total	32	\$2,747,086	\$3,522,472	\$4,904,162

TOTAL				
	Employment	Labor Income	Value Added	Output
Direct	3,972	\$420,785,710	\$501,005,934	\$642,650,090
Indirect	1,381	\$93,263,966	\$127,231,903	\$249,579,577
Induced	1,994	\$104,024,709	\$203,048,535	\$326,022,800
Total	7,347	\$618,074,385	\$831,286,372	\$1,218,252,468

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Figure 3.1 Charlottesville Region Defense Industry Total Employment Impact by Component



Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Table 3.3 Charlottesville Region Economic Impacts by University of Virginia Source

DEPARTMENT OF DEFENSE CONTRACTS AND GRANTS				
	Employment	Labor Income	Value Added	Output
Direct	320	\$20,183,643	\$20,183,643	\$35,713,137
Indirect	85	\$3,663,598	\$7,329,846	\$15,675,151
Induced	64	\$3,327,261	\$6,504,498	\$10,453,046
Total	469	\$27,174,501	\$34,017,987	\$61,841,334

ROTC				
	Employment	Labor Income	Value Added	Output
Direct	66	\$5,219,926	\$5,653,137	\$7,278,248
Indirect	11	\$485,573	\$971,502	\$2,077,599
Induced	15	\$791,740	\$1,548,086	\$2,487,786
Total	93	\$6,497,239	\$8,172,726	\$11,843,633

GI BILL				
	Employment	Labor Income	Value Added	Output
Direct	148	\$9,360,956	\$9,360,956	\$16,563,368
Indirect	39	\$1,699,128	\$3,399,490	\$7,269,941
Induced	30	\$1,543,115	\$3,016,653	\$4,847,908
Total	217	\$12,603,199	\$15,777,098	\$28,681,217

ACTIVE-DUTY MILITARY				
	Employment	Labor Income	Value Added	Output
Direct	0	\$0	\$0	\$0
Indirect	0	\$0	\$0	\$0
Induced	51	\$2,662,777	\$5,171,222	\$8,280,932
Total	51	\$2,662,777	\$5,171,222	\$8,280,932

STARTUPS				
	Employment	Labor Income	Value Added	Output
Direct	64	\$5,360,518	\$5,780,251	\$11,428,271
Indirect	32	\$2,010,305	\$2,823,488	\$5,073,410
Induced	21	\$1,073,559	\$2,096,166	\$3,369,177
Total	117	\$8,444,383	\$10,699,905	\$19,870,858

TOTAL UNIVERSITY OF VIRGINIA				
	Employment	Labor Income	Value Added	Output
Direct	599	\$40,125,043	\$40,977,986	\$70,983,024
Indirect	168	\$7,858,604	\$14,524,326	\$30,096,100
Induced	180	\$9,398,453	\$18,336,625	\$29,438,849
Total	946	\$57,382,099	\$73,838,937	\$130,517,973

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Defense industry economic impacts vary by industry as reflected in **Table 3.4** and **Figure 3.2**, which show economic impacts by 2-digit NAICS industry. Federal government, educational services, and manufacturing were stimulated largely through the direct effects of defense spending. Government accounts for 60 percent of the direct impact, educational services for 16 percent, and professional, scientific, and technical services and manufacturing for 9 percent each. The effect of veteran and activity-duty military spending in the region and worker incomes are reflected entirely in the induced impacts and distributed among consumer-oriented industries, such as retail trade, health care, food services, and other services. The defense industry activity catalyzed significant additional activity (primarily through indirect effects) in sectors related to professional services, administrative support, waste management, and real estate and rental industries.

Table 3.4 Charlottesville Region Defense Industry Economic Impacts by Industry

EMPLOYMENT				
Sector	Direct	Indirect	Induced	Total
Ag, Forestry, Fishing and Hunting	0	5	19	25
Mining	0	0	0	0
Utilities	0	2	2	4
Construction	2	9	15	26
Manufacturing	358	4	7	369
Wholesale Trade	2	19	30	51
Retail trade	13	5	344	361
Transportation and Warehousing	30	40	65	136
Information	2	31	41	75
Finance and Insurance	0	31	167	198
Real Estate and Rental	0	205	125	330
Professional, Scientific and Technical Services	375	677	97	1,149
Management of Companies	0	93	24	116
Admin., Support, and Waste Management	4	173	79	256
Educational Services	635	4	59	698
Health Care and Social Assistance	44	0	347	391
Arts, Entertainment, and Recreation	22	9	54	85
Accommodation and Food Services	78	45	249	372
Other Services	4	18	255	278
Government Enterprises	0	8	14	22
Administrative Government	2,403	0	0	2,403
TOTAL	3,972	1,381	1,993	7,347

SECTION 3: CHARLOTTESVILLE REGION DEFENSE INDUSTRY ECONOMIC IMPACT

LABOR INCOME				
Sector	Direct	Indirect	Induced	Total
Ag, Forestry, Fishing and Hunting	\$0	\$103,794	\$172,349	\$95,846
Mining	\$0	\$50,260	\$41,539	\$25,981
Utilities	\$0	\$901,264	\$1,300,102	\$638,652
Construction	\$128,743	\$891,416	\$1,381,605	\$1,476,533
Manufacturing	\$36,071,275	\$476,001	\$881,780	\$36,651,241
Wholesale Trade	\$239,916	\$3,452,092	\$6,163,762	\$4,608,899
Retail trade	\$380,781	\$417,965	\$24,132,185	\$13,369,653
Transportation and Warehousing	\$565,445	\$2,350,028	\$3,692,444	\$6,272,683
Information	\$90,543	\$5,534,722	\$7,228,757	\$5,992,364
Finance and Insurance	\$0	\$5,465,701	\$25,264,942	\$19,479,749
Real Estate and Rental	\$0	\$18,057,069	\$62,004,005	\$8,414,974
Professional, Scientific and Technical Services	\$31,409,892	\$64,755,426	\$10,094,616	\$95,678,744
Management of Companies	\$0	\$11,044,974	\$2,851,464	\$11,345,925
Admin., Support, and Waste Management	\$250,780	\$8,551,422	\$4,238,608	\$10,773,709
Educational Services	\$42,187,102	\$211,449	\$2,384,582	\$45,036,591
Health Care and Social Assistance	\$4,964,716	\$49,335	\$24,395,904	\$28,422,995
Arts, Entertainment, and Recreation	\$500,116	\$582,321	\$2,680,199	\$2,898,027
Accommodation and Food Services	\$2,491,770	\$1,901,473	\$10,683,534	\$10,868,297
Other Services	\$144,424	\$1,202,904	\$11,406,722	\$12,271,578
Government Enterprises	\$0	\$1,232,290	\$2,049,437	\$2,391,738
Administrative Government	\$301,360,207	\$0	\$0	\$301,360,207
TOTAL	\$420,785,710	\$127,231,904	\$203,048,535	\$618,074,385

