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An Analysis of U.S. Army Unmanned Ground Vehicle Strategy

by

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United States Army

United States Army War College
Class of 2012

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The U.S. Army's current portfolio of unmanned ground vehicles (UGVs) is the culmination of more than forty years of effort since the first mobile robot was developed in the late 1960's. DoD and DA have made significant progress in acquiring warfighting capabilities associated with UGVs over that time. This progress was enabled through the work of both department and partners in government, academia, and industry. It was guided by a variety of strategies from national strategic documents to science and technology master plans. This paper analyzes the existing, emergent U.S. Army UGV strategy through the use of a framework developed for analyzing business strategy and system dynamics techniques. Through this analysis, the need for a designed and deliberate Army UGV strategy is identified and recommendations for inclusion in the strategy are proposed.

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AN ANALYSIS OF U.S. ARMY UNMANNED GROUND VEHICLE STRATEGY

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ABSTRACT

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The U.S. Army's current portfolio of unmanned ground vehicles (UGVs) is the culmination of more than forty years of effort since the first mobile robot was developed in the late 1960's. DoD and DA have made significant progress in acquiring warfighting capabilities associated with UGVs over that time. This progress was enabled through the work of both departments and partners in government, academia, and industry. The work was guided by a variety of strategies from national strategic documents to science and technology master plans. This paper analyzes the existing DoD strategy and the emergent U.S. Army UGV strategy through the use of a framework developed for analyzing business strategy. Through this analysis, the need for a published, deliberate Army UGV strategy is identified and recommendations for inclusion in the strategy are proposed.

AN ANALYSIS OF U.S. ARMY UNMANNED GROUND VEHICLE STRATEGY

The U.S. Army does not have a published unmanned ground vehicle (UGV) strategy. This has been true since 1990 when the Office of the Secretary of Defense (OSD) took policy, programmatic, and resourcing control of UGV development at the direction of Congress.[1] The lack of an Army UGV strategy and the analysis associated with developing that strategy has contributed to a number of concerns regarding the Army's current UGV fleet. These problems include: a fleet with a number of models having redundant capability, a requirement to provide long term sustainment for the current UGV fleet which is the result of a number of different and disjointed acquisition strategies by a variety of Department of Defense (DoD) agencies, a need to increase and synchronize the existing capability of the current UGV fleet which does not meet service and joint requirements, and a need to determine the composition and size of the future UGV fleet as combat operations end and financial resources are reduced.

This paper will analyze whether the U.S. Army needs a UGV deliberate strategy and provides potential recommendations for that strategy should it be required. The remainder of the paper is organized as follows. The first section presents the development of the current DoD UGV strategy and its evolution from the original Tactical Warfare Program Office (TWPO) Unmanned Ground Vehicle Master Plan (UGVMP). Then, the current DoD UGV strategy is summarized and a business strategy framework for conducting the strategy analysis is introduced. This is followed by an analysis of how environmental factors affect the UGV industry and an analysis of how

the current UGV strategy links the organization to its industry environment. Following this analysis conclusions and recommendations are provided.

Background

The U.S. Army's current portfolio of unmanned ground vehicles (UGVs), a subset of a class of machines called *mobile robots* in academia,[2] is the culmination of more than forty years of effort by government organizations, commercial industry, and academic institutions. DoD funding of basic and applied research through the Defense Advanced Research Projects Agency (DARPA) resulted in the first mobile robot developed in the late 1960's.[3] The initial success of this research and a belief in the potential of these devices caused U.S. government support for unmanned ground systems to grow steadily over time and was manifested in continuous funding of UGV research by a number of organizations including: DARPA, the Department of Energy (DOE), the Department of Transportation (DOT), the National Aeronautics and Space Administration (NASA), the U.S. Army's Tank-Automotive Command (TACOM) and Army Research Laboratory (ARL), the U.S. Air Force, and the U.S. Navy's Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV).[4] Unfortunately, there were very few experimental or deployable solutions that made their way to the field over more than twenty years of work.