SECTION 3: CHARLOTTESVILLE REGION DEFENSE INDUSTRY ECONOMIC IMPACT

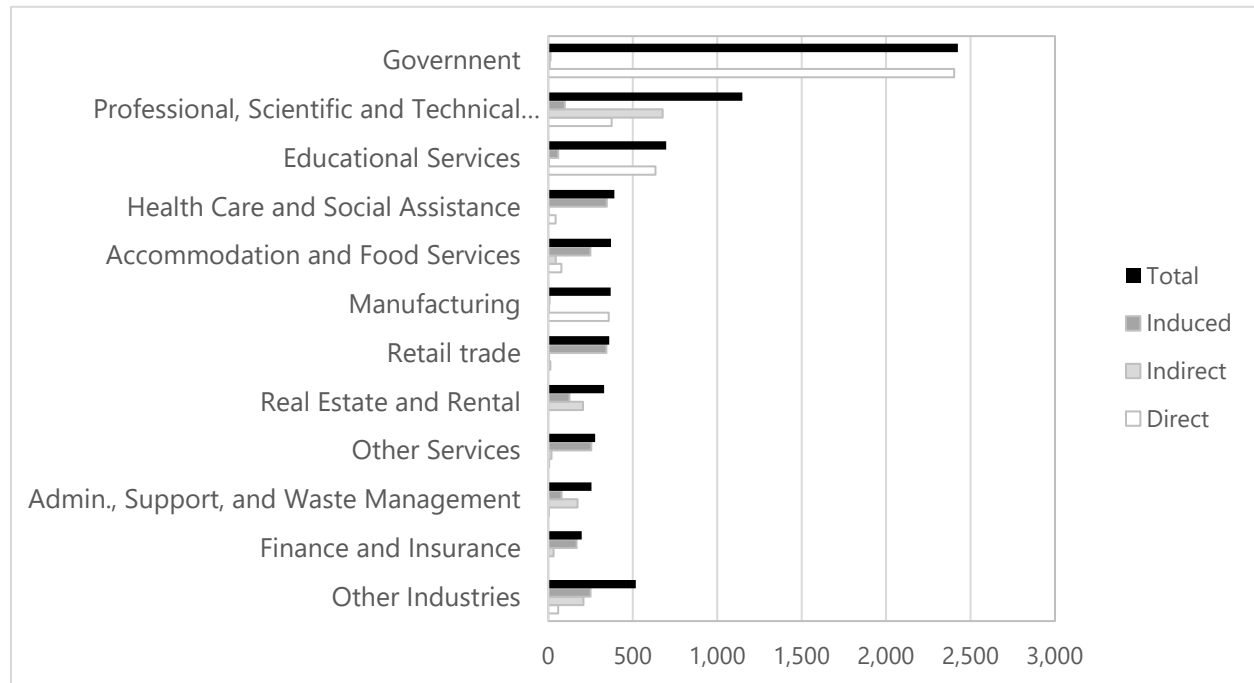
VALUE ADDED				
Sector	Direct	Indirect	Induced	Total
Ag, Forestry, Fishing and Hunting	\$0	\$103,794	\$172,349	\$276,143
Mining	\$0	\$50,260	\$41,539	\$91,799
Utilities	\$0	\$901,264	\$1,300,102	\$2,201,366
Construction	\$156,341	\$891,416	\$1,381,605	\$2,429,362
Manufacturing	\$48,241,202	\$476,001	\$881,780	\$49,598,983
Wholesale Trade	\$448,732	\$3,452,092	\$6,163,762	\$10,064,586
Retail trade	\$552,064	\$417,965	\$24,132,185	\$25,102,215
Transportation and Warehousing	\$547,922	\$2,350,028	\$3,692,444	\$6,590,394
Information	\$177,974	\$5,534,722	\$7,228,757	\$12,941,453
Finance and Insurance	\$0	\$5,465,701	\$25,264,942	\$30,730,642
Real Estate and Rental	\$0	\$18,057,069	\$62,004,005	\$80,061,073
Professional, Scientific and Technical Services	\$33,568,652	\$64,755,426	\$10,094,616	\$108,418,694
Management of Companies	\$0	\$11,044,974	\$2,851,464	\$13,896,438
Admin., Support, and Waste Management	\$351,168	\$8,551,422	\$4,238,608	\$13,141,197
Educational Services	\$45,538,760	\$211,449	\$2,384,582	\$48,134,791
Health Care and Social Assistance	\$5,047,831	\$49,335	\$24,395,904	\$29,493,070
Arts, Entertainment, and Recreation	\$697,677	\$582,321	\$2,680,199	\$3,960,197
Accommodation and Food Services	\$4,175,659	\$1,901,473	\$10,683,534	\$16,760,666
Other Services	\$190,373	\$1,202,904	\$11,406,722	\$12,799,999
Government Enterprises	\$0	\$1,232,290	\$2,049,437	\$3,281,727
Administrative Government	\$361,311,579	\$0	\$0	\$361,311,579
TOTAL	\$501,005,934	\$127,231,904	\$203,048,535	\$831,286,372

SECTION 3: CHARLOTTESVILLE REGION DEFENSE INDUSTRY ECONOMIC IMPACT

OUTPUT				
Sector	Direct	Indirect	Induced	Total
Ag, Forestry, Fishing and Hunting	\$0	\$132,719	\$280,508	\$413,227
Mining	\$0	\$102,714	\$102,572	\$205,286
Utilities	\$0	\$1,610,278	\$2,360,621	\$3,970,899
Construction	\$298,316	\$2,173,631	\$3,329,657	\$5,801,604
Manufacturing	\$124,590,088	\$1,239,006	\$2,545,533	\$128,374,627
Wholesale Trade	\$724,516	\$6,004,170	\$9,956,990	\$16,685,676
Retail trade	\$975,188	\$608,094	\$37,119,842	\$38,703,123
Transportation and Warehousing	\$1,087,431	\$3,757,172	\$6,151,074	\$10,995,677
Information	\$456,746	\$13,416,113	\$16,136,713	\$30,009,571
Finance and Insurance	\$0	\$10,464,679	\$53,485,832	\$63,950,510
Real Estate and Rental	\$0	\$41,761,482	\$84,079,734	\$125,841,215
Professional, Scientific and Technical Services	\$58,674,882	\$125,864,721	\$15,019,125	\$199,558,728
Management of Companies	\$0	\$19,190,638	\$4,954,417	\$24,145,056
Admin., Support, and Waste Management	\$735,155	\$14,967,634	\$7,527,174	\$23,229,963
Educational Services	\$79,921,979	\$388,603	\$3,716,235	\$84,026,816
Health Care and Social Assistance	\$7,025,431	\$61,274	\$34,840,161	\$41,926,866
Arts, Entertainment, and Recreation	\$1,203,828	\$732,084	\$3,883,031	\$5,818,943
Accommodation and Food Services	\$6,697,904	\$3,151,079	\$19,299,689	\$29,148,672
Other Services	\$293,193	\$1,855,411	\$17,706,945	\$19,855,549
Government Enterprises	\$0	\$2,098,074	\$3,526,950	\$5,625,024
Administrative Government	\$359,965,434	\$0	\$0	\$359,965,434
TOTAL	\$642,650,090	\$249,579,577	\$326,022,800	\$1,218,252,468

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Figure 3.2. Charlottesville Region Defense Industry Employment Impacts by Industry



Source: Weldon Cooper Center for Public Service analysis using IMPLAN

Table 3.5 provides a summary of the Charlottesville Region Defense Industry local government revenue impacts. The total revenue impact is \$18.3 million dollars. Rivanna Station accounts for 42 percent of the impact (\$7.6 million), with 22 percent (nearly \$4 million) attributed to veterans, 13 percent (\$2.4 million) to contracts, 12 percent (\$2.2 million) to the JAG Legal Center and School, and 11 percent (nearly \$2 million) to UVA.

Table 3.5 Charlottesville Region Defense Industry Local Government Revenue Impacts by Component

COMPONENT	REVENUE
Rivanna Station	\$7,641,113
Contracts	\$2,429,102
Veterans	\$3,955,984
The Judge Advocate General's Legal Center and School	\$2,207,706
Reserves and National Guard	\$147,109
University of Virginia	\$1,980,085
Other Sources	\$53,327
TOTAL	\$18,272,500

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

The regional defense industry provides a slightly larger economic impact to the state than the region. This occurs because firms within the region employ workers and secure supplies and services from elsewhere in the state. For example, some Rivanna Station workers may commute from nearby Louisa, Orange, and Madison counties where much of their household spending occurs. **Table 3.6** shows that the direct effects are exactly the same, but the indirect and induced impacts are larger. The statewide total economic impact is 8,082 jobs, \$659 million in labor income, \$907 million in value-added, and \$1.3 billion in output.