In 1989, Congress "became increasingly concerned about the direction and composition of the many diverse robotics projects undertaken by the armed services and defense agencies" and requested the consolidation of all UGV projects under the Office of the Secretary of Defense (OSD) for policy and program direction to bring order to an otherwise disorganized situation.[5] OSD created the Unmanned Ground Vehicle

and Systems Joint Project Office (UGV/S JPO) within the Tactical Warfare Program Office (TWPO) with authority over ongoing UGV programs. The UGV/S JPO developed the first UGV strategy, the *Unmanned Ground Vehicle Master Plan (UGVMP*), to provide a single, integrated DoD document that laid out the strategy for introducing supervised robotic vehicles into the services and planning for the development and acquisition of UGV systems. In addition, the plan described a conceptual and management framework within which robotics projects were to be pursued, provided the details of the projects, and the relationship among them.[6] This plan and those that followed were intended to coordinate the activities of Department of Defense (DoD) agencies, universities, and industry partners involved in developing UGV capability. The UGV/S JPO and its successors, most recently the Robotic Systems Joint Project Office, continued driving DoD strategy regarding UGV's, but allowed the services and DoD agencies to work the details of implementing the strategy through their science and technology development processes.

After the initiation of combat operations in Afghanistan and Iraq; DoD, the Joint Staff, Combatant Commander's, and the military services' scrambled to identify and field new capabilities to address operational capabilities gaps highlighted by the enemy's use of unanticipated weapons and tactics. The most notable of these weapons were improvised explosive devices (IEDs). Joint and Army commanders responsible for operations in the combat theatre began producing Joint Urgent Operational Needs Statements (JUONS) and Operational Needs Statements (ONS) requesting additional equipment to defeat these weapons or mitigate their impact in order to reduce soldier injuries and save soldier lives. Warfighter requests sought new capabilities in counter

IED technology; intelligence, surveillance, and reconnaissance (ISR) technology; and command and control (C2) equipment.[7] DoD organizations including the Army Rapid Equipping Force (REF), the Army EID Task Force, and its successor, the Joint Improvised Explosive Device Defeat Organization (JIEDDO), and NAVEODTECHDIV began acquisition efforts to fulfill these non-standard requests. These efforts were resourced by more than $2.5 billion dollars in Overseas Contingency Operations (OCO) funding annually and resulted in the acquisition of various pieces of equipment including over 5,000 commercial off the shelf (COTS) UGV's.[8] These JUONS/ONS generated acquisitions did not follow the Joint Capabilities Integration Development Systems (JCIDS) process and were not required to undergo a Functional Needs Analysis (FNA) nor were they analyzed to insure that their Doctrine, Organization, Training, Materiel, Leadership and education, Personnel, and Facilities (DOTMLPF) aspects were addressed and resourced.

The impact of these OCO funded, urgent acquisitions on the UGV strategy included a significant advance in research and development and system fielding, and an unanticipated increase in current and future funding requirements, associated with fleet composition and developing, training and resourcing a maintenance and upgrade capability for this non-standard equipment. The majority of these costs were paid with OCO funds augmented with Army base budget funds. In the long term, OCO funds cannot defray these requirements due to regulations governing the use of those funds and the termination of this supplemental funding at the end of combat operations. The current UGV strategy does not address this long term maintenance and life cycle funding challenge.

The Existing UGV Strategy

In 2007, the DoD published the Unmanned Systems Roadmap 2007-2032 (USR 07-32) to provide a plan for future prioritization and funding of unmanned systems development and technology and ensure an effective return on the Department's investment. To do this, the USR 07-32 highlights the most urgent mission needs supported by unmanned systems and encourages future R&D and acquisitions focus on Reconnaissance and Surveillance, Target Identification and Designation, Counter-mine Warfare, and Chemical, Biological, Radiological and Nuclear, Explosive (CBRNE) Reconnaissance. The document also stated that the 2009 version of the Roadmap would provide a single, joint-coordinated, acquisition and technology deployment strategy encompassing all the DoD's unmanned efforts, thus, reasserting control of the existing situation.[9]

The Roadmap provides a prioritized list of capability gaps to be addressed by UGVs and is both informative and confusing. The Roadmap explains that a complete list of capability gaps was generated by a DoD survey of Combatant Commands, review of Contingency Plan (CONPLAN) 7500, and lessons learned from the Global War on Terrorism (GWOT). The full list included 526 capability gaps. After analysis, the UGV priority list was consolidated and trimmed to 13 capability gaps addressable by current or potential unmanned ground systems. These ground related capability gaps were organized by level of command (Company, Brigade Combat Team, and Division) with each of the 13 gaps reprioritized based on each level. Only the first two priorities, reconnaissance and mine detection/countermeasures, hold across all three levels with the remaining capability gaps prioritized in an order unique to each level of command.[10]

This prioritization re-emphasizes the goal of prioritizing Reconnaissance and Surveillance, and Counter-mine Warfare, but does little to prioritize the remaining eleven capability gaps or the gaps not included in the abbreviated list.