Table 3.6 Charlottesville Region Defense Industry Economic Impacts on Commonwealth of Virginia

	EMPLOYMENT	LABOR INCOME	VALUE ADDED	OUTPUT
Direct	3,972	\$420,785,710	\$501,005,934	\$642,650,090
Indirect	1,479	\$100,351,546	\$138,427,301	\$269,349,869
Induced	2,631	\$137,684,841	\$267,440,650	\$433,077,410
Total	8,082	\$658,822,097	\$906,873,885	\$1,345,077,369

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

The ongoing Rivanna Station project is another source of regional economic impact (**Table 3.7**). It will provide a temporary boost to area economic activity during the 2022-2024 period. The project is estimated to create a direct economic impact of 523 jobs, \$29 million in labor income, \$35 million in value added, and \$68 million in output. Once indirect and induced effects are accounted for, the total regional economic impact is 687 jobs, \$397 million in income, \$53 million in value-added, and \$96 million in output.

Table 3.7 Rivanna Station Capital Project Economic Impacts

	EMPLOYMENT	LABOR INCOME	VALUE ADDED	OUTPUT
Direct	523	\$29,133,539	\$35,378,659	\$67,506,380
Indirect	68	\$4,655,455	\$7,407,897	\$13,174,684
Induced	96	\$4,997,270	\$9,748,544	\$15,670,742
Total	687	\$38,786,264	\$52,535,100	\$96,351,805

Source: Weldon Cooper Center for Public Service analysis using IMPLAN

SECTION 4

OTHER SOCIAL AND ECONOMIC CONTRIBUTIONS

This section examines the contribution of the defense industry to the local community in other areas such as quality of life. Some scholarly research suggests that the defense industry benefits its community through improved safety, greater volunteerism, and better social and economic distributional outcomes. The defense industry may also stimulate regional innovation that has beneficial economic spillover effects. The section provides several concrete examples of how the region's defense industry contributes to the community.

VOLUNTEERISM

Some research suggests that military members exhibit high rates of community engagement. Dolch, Wise, and Wade (2017) find that community volunteering among the U.S. Air Force personnel is much higher than civilian workers. Results of a survey at Barksdale Air Force Base and the surrounding Shreveport-Bossier community indicate that approximately 71 percent of military members volunteer, which is higher than the general community at 53 percent, and much greater than the U.S. overall at 33 percent. Military members move frequently, making it difficult to forge lasting bonds that can foster stronger levels of community engagement. Despite this, their participation in volunteer work remains high, likely because they belong to a military culture that values public service and offers networking activities that facilitate volunteer activities.

Local defense industry entities contribute to the well-being of the community through volunteerism, charitable contributions, and civic engagement. Several examples drawn from the experience of the largest agencies and firms illustrate the range and depth of activities sponsored:

Rivanna Station personnel are active in the community and “serve as leaders, board members, volunteers, coaches, and mentors to improve the quality of life in central Virginia.”¹² Rivanna station personnel support a variety of area activities, including membership and participation in the Charlottesville Region Chamber of Commerce, its committees (DAC) and activities. Staff are also active in local public school science fairs and support robotics/stem activities.

The Judge Advocate General's Legal Center and School students, faculty, and staff are involved in community service, and the School offers a 15-week course that contains a community service component.

UVA ROTC cadets are very active in the Charlottesville community. For example, the Army ROTC's Cavalier Battalion sponsors several activities each year that benefit the community and honor the contributions of military veterans.

- The Parade Rest program provides financial and social support for wounded veterans to attend sports games.

- Through annual Service Day activities, cadets volunteer with local nonprofit organizations such as Habitat for Humanity and Ronald McDonald House.
- The Battalion also sponsors a Veteran’s Day Dinner that brings UVA students together to dine and engage with local veterans.
- Since 2014, the Battalion has sponsored an annual race, the R.J. Hess Memorial 5K, to honor a UVA ROTC program alumnus who was killed in action in Afghanistan in 2013. Proceeds from the race have been used to support college scholarships and area charitable organizations, such as the Companion Animal Fund in 2022.

QUALITY OF LIFE

In one recent wide-ranging study, Auerbach et al (2022) found that DoD spending has a positive effect on a variety of social outcomes at the local level. These effects are pronounced for less advantaged households, including those without a bachelor’s degree and Black households, and thus improve social and economic equity. Defense spending has been tied to lower rates of poverty, divorce, health insurance, disability, and mortality, and higher rates of employment, homeownership, and job satisfaction. No comparable beneficial outcomes for general federal government spending were found, mostly likely because military spending tends to pull less advantaged workers into good jobs through more equitable and inclusive employment practices.

COMMUNITY SAFETY

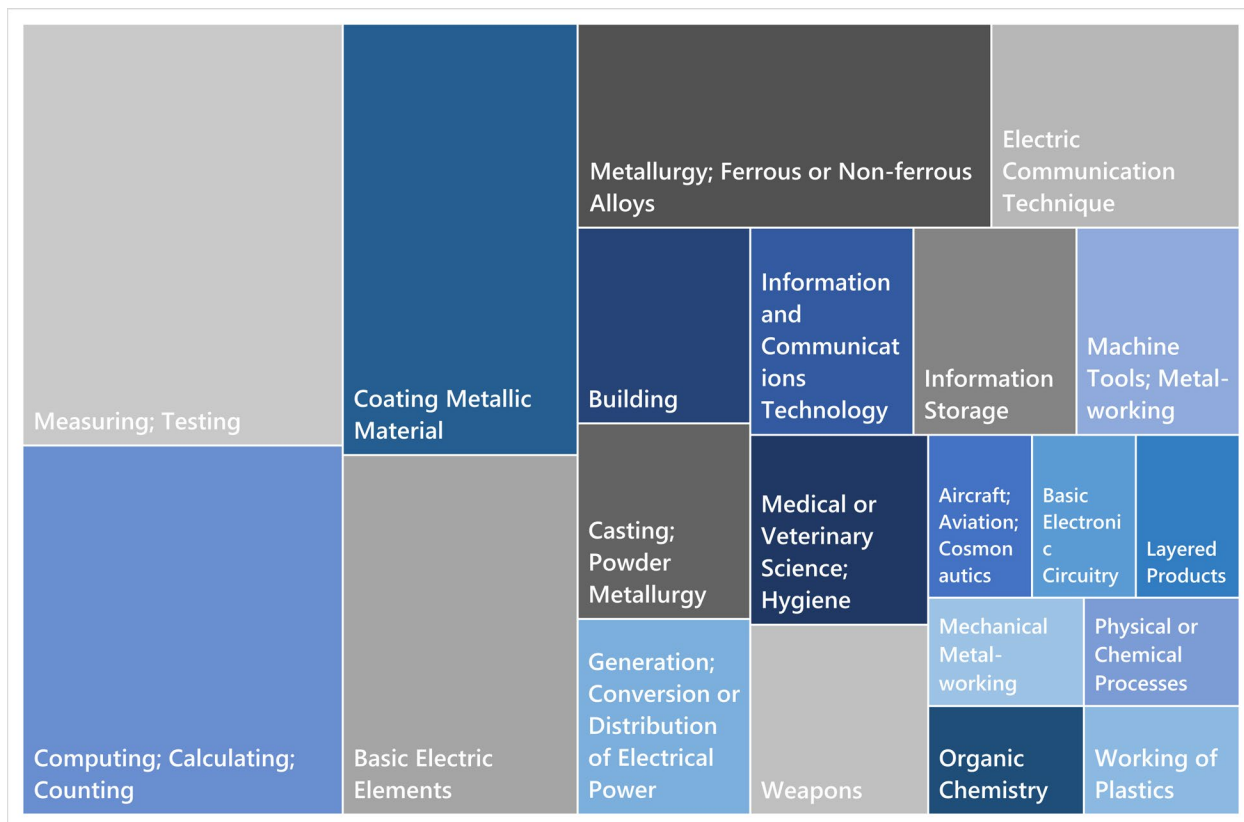
Several academic studies indicate that federal military facilities improve community perceptions of safety or decrease regional crime rates. In a study of nonmetropolitan counties, Rephann (1999) found that federal military employment is associated with lower county-level crime rates. This may be explained by the presence of “regimented, law-abiding employees, added law enforcement capabilities brought to the region by the base, and the fact that justice is meted out by military courts rather than local law enforcement authorities in cases involving military offenders.” In a study of the Polish military, survey data indicated that over half (54-57 percent) of residents in a military community believed that the presence of the military unit contributed to a greater sense of security (Sirko, Kozuba, and Piotrowska-Trybull 2019). In their study of DoD spending on local social outcomes, Auerbach et al. (2022) found that it decreased motor vehicle thefts but not overall crime.