Funding prioritization is address by stating that the Joint Ground Robotics Enterprise (JGRE) Senior Steering Group, composed of flag officers, provides advice on funding priorities and allocation. Joint Ground Robotics Enterprise (JGRE) is a supporting organization to the RS JPO with its mission as defined by Congress and Office of the Undersecretary of Defense for Acquisition Technology and Logistics (OUSD AT&L). No further discussion regarding the basis for funding advice is provided.[11] This brief explanation of funding procedures does little to inform stakeholders of the basis for DoD funding decisions and provides little to guide their own funding decisions.

The Unmanned Systems Integrated Roadmap FY 2009-2034 (USIR FY09-34) is the first update of USR FY07-32 with the stated purpose of proposing a feasible vision for capitalizing on unmanned systems technologies so that the Warfighter can conduct missions more effectively with less risk; while, establishing recommendations for technologies to pursue, departmental strengths and opportunities to exploit, risks and challenges to overcome, and actions that can be taken to bring to fruition whatever aspects of this proposed future vision best serves the future needs of the Warfighters; and identifying those missions that could, in the future, feasibly be performed by unmanned systems and lays out a prospective associated timeline. Finally, this Roadmap discusses unmanned systems performance characteristics expected to be

needed by the industrial base to develop the types of enabling technologies supportive of the Warfighter.[12]

USIR FY09-34's recommendations for technologies to pursue are derived from mapping current and project future unmanned system capabilities across the nine Joint Capability Areas (JCAs), mapping key performance attributes across each domain and over time to provide a sense of DoD required improvements in unmanned systems performance to provide a sense of how unmanned systems could contribute in the present and future to mission accomplishment. Based on this mapping eight goals related to unmanned systems are provided, along with performance metric for the goals and time increments for assessing progress to the goals.[13]

Of the nine JCAs, unmanned systems are seen as contributing measurably to: Battlespace Awareness, Protection, Force Application, Building Partnerships, Logistics, Command and Control, Net-Centric. Contributions by unmanned systems in Force Support and Corporate Management and Support are seen as less significant due to the types of tasks and missions within these JCAs.[14] Recommendations on technologies to pursue are based on a technologies presence within these capability maps, but no explicit recommendations are made. Likewise, no prioritization of key performance attributes is provided after the attributes are mapped and described. The goals and performance metrics associated with: unmanned systems integration, increased autonomy, expedited fielding of unmanned systems, increased interoperability, manned unmanned teaming, standardization, improved testing, and improved logistics, could be helpful in driving the UGV strategy.

Finally, USIR FY09-34 contains a modified SWOT analysis with strengths and opportunities provided for each domain and weaknesses and threats provided in one consolidated list for all domains.[15] These concise explanations of unmanned systems issues provide valuable information for unmanned systems stakeholders and have the potential to drive implementation of the roadmap vision.

The latest update to the Roadmap series of documents is the Unmanned Systems Integrated Roadmap FY 2011-2036 (USIR FY11-36). The purpose of the USIR FY11-36 is to describe a vision for the continued integration of unmanned systems into the Department of Defense (DoD) Joint force structure and to identify steps that need to be taken to affordably execute this integration.[16] As a vision document, the USR FY11-36 provides vital information to be incorporated in a UGV strategy, but may not provide an authoritative strategy covering the development, acquisition, and resourcing of UGVs. The lack of authoritative DoD or published Army UGV strategies results in the Army's UGV strategy being an emergent rather than explicitly stated strategy. This means the strategy rises from national strategic documents, congressional legislation, and DoD, Joint and service documents and the current UGV situation. Of the Joint documents that serve as a basis for the emergent strategy, the USIR FY11-36 and the Unmanned Ground Systems Roadmap published by the Robotic Systems Joint Project Office are the most relevant and influential based on the authority vested in the organizations publishing these documents.