INNOVATION

Defense industry R&D spending is responsible for some of the U.S.’s greatest technological achievements. For example, technologies that have benefited civilians, such as the Internet and Global Positioning Systems (GPS), were products of Defense Advanced Research Projects Agency (DARPA) research, sponsored as far back as the 1950s and 1960s (DARPA 2009). Patent data from the UVA Licensing and Ventures group indicates that DoD funding was used in research that resulted in 57 patents over the 2000-2021 period (See **Appendix E**). As Figure 1.7 illustrates, DoD-funded university patent activity has been on an upswing and corresponds to an

increased pace of university startups resulting from DoD-funded research. The patents issued at UVA fall into various fields of study, including biology, chemistry, and physics. However, the patents are generally for engineering and applied science products and processes in the areas of measurement and measuring devices, information technology, metallurgy and materials, and electronics.

Figure 4.1. Cooperative Patent Classification of UVA Department of Defense Sponsored Patents



Source: University of Virginia Licensing and Ventures Group and Google Patents

DoD spending may also help foster innovation by cultivating university business-industry partnerships. For example, Libaers (2009) found that DoD-funded academics engage in more industry interaction than academics receiving funding from other sources. However, this interaction is partly due to disciplinary effects and is stronger in universities (such as UVA) that have established university research centers.

APPENDIX A. REGIONAL SBIR/STTR GRANTS

Table A.1 Charlottesville Region Companies Receiving SBIR/STTR Grants, FY2012-FY2021

COMPANY	AWARDED AMOUNT	# OF AWARDS	ADDRESS	URL
Axon Connected, LLC	\$24,984	1	379 Reas Ford Road Ste 1, Earlysville, VA 22936	http://axonconnected.com/
Babylon Micro-farms, Inc.	\$49,898	1	700 Harris St Ste 107, Charlottesville, VA 22903	https://babylonmicrofarms.com/
Barron Associates, Inc.	\$12,924,845	29	1410 Sachem Place Ste 202, Charlottesville, VA 22901	https://www.barron-associates.com/
BrightSpec, Inc. **	\$1,997,953	2	770 Harris Street Unit #104B, Charlottesville, VA 22903	http://brightspec.com
Cellular Materials International, Inc.*	\$1,138,941	2	1200 Five Springs Road Ste 201, Charlottesville, VA 22902	http://www.cellularmaterials.com
Commonwealth Computer Research Inc	\$2,654,376	7	1422 Sachem Place Unit #1, Charlottesville, VA 22901	http://www.ccri.com
Directed Vapor Technologies International, Inc.*	\$3,949,898	9	2 Boars Head Lane Charlottesville, VA 22903	http://www.directedvapor.com
Dominion Microprobes, Inc. *	\$149,923	1	1027 Stonewood Drive, Charlottesville, VA 22911	https://www.dmpi.co/
Eiden Systems Corporation	\$49,850	1	1001 Research Park Blvd Ste 410, Charlottesville, VA 22911	https://www.eidensys.com/
Elder Research, Inc	\$50,000	1	300 West Main Street Ste 301, Charlottesville, VA 22903	http://www.elderresearch.com
Everactive, Inc.*	\$2,765,233	3	313 2nd Street S.E. Ste 207, Charlottesville, VA 22902	http://www.psikick.com
Hemosonics**	\$1,649,693	3	400 Preston Avenue Ste 250, Charlottesville, VA 22903	http://www.hemosonics.com

APPENDIX A. REGIONAL SBIR/STTR GRANTS

COMPANY	AWARDED AMOUNT	# OF AWARDS	ADDRESS	URL
MC Technologies, LLC	\$149,999	1	1163 River Chase Ridge, Charlottesville, VA 22901	CLOSED
Mikro Systems, Inc.	\$899,692	2	1180 Seminole Trail Ste 220, Charlottesville, VA 22901	http://www.mikrosystems.com
Mission Secure, Inc.**	\$2,131,863	3	300 Preston Avenue Ste 500, Charlottesville, VA 22902	http://www.missionsecure.com
Spire Innovations, LLC	\$399,892	2	2350 Commonwealth Dr. Ste B, Charlottesville, VA 22901	http://www.spire-innovations.com
Synaptic Security, Inc.	\$49,997	1	529 Rookwood Place, Charlottesville, VA 22903	https://www.valicyber.com/
Xdot Engineering and Analysis, PLLC	\$899,733	2	705 Dale Avenue, Charlottesville, VA 22903	http://www.XdotEA.com

Source: Small Business Administration, Small Business Innovative Research Program Award Data (<https://www.sbir.gov/>)

*=UVA startup that received DoD sponsored funding; **=Other UVA startups

APPENDIX B. UNIVERSITY OF VIRGINIA STARTUPS

Table B.1 University Startups Based on Department of Defense Sponsored Research, 2000-2021

LICENSEE	YEAR FOUNDED	FUNDING	PRODUCT DESCRIPTION	ADDRESS	WEBSITE URL
Directed Vapor Technologies	2000	DOD	Advanced coatings and coating deposition systems. Company technology allows manufacturers to apply high performance coatings to complex shapes, with or without a clear line of sight.	2 Boar's Head Lane, Charlottesville, VA 22903	https://directedvapor.com/
Cellular Materials International	2011	DOD	Periodic Cellular Materials (PCMs). The materials reduce the weight and increase the structural performance in products.	1201 Five Springs Road, Charlottesville, VA 22902	http://www.cellularmaterials.net/
Dominion Microprobes	2013	DOD; NSF	Millimeter and sub-millimeter wavelength on-wafer ground-signal ground probes and associated components for electrical measurement of devices and materials.	1027 Stonewood Drive, Charlottesville, VA 22911	https://www.dmpi.co/
Everactive	2013	DOD; NSF; Coulter Foundation	Batteryless, self-powered Internet of Things (IoT) industrial sensing products.	921 2nd Street SE, Charlottesville, Virginia 22902	https://everactive.com/

APPENDIX B. UNIVERSITY OF VIRGINIA STARTUPS

LICENSEE	YEAR FOUNDED	FUNDING	PRODUCT DESCRIPTION	ADDRESS	WEBSITE URL
MicroGEM	2016	DOD; DOJ; FBI; NIH; Ivy Foundation	Materials, diagnostic instruments and kits for the enzymatic approach to nucleic acid extraction that allow rapid sample preparation suitable for polymerase chain reaction (PCR) lab analysis.	705D Dale Ave, Charlottesville, VA 22903	https://microgembio.com/
Emergency Scientific	2020	DOD	Temporary aortic occlusion device for controlling traumatic torso hemorrhage in the field.		
Laser Thermal Analysis	2020	DOD; Center for Innovative Technology	Instrument for thermal measurement of thin-film thermal conductivity utilizing optical technology.	937 2nd St SE, Charlottesville, VA 22902	https://laserthermal.com/

Source: University of Virginia, Licensing and Ventures Group (LVG)

Key: Department of Defense (DOD); National Science Foundation (NSF); Federal Bureau of Investigation (FBI); Department of Justice (DOJ); National Institute of Health (NIH).

APPENDIX C. DATA

This report relies on a dozen different public and unpublished data sources for input data in the defense industry economic impact analysis. These sources are listed in **Table C.1** with public sources identified in the references and further details for major data sources described below.

Table C.1 Data Sources Used for Economic Impact Analysis

DATA ELEMENT	SOURCE
Rivanna Station	NGIC special data request and Albemarle County Economic Development Office
The Judge Advocate General's Legal Center and School	JAG Legal Center and School special data request
Veterans Administration Military Retirement Income	Department of Veteran Affairs, Geographic Distribution of VA Expenditures (GDX)
Department of Defense Military Retirement Income	Department of Defense, Office of the Actuary special data request
VA Medical Clinic	Bureau of Labor Statistics, Quarterly Census of Employment and Wages
DoD Contract and Grants	USAspending.gov
GI Bill Tuition Assistance	National Center for Education Statistics (NCES) Integrated Postsecondary Educational Data System (IPEDS) (Student Financial Aid report), University of Virginia, and Piedmont Virginia Community College
UVA ROTC	UVA Army, Air Force, and Naval ROTC Programs
UVA Active-Duty Military Students	UVA Registrar's Office
UVA DoD Sponsored Startups	University of Virginia Licensing and Ventures Group
Reserves and National Guard	Department of Defense, Office of Local Defense Community Cooperation special data request
Military Recruitment Centers	Local Army, Navy, and Marines recruitment station special data request

CONTRACTS AND GRANTS

Data for estimating economic impacts of Department of Defense contracts and grants was obtained from USAspending.gov. USAspending.gov is a website that was created by the Federal Funding Accountability and Transparency Act of 2006 (FFATA) to provide greater public access to federal spending information and is maintained by the Office of Management and Budget (OMB). It contains a publicly accessible database of federal agency obligations and transactions for federal grants, contracts, loans, and other forms of finance assistance. Obligations and

transactions are categorized along two different dimensions: prime award versus sub-award and contracts versus financial assistance. Prime awards are agreements with external entities that perform the terms of an agreement. Sub-awards are, in effect, subcontracts that prime award recipients make with other parties. Contracts are used to purchase goods and services for government purposes while financial assistance is a transfer payment to serve other public purposes and include grants, loans, and other forms of assistance. For the Charlottesville Region, this latter category consists mainly of research grants to the University of Virginia.

USAspending.gov also allows users to parse obligations and transactions by “place of recipient” and “place of performance.” Recipient location for multi-establishment enterprises is often the headquarters of the company rather than where the work is conducted. For example, in the recipient database, Northrop Grumman awards/transactions are assigned to Northrop Grumman’s headquarters in Falls Church, VA rather than its Charlottesville Seminole Trail manufacturing facility. Place of performance was created to allow users to identify the location where the spending occurs. It identifies where the project or program funded by the contract or financial assistance is carried out. For manufacturing industries, it would be where the product is manufactured; for trade industries the location from where the product was kept in inventory; and for services, where the work was performed.

USAspending.gov represents a huge leap forward in federal government budget data transparency and accessibility for use in state and local economic impact analysis. However, it is important to recognize some of its limitations (Teefy 2021). First, U.S. Government Accountability Office (GAO) audits of USAspending.gov indicate that data quality issues have been a persistent problem with platform data though performance has gradually improved since its initiation. The GAO (2020) reports that DoD records have lower average completeness and accuracy than most other federal agencies. Second, place of performance can sometimes not always align with the concept of “place of work” used in economic impact analysis for several reasons. This can occur because place of performance is not always known. When this happens, agencies will substitute the location of the recipient. It can also happen when service contracts identify the location of the ultimate beneficiary of the contract rather than where the bulk of the project was carried out. For example, Architectural and Engineering services can be assigned to the project site rather than the establishment office location where the design occurs. Third, North American Industrial Classification Codes in USAspending.gov appear to be closely related to product codes and not always align with the exact nature of the business entity. For example, procurement contract through wholesale and retail vendors are often identified as manufacturing industries based on the products received. Thus, reliance on the provided NAICS codes will tend to overestimate impacts because: (a) wholesale and retail obligation and transaction amounts are reported in purchaser prices (i.e., prices paid by the federal government) rather than producer prices (i.e., expenditure received by the producer for goods and services sold). However, it is only the wholesale or retail margin that is received by these businesses; (b) wholesale and retail trade industry multipliers are generally lower than manufacturing industries. Lastly, USAspending.gov provides contract and public assistance start and ending dates and transaction dates. However, the period when the spending occurs must be inferred from these fields. After experimenting with linear interpolation and transactions

dates, the latter were found to provide more representative numbers and result in a smoother expenditure pattern suitable for economic impact analysis.

In obtaining data for economic impact analysis, transactions for federal fiscal year 2021 were obtained by place of performance. Both prime transactions and sub-awardee transactions were used. However, in order to avoid double-counting of expenditures, several efforts were made to cull redundant records, including the following: (a) removal of subawards/transactions made for prime awards/transactions in the region, (b) removal of UVA ROTC contract funding, (c) removal of contract funding for Rivanna Station entities associated with federal funding office codes for United States Army Intelligence and Security Command (INSCOM), NGIC, DIA, NGA, and The JAG Legal Center and School. Nonduplicative contract and grant spending was divided into three components: (a) general contract spending with primarily local businesses, (b) contract and grant spending with the University of Virginia, and (c) grant spending with other private businesses and non-profit organizations.

UNIVERSITY OF VIRGINIA

The economic impact of DoD spending associated with the University of Virginia was divided into several different categories: (a) contracts and research grant spending, (b) Department of Veteran Affairs GI Bill tuition assistance, (c) ROTC program operations employment and payroll and student tuition assistance and living stipends, (d) household income associated with active-duty military members enrolled full-time, and (e) university startup employment that could be connected to DoD sponsored research. The largest category was research contracts and grant assistance. Research contracts identified in USAspending.gov amounted to \$24.8 million and included items such as tuition and fees, special coursework, and contract research. Research grants (prime financial assistance and subcontracts) summed to \$11 million. GI Bill tuition assistance figures for veteran students enrolled at UVA were obtained from the National Center for Education Statistics (NCES), Integrated Postsecondary Educational Data System (IPEDS) Student Financial Aid report with assistance from the University of Virginia Institutional Research and Analytics (IRA). ROTC spending was obtained from the individual UVA ROTC programs (i.e., Army, Naval, and Air Force). The programs provided data on tuition assistance and student stipends, staff payroll, and other office-related spending (i.e., services and supplies). Information on the number of active-duty military was obtained from the UVA Registrar's Office. The total number of active-duty military enrolled at UVA across several programs during the 2020-21 academic year was approximately 200. However, since some of the students taking credit coursework may not have taken individual courses or may have been enrolled in Distance Learning coursework, only full-time 2020-21 academic year students estimated at 127 service members were counted as those most likely to be living in the community. The tuition payments for active-duty military were not estimated since they were likely already included in USAspending contract data. In order to estimate the contribution of household spending associated with the students, an assumption was made based on information from the DAC that the average student was a Senior Captain (Pay Grade O-3) with five years of service. Thus, the average base pay (based on a January FY2021 monthly pay table) was \$75,732. This salary was

multiplied by 127 to obtain the additional household income present in the community due to these students. The last component consists of UVA startups. The list of UVA startups that benefited from DoD research contracts during the time in which their intellectual property was obtained from the UVA Licensing and Ventures Group. Using online business directories and other data sources, the number of employees was estimated for each startup, which summed to 64 total employees.

VETERAN RETIREMENT BENEFITS

Spending by military veterans attributable to DoD and VA retirement payments are counted as injections of spending into the local economy. The VA counts veteran benefits for those who qualify under the VA disablement rules. This information was obtained from the U.S. Department of Veteran Affairs report Data on Geographic distribution of VA expenditures (GDX) FY 2021. Two categories of benefit were counted: VA compensation and pension, and insurance and indemnities. The former consists of VA pension payments. The latter category includes “VA expenditures for death claims, matured endowments, dividends, cash surrender payments, total disability income provision payments, and total and permanent disability benefits payments.”