USIR FY11-36 states that DoD's goals for unmanned systems are enhanced mission effectiveness, improved operational speed and efficiency, and affordable closure of warfighting gaps over a twenty-five year planning horizon.[17] Examples of the

capabilities required to close identified capability gaps are provided by vignettes describing notional, future scenarios in which unmanned systems would be used to develop or address a situation without placing personnel in harm's way. The capabilities required in these vignettes are interoperability across the air, land, and sea domains; autonomy, endurance, and reliability. An additional vignette illustrates the test and evaluation (T&E) capability required to mitigate risk involved in upgrading capabilities of existing and future complex and interrelated systems in a robust testing setting. This capability would validate that improvements to unmanned systems function as intended without risking mission failure.[18]

The USR FY11-36 also identifies the financial resources budgeted and programmed for unmanned systems' development, acquisition, and sustainment for the period FY11-15 in the Planning, Programming, Budgeting and Execution (PPBE) system (See Table 1).

Unmanned Funding ($ Mil)							
Fiscal Year Defense Prog		FY11	FY12	FY13	FY14	FY15	Total
Air	RDTE	1,106.72	1,255.29	1,539.58	1,440.57	1,296.25	6,638.40
	PROC	3,351.90	2,936.93	3,040.41	3,362.95	3,389.03	16,081.21
	O&M	1,596.74	1,631.38	1,469.49	1,577.65	1,825.45	8,100.71
Domain Total		6,055.36	5,823.59	6,049.48	6,381.17	6,510.72	30,820.32
Fiscal Year Defense Prog		FY11	FY12	FY13	FY14	FY15	Total
Ground	RDTE	0.00	0.00	0.00	0.00	0.00	0.00
	PROC	20.03	26.25	24.07	7.66	0.00	78.01
	O&M	207.06	233.58	237.50	241.50	245.96	1,165.60
Domain Total		227.09	259.83	261.57	249.16	245.96	1,243.61
Fiscal Year Defense Prog		FY11	FY12	FY13	FY14	FY15	Total
Maritime	RDTE	29.69	62.92	65.72	48.60	47.26	254.19
	PROC	11.93	45.45	84.85	108.35	114.33	364.90
	O&M	5.79	4.71	3.76	4.00	4.03	22.28
Domain Total		47.41	113.08	154.32	160.94	165.62	641.37
Fiscal Year Defense Prog		FY11	FY12	FY13	FY14	FY15	Total
All Unmanned	RDTE	1,136.41	1,318.21	1,605.29	1,489.16	1,343.52	6,892.59
	PROC	3,383.86	3,008.63	3,149.32	3,478.96	3,503.36	16,524.12
	O&M	1,809.59	1,869.67	1,710.75	1,823.15	2,075.44	9,288.59
Domain Total		6,329.86	6,196.50	6,465.36	6,791.27	6,922.31	32,705.30

Table 1 – FY11-15 Unmanned Systems Funding[19]

USR FY11-36's describes the security environment as complex and uncertain characterized by an accelerated rate of change in an environment populated by rising national powers, increasingly influential non-state actors, spreading weapons of mass destruction and other irregular threats, and continuing socioeconomic unrest that threatens the existing international order.[20] This description of the security environment is similar to that described in the latest version of the National Security Strategy (NSS),[21] the 2012 Defense Strategic Guidance (DSG),[22] and the National Military Strategy (NMS)[23] indicating that the vision contained in the USR FY11-36 is synchronized with national strategic thought contained in these documents.

The Roadmap goes on to describe the specific unmanned capabilities desired and challenges to attaining these capabilities. In the most basic terms, the capabilities

desired would facilitate mission accomplishment while removing the burden and potential harm to military personnel associated with “dull, dangerous or dirty” missions and tasks.[24] The formal description of the desired capabilities is contained in the Joint Capability Areas (JCAs) framework of nine Tier One JCAs. Unmanned systems were assessed as being key contributors to five of these and are listed in the table below.

Tier One JCA’s accomplished with the use of Unmanned Systems	Definition
Battlespace Awareness	The ability to understand dispositions and intentions as well as the characteristics and conditions of the operational environment that bear on national and military decision-making.
Force Application	The ability to integrate the use of maneuver and engagement in all environments to create the effects necessary to achieve mission objectives.
Protection	The ability to prevent/mitigate adverse effects of attacks on personnel (combatant/noncombatant) and physical assets of the United States, allies and friends.
Logistics	The ability to project and sustain a logistically ready joint force through the deliberate sharing of national and multi-national resources to effectively support operations, extend operational reach and provide the joint force commander the freedom f action necessary to meet mission objectives.
Building Partnerships	The ability to set the conditions for interaction with partner, competitor or adversary leaders, military forces, or relevant populations by developing and presenting information and conducting activities to affect their perceptions, will, behavior, and capabilities.