The GDX report also contains data on VA medical care expenditures and education and vocational rehabilitation/employment. Medical care expenditures include funds assigned by place of residence, including VA medical care and Choice Act Funds. It also contains medical and prosthetic research. Using Choice Act Funds and under selected other circumstances, eligible veterans can utilize their benefit with local non-VA providers. However, this is the exception rather than the rule. While veterans with other forms of public (e.g., Medicare and Medicaid) or private health insurance may elect to use local health care services, this spending is not accounted for in the economic impact analysis. Veterans receiving VA care can receive it from an integrated network consisting of numerous VA hospitals, health care centers, and community-based outpatient clinics (CBOCs) (Panangala and Sussman 2019). Since the vast majority of VA medical services are likely provided outside the region, only services offered at the local VA COBC, the Hunter Holmes McGuire VA Medical Center, on Pantops in close proximity to Martha Jefferson Hospital, is accounted for. According to 2021 BLS QCEW data, the facility (represented by one federal government owned establishment in the region for NAICS 6211 (Offices of physicians)) employed 37 workers with an average annual pay of \$105,643.

Education and Vocational Rehabilitation/Employment spending includes GI Bill (tuition assistance program for veterans), Transition Assistance Program (TAP) (higher education tuition assistance funds for soon-to-be retiring active-duty military) as well as funds for vocational rehabilitation and adaptive equipment. However, the study accounts for GI Bill funds that are funneled through local educational institutions elsewhere instead using information from NCES IPEDS reports. Because of the large size of higher education in the region, GI Bill spending for UVA and PVCC students is significantly larger than the total amount of VA educational and vocational rehabilitation funds provided to resident veterans.

RIVANNA STATION

Information on Rivanna Station operations was obtained from National Ground Intelligence Center public affairs office, the Albemarle County Economic Development Office and other sources. Rivanna Station organizations collectively directly employ a total of approximately 2,100 federal civilian and federal military workers. In addition, there were approximately 400 contract workers located on-site and elsewhere in the region during the federal fiscal year. These contract employment numbers can fluctuate widely from year to year depending on military intelligence needs based on external threats.¹³ Rivanna Station also receives approximately 10,000 visitors from outside the region. To tabulate the economic impact of visitations, information from NGIC on the number of day-trip (80 percent) and overnight visitors (20 percent) from outside the region was combined with information from the Virginia Tourism Corporation on average Virginia business travel expenditures per visitor (\$74 per diem) by type of spending to estimate total local expenditures by major category of expenditure.¹⁴ Lastly, capital improvement expenditures for the Secure Operations and Administration Facility (SOAF) Addition was obtained from USAspending.gov. Only construction expenditures were counted. Architectural services are sourced from a firm from outside the region. Also, future furniture and equipment to furnish the facility will be imported as well. In order to avoid double-counting, expenditures attributable to Rivanna Station agencies were removed from transactions data sourced from USAspending.gov in computing regional contract spending.

THE JUDGE ADVOCATE LEGAL CENTER AND SCHOOL

Information on The Judge Advocate General's Legal Center and School was obtained from The JAG Legal Center and School. The information included the number of employees, payroll, student headcounts by program, and estimated student income/spending. The JAG School presented the number of students by major program area, including both long-courses as well as short-courses. Since some students are housed in apartments leased at the JAG School, these estimated expenditures were backed out of the student spending to avoid double-counting. The School offers 81 apartments for rent during studies, but this lodging can accommodate only a fraction of its students. Officers enrolled in longer term coursework such as the Graduate School typically rent private apartments in the region, while shorter coursework students typically use area hotels. In order to avoid double-counting of USAspending contract spending, expenditures attributable to the JAG Legal Center and School were removed from the contracts data.

RESERVES AND NATIONAL GUARD

Data on area Reserves and National Guard employment and payroll was obtained from a Department of Defense, Office of Local Defense Community Cooperation (OLDCC) special data request based on FY2021. The Office publishes an annual report (*Defense Spending by State*) that includes defense manpower data for states and the ten largest defense spending localities in each state. Since Charlottesville region localities do not rank in the top ten for Virginia, the Office was contacted to provide a similar report for the localities in the region.

OTHER

Data for three otherwise uncategorized smaller economic impact sources were obtained from different sources. First, information on local military recruitment office employment (Army, Navy, Marines) was obtained from the individual recruitment stations. Second, information on GI Bill financial assistance for Piedmont Virginia Community College students was obtained from National Center for Education, Integrated Postsecondary Educational Data System (IPEDS) Financial Aid report data provided by the PVCC Office of Institutional Research, Planning, and Institutional Effectiveness. Finally, Department of Defense grants to one private business and two non-profit organizations during FY 2021 were included in this total.

APPENDIX D. IMPLAN METHODOLOGY

The study used multi-regional input-output (MRIO) analysis to estimate the Charlottesville region and state and economic and local government revenue impacts of defense-related spending in the Charlottesville region. The analysis was conducted using IMPLAN Online version 6.9 software release on October 20, 2022. MRIO analysis measures the economic impacts of spending within the principal study region as well as impacts on other areas that are linked with the principal study area. Because of these linkages, spending leakages into other regions cause economic impacts that cause leakages from those areas back into the principal study region. Two regional models representing the (a) the three locality Charlottesville region and (b) a residual region constituting the 130 other state localities were linked. Charlottesville region economic impacts were obtained from the Charlottesville regional model, while state impacts were obtained by summing the results of the Charlottesville region and Virginia regional linked models.

Data inputs that were obtained using the procedures described into Appendix C were mapped onto the relevant IMPLAN demand sectors in the manner described in in **Table D.1** below. Most component modelling was conducted by using IMPLAN Industry Employment or Industry Output modelling events. However, in several instances adjustments needed to be made to accommodate the special circumstances of public sector entities.

Both UVA and the JAG Legal Center and School are treated as public higher education institutions. There is no IMPLAN sector that fully accounts for the output of public higher education. Therefore, the IMPLAN sector that includes private colleges and universities (481- Junior colleges, colleges, universities, and professional schools) was used instead. The sector was modified via a specialized IMPLAN model type (Industry Impact Analysis) to zero out proprietor income, other property income, and taxes on production and imports to create a synthetic public college and university sector.

The same modification was required for modelling the Charlottesville Veterans Administration (VA) Medical center. IMPLAN sector 483 representing "Offices of physicians" was used. The sector was modified via a specialized IMPLAN model type (Industry Impact Analysis) to zero out proprietor income, other property income, and indirect business taxes to make the sector a synthetic public outpatient clinic sector.

Rivanna Station is a military installation which also requires special modelling.¹⁵ Employment and payroll were assigned to 545-Employment and payroll of federal government, military and 546-Employment and payroll of federal government, non-military. Military installations must procure goods and services through General Services Administration (GSA) scheduling. This competitive bidding system typically results in far fewer goods and services procured from the local region than would otherwise be the case. Therefore, only direct employment was considered with two

notable exceptions. Rivanna Station agencies also contract with a dozen private firms who employ several hundred private intelligence and information technology workers that work at the facility, the North Fork Research Park and other proximate locations. Therefore, the economic impact of these contract employees was counted. Since the typical NAICS classification of these firms is professional, scientific, and technical services, they were modelled using the industry employment event corresponding to this IMPLAN sector (464-Scientific research and development services). Rivanna Station also pays \$3.1 million for property leases each year. These were modelled as payments to IMPLAN section 447—Other real estate. Since the services and property leases were purchased inputs and should be classified as indirect impacts, they were converted from direct impacts to indirect impacts before final tabulation. Rivanna Station also has visitors associated with it. These visitors are military and federal, civilian workers based elsewhere who visit the facility for work purposes. The estimated spending of these visitors based on their origin and length of stay was assigned to IMPLAN sectors based on the proportion of the typical business traveler's budget on various retail goods and services (e.g., \$330,459 to "507-Hotels and motels") Finally, the construction of the Secure Operations and Administration Facility (SOAF) and parking garage was modelled by assigning the construction award of \$67.5 million to the IMPLAN sector 55—"Construction of new commercial structures."