Table 2 - Tier One JCA’s accomplished with the use of Unmanned Systems[25]

Challenges to attaining the desired capabilities and the vision for unmanned systems include: affordability, interoperability, autonomy, airspace integration, communications, training, power and propulsion, and manned-unmanned teaming. Each of these challenges is treated in a similar manner within the document: an overview and goal for the challenge area is stated, followed by a functional description of the challenge, next a description of the current state of the challenge is provided, this is followed by a problem statement that provides a detailed description of the problem to

be addressed with the challenge, and a detailed list of steps for solving the challenge problem is provided in a way ahead section and the steps are displayed within a calendar for the 2011 to 2025 time frame.[26]

While this methodology provides significant detail regarding the nature of the challenges facing unmanned system development, it has shortcomings. It does not provide definitive performance metrics to be used in determining success or failure in addressing these challenges. Further, the steps to addressing the challenges arranged in a chronological order provides a kind of prioritization, but an explanation for this arrangement is lacking. A key to the effective implementation of the prescribed steps for solving the problems within the challenge area is a clear articulation of the rationale for prioritizing the steps to solving the problems.

In its role as the integrator for the Program Executive Office for Ground Combat Systems (PEO GCS) and the Marine Corps Systems Command (MARCORSYSCOM), the executive agencies for the acquisition of unmanned ground systems, the Robotics Systems Joint Project Office (RS JPO) published the 2011 Unmanned Ground Systems Roadmap (2011-2020) (2011 UGSR), the second relevant document to Army's UGV strategy development. This document is influential due to RS JPO's role as the executive agent for unmanned ground systems acquisition, but it does not address the services role as requirements generators and capability developers. The objective of the 2011 UGSR is to serve as a practical reference to assist in Warfighter requirements definition, identify relevant technology maturation and to focus Science and Technology (S&T) investment on Warfighter needs.[27] Additionally, the main goal of the 2011 UGSR is to convey the RS JPO's short- and long-term strategies. The short-term period covers

one to five years, with long-term covering beyond five years.[28] This document provides the granular short to mid-term detail of the RS JPO's UGV strategy. The RS JPO's strategy is intended to modernize the current UGV fleet by increasing functionality and reliability, promoting interoperability in terms of communication with other unmanned and manned systems and mitigating battlefield interference, and while increasing the military services' ability to support and maintain fielded systems. All of this is to be accomplished while RS JPO gains insight regarding the operational gaps the systems were fielded to address.

In order to operationalize its strategy, RS JPO has partnered with a wide range of organizations within and outside the government to leverage their expertise and address technological, acquisition, and system development issues.[29] Through these partnerships; interactions with the Joint Staff, Combatant Commands, and services, and its organic resources the RS JPO utilizes the Joint Capabilities Integration and Development System (JCIDS), the Defense Acquisition System (DAS) and the PPBE to establish required capabilities, acquire material solutions, and sustain those capabilities throughout their life cycle.[30]

Finally, the 2011 UGSR acknowledges the Army's need for a deliberate, organic unmanned systems strategy and provides some insight into its development. The Army authored and received approval for an Air, Ground, and Maritime Initial Capabilities Document (ICD) that provides a single overarching strategy for modular, interoperable, coordinating, and collaborating unmanned systems across warfighting functions which was approved in November 2009 and indicates that the service is developing an Unmanned Systems Campaign Plan.[31]

The choice of an ICD to serve a strategy document bears investigation. An ICD is a JCIDS required document intended to serve as a program initiation document when beginning development of a single material solution. It is not generally considered a strategy document and as a strategy document would only pertain to the specific material solution being initiated. In addition, this claim is not seen as sufficient to address the need for a UGV specific strategy based on language in the Senate Report on the National Defense Authorization Act for Fiscal Year 2012 (Senate Report 112–26)

> The committee understands that Army leadership is in the process of determining operational and technical requirements for ground robotics vehicles that will guide the development of a long term research, development, and acquisition strategy. The