TJAGLCS had a student population of 6,250 in FY2021 who stayed in the Charlottesville region for various durations. TJAGLCS student spending was accounted for by assigning the total military income of graduate program students to household income while per diem spending by other students was allocated to IMPLAN sectors using information from the Virginia Tourism Corporation on the composition of business traveler expenditures.

Both USAspending contract and UVA startup employment were identified by North American Industrial Classification System (NAICS) 6-digit codes. These NAICS codes were crosswalked to IMPLAN codes using and IMPLAN crosswalk file and aggregated by IMPLAN code.

Table D.1 IMPLAN Assignments and Values

DEFENSE COMPONENT	DATA ELEMENT	EVENT TYPE	SPECIFICATION	VALUE(S)
Rivanna Station	Operations	Industry Employment	545-Employment and payroll of federal government, military; 546-Employment and payroll of federal government, non-military	Employment=1,861 (546) and 233 (545)
	Local Contractors	Industry Employment	464-Scientific research and development services	Employment=400
	Property Lease	Industry Output	447-Other real estate	Total output=\$3,100,000
	Visitors	Industry Output	Assignment to various business traveler spending sectors	Total output=\$870,209
	Capital Improvement Project	Industry Output	55--Construction of new commercial structures	Total output=\$67,506,380
The Judge Advocate General's Legal Center and School	Operations	Industry Impact Analysis (Detailed)	481-Junior colleges, colleges, universities, and professional schools	Employment=122; Employee compensation=\$9,811,457
	Student Spending (Graduate)	Household Income	10007-Households \$100-150k	Household income=\$13,076,256
	Student Spending (Other Coursework)	Industry Output	Per diem assignment to various business traveler spending sectors	Total output=\$13,219,050
Veterans	DoD and VA Military Retirement Income	Household Income	10006-Households \$70-100k	Household income=\$92,415,419
	Charlottesville VA Medical Center	Industry Impact Analysis (Detailed)	483-Offices of physicians	Employment=37; Employee compensation=\$4,745,582
DoD Contracts	DoD Contract and Grant Assistance	Industry Output	IMPLAN sectors based on NAICS codes	Total output=\$198,734,721

APPENDIX D. IMPLAN METHODOLOGY

University of Virginia	GI Bill	Industry Impact Analysis (Detailed)	481-Junior colleges, colleges, universities, and professional schools	Total output=\$16,563,368
	ROTC--Staffing	Industry Employment	545-Employment and payroll of federal government, military	Employment=24; Employee compensation=\$2,544,730
	ROTC--Tuition Support	Industry Impact Analysis (Detailed)	481-Junior colleges, colleges, universities, and professional schools	Total output=\$4,733,518
	DoD Contract and Grant Assistance	Industry Impact Analysis (Detailed)	481-Junior colleges, colleges, universities, and professional schools	Total output=\$35,713,137
	Active-Duty Military Students	Household Income	10006-Households \$70-100k	Household income=\$9,617,964
	DoD Sponsored Startups	Industry Employment	IMPLAN sectors based on firm NAICS codes	Total employment=64
Reserves and Virginia National Guard	Employment and Payroll	Industry Employment	545-Employment and payroll of federal government, military; 546-Employment and payroll of federal government, non-military	Employment=271; Employee compensation=\$6,687,899
Other	Military Recruitment Centers	Industry Employment	545-Employment and payroll of federal government, military	Employment= 14
	PVCC GI Bill	Industry Impact Analysis (Detailed)	481-Junior colleges, colleges, universities, and professional schools	Total output=\$241,2099
	DoD Grants to Private Sector	Industry Output	IMPLAN sectors representing grant recipients (R&D services and foundations)	Total output=\$1,000,227

APPENDIX E. UNIVERSITY OF VIRGINIA PATENTS

Table E.1 University of Virginia Department of Defense Sponsored Patents, 2000-2021

IP NUMBER	ISSUE DATE	SPONSOR	TITLE
6060511	5/9/00	Department of Defense; ONR	Trans-Sodium Crocetininate, Methods of Making and Method of use Thereof
6245440	6/12/01	Office of Naval Research	Continuous Metal Fiber Brushes
7014889	3/21/06	Navy - Office of Naval Research	A Process and Apparatus for Plasma Activated Deposition in a Vacuum
7067020	6/27/06	Navy - Office of Naval Research	Bulk-Solidifying High Manganese Non-Ferromagnetic Amorphous Steel Alloys and Related Method of Using
7211348	5/1/07	Navy - Office of Naval Research	Multifunctional Electrochemical Energy Storage Materials
7401643	7/22/08	Navy - Office of Naval Research	Heat Exchange Foam
7424967	9/16/08	Navy - Office of Naval Research	Method for Manufacture of Truss Core Sandwich Structures and Related Structures Thereof
7517416	4/14/09	Navy - Office of Naval Research	Bulk-Solidifying High Manganese Non-Ferromagnetic Amorphous Steel Alloys and Related Method of Using and Making the Same
7517415	4/14/09	Navy - Office of Naval Research	Non-Ferromagnetic Amorphous Steel Alloys containing Large Atom Metals
7704507	4/27/10	Army/MRMC	Anticancer Vaccine and Diagnostic Methods and Reagents
7718222	5/18/10	Navy - Office of Naval Research	Apparatus and Method for Uniform Line of Sight and Non-Line of Sight Coating at High Rate
7763125	7/27/10	Navy - Office of Naval Research	Non-Ferromagnetic Amorphous Steel Alloys Containing Large-Atom Metals
7871978	1/18/11	Army/MRMC	Adhesion of Endothelial Cells
7879411	2/1/11	Navy - Office of Naval Research	Method and Apparatus for Efficient Application of Substrate Coating
7913611	3/29/11	Navy - Office of Naval Research	Blast and Ballistic Protection Systems and Methods of Making Same

APPENDIX E. UNIVERSITY OF VIRGINIA PATENTS

IP NUMBER	ISSUE DATE	SPONSOR	TITLE
7949498	5/24/11	Army/MRMC	Method, System and Computer Program Product for Registration of Multidimensional Datasets
7963085	6/21/11	Navy - Office of Naval Research	Multifunctional Periodic Cellular Solids and the Method of Making the Same
8124178	2/28/12	Navy - Office of Naval Research	Method and Apparatus for Application of Metallic Alloy Coatings
8176635	5/15/12	Navy - Office of Naval Research	Manufacture of Lattice Truss Structures from Monolithic Materials
8211436	7/3/12	Army/MRMC	Anticancer Vaccine and Diagnostic Methods and Reagents
8247333	8/21/12	Navy - Office of Naval Research	Multifunctional Periodic Cellular Solids and the Method of Making Thereof
8313588	11/20/12	Navy - Office of Naval Research	Amorphous Magnetic Alloys, Associated Articles and Methods
8360361	1/29/13	Navy - Office of Naval Research	Method and Apparatus for Jet Blast Deflection
8426568	4/23/13	Army/MRMC	Rhamnose Substituents of SL0101 and Therapeutic Uses Thereof
8650756	2/18/14	Navy - Office of Naval Research	Manufacture of Lattice Truss Structures from Monolithic Materials
8744155	6/3/14	Army/MRMC	Imaging or Communications System Utilizing Multisample Apodization and Method
8761477	6/24/14	Army/MRMC	System and Method for Adaptive Beamforming for Image Reconstruction and/or Target/Source Localization
9051630	6/9/15	Navy - Office of Naval Research	Amorphous Steel Composites with Enhanced Ductilities, Strengths, and Elastic Properties
9064321	6/23/15	Army/MRMC	Imaging or Communications System Utilizing Multisample Apodization and Method
9178518	11/3/15	Army/ARO	A Sub-Threshold FPGA and Related Circuits and Methods thereof
9366697	6/14/16	Department of Defense	Micromachined On-wafer Probes and Related Method
9555467	1/31/17	Navy - Office of Naval Research	Amorphous Steel Composites with Enhanced Ductilities, Strengths, and Elastic Properties

APPENDIX E. UNIVERSITY OF VIRGINIA PATENTS

IP NUMBER	ISSUE DATE	SPONSOR	TITLE
9635033	4/25/17	IARPA	Methods, Systems, and Computer Readable Media for Detecting Command Injection Attacks
9698685	7/4/17	Army	Methods and Apparatus for a Single Inductor Multiple Output (SIMO) DC-DC Converter Circuit
9745736	8/29/17	Army	Three-Dimensional Space Frames Assembled from Component Pieces and Methods for Making the Same
9746361	8/29/17	Navy - Office of Naval Research	Gaseous Flow Sensor and Related Method Thereof
9920530	3/20/18	Navy - Office of Naval Research	Heat-Managing Composite Structures
9921037	3/20/18	Navy - Office of Naval Research	Hybrid Periodic Cellular Material Structures, Systems, and Methods for Blast and Ballistic Protection
9989497	6/5/18	Army/MRMC	Front End Circuitry for Imaging Systems and Methods of Use
10032950	7/24/18	Army/ARO	AllInAsSb Avalanche Photodiode and Related Method thereof
10170990	1/1/19	Army	Methods and Apparatus for a Single Inductor Multiple Output (SIMO) DC-DC Converter Circuit
10193927	1/29/19	US Air Force	Method of Instruction Location Randomization (ILR) and Related System
10260143	4/16/19	Navy - Office of Naval Research	Method and Apparatus for Application of Metallic Alloy Coatings
10283363	5/7/19	National Ground Intelligence Center	Quasi-Vertical Diode with Integrated Ohmic Contact Base and Related Method Thereof
10378861	8/13/19	Army	Impulse Mitigation Systems for Media Impacts and Related Methods thereof
10382448	8/13/19	IARPA	Methods, Systems, and Computer Readable Media for Detecting Command Injection Attacks
10438700	10/8/19	Army/MRMC	Computer Simulation for Testing and Monitoring of Treatment Strategies for Stress Hyperglycemia
10482210	11/19/19	Defense Advanced Research Projects Agency	System, Method, and Computer Readable Medium for Walking Pads: Fast Power-Supply Pad-Placement Optimization

IP NUMBER	ISSUE DATE	SPONSOR	TITLE
RE47863	2/18/20	Navy - Office of Naval Research	Non-Ferromagnetic Amorphous Steel Alloys Containing Large-Atom Metals
10580481	3/3/20	Defense Advanced Research Projects Agency	Methods, Circuits, Systems, and Articles of Manufacture for State Machine Interconnect Architecture using Embedded DRAM
10664241	5/26/20	Department of Defense	Memory Systems Including Support for Transposition Operations and Related Methods and Circuits
10678505	6/9/20	Defense Advanced Research Projects Agency	Subset Encoding Method; Increasing Pattern Density for Finite Automata
10782164	9/22/20	Navy - Office of Naval Research	Flexible, Self-Rolled Superficial Flow Sensor
11042631	6/22/21	Army/ARO	System, Method and Computer Readable Medium for Software Protection via Composable Process-level Virtual Machines
11049551	6/29/21	Defense Advanced Research Projects Agency	Memory Devices Providing In Situ Computing Using Sequential Transfer of Row Buffered Data and Related Methods and Circuits
11055257	7/6/21	Department of Defense	Systems and Methods for Disjoint Character Set Report Merging
11135583	10/5/21	Office of Naval Research	Devices and methods for Extraction, Separation, and Thermocycling

Source: University of Virginia, Licensing and Ventures Group (LVG)

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ENDNOTES

¹ Some industries' production is almost entirely dedicated to domestic military use (e.g. Military Armored Vehicle, Tank, and Tank Component Manufacturing—NAICS 336992; Guided Missile and Space Vehicle Manufacturing—NAICS 336414). However, other industries (e.g., Aircraft Engine and Engine Parts Manufacturing 336412; Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instrument Manufacturing—NAICS 334511) have both civilian and military uses.

² The contract employment figures were estimated using contract spending data from USAspending.gov, output-employment ratios by sector from IMPLAN by federal fiscal year (2011-2021), and a NAICS-IMPLAN crosswalk. The estimates were smoothed using an exponential smoothing technique.

³ Military veterans are more mobile than nonveterans. Many states and communities have sought to attract them for economic development purposes by not taxing personal income or establishing exemptions for veteran income and property.

⁴ VA health benefits can be spent at the local VA COBC, VA medical facilities outside the region, or in some other circumstances other privately or publicly owned health facilities.

⁵ Funding is available in two phases. Phase I awards are for establishing technical feasibility or proof of concept of a technology and awards range from \$50,000 to \$250,000. The program is highly competitive with an average application acceptance rate of just 15 percent (Lanahan, Joshi and Johnson 2021). Phase II awards are restricted to Phase I awardees and are for scaling up Phase I efforts, conducting R&D, and commercializing the technology. Awards are typically much higher, \$750,000 for two years. The acceptance rate for the more restricted pool of applicants for this phase averages 35 percent (Lanahan, Joshi and Johnson 2021).

⁶ A startup is defined by the Association of University Technology Transfer (AUTM) as new companies that were dependent on licensing of university technology for their formation.

⁷ Two startups are located outside the Charlottesville region, including CytoRecovery (Blacksburg, VA) and BlueXThermal (Cambridge, MA). Two additional startups, not shown in Figure 1.7, were established in 2022.

⁸ The economic impact analysis is based on a two-region IMPLAN model constructed for the three-locality region and a residual region consisting of the other 130 counties and independent cities of the Commonwealth of Virginia. These models are constructed using baseline U.S. data and area-specific data for each constituent county of the corresponding regions.

⁹ Local government revenue estimates are obtained from IMPLAN for subcounty general (e.g., township government), subcounty special districts, and county. The methodology that IMPLAN uses to estimate local government revenue using IMPLAN economic impact results can be found at: <https://support.implan.com/hc/en-us/articles/115009674528-Generation-and-Interpretation-of-IMPLAN-s-Tax-Impact-Report>

¹⁰ This study does not include several elements of economic impact sometimes considered in state and regional defense and national security industry economic impact studies because of the study scope, data unavailability, or economic modelling limitations. This study does not include Department of Homeland Security (e.g., U.S. Coast Guard) or other civilian intelligence agency (e.g., Central Intelligence Agency) activity. The study also does not incorporate some defense-related spending impacts, such as defense department civilian retiree spending or military and veteran spousal or dependent incomes and spending. Since IMPLAN is a demand driven model, supply-side changes induced by the defense industry are not considered. For example, the analysis does not estimate the effects of increases in the region's labor supply due to spouses and dependents entering the area workforce.

¹¹ These percentages are based on IMPLAN estimates of employment, labor income, value-added, and output for the Charlottesville region in 2021.

¹² This is an excerpt from a Rivanna Station brochure.

¹³ Information was obtained on the number of employees and contract workers for the facility from confidential sources because publicly available employment and procurement data did not fully reflect employment and defense department contacts associated with the facility and were likely assigned to other military bases where the agencies are headquartered such as Ft. Belvoir.

¹⁴ Virginia Tourism Corporation, Business Travel Profile (based on TNS Travels America FY2016). The 2016 visitor spending data was adjusted for inflation.

¹⁵ The Rivanna Station economic impact analysis follows the IMPLAN recommended approach to measuring the economic impact of military bases (see <https://support.implan.com/hc/en-us/articles/115009542347-IMPLAN-Pro-Case-Study-Working-with-Military-Bases-Examining-Base-Closure>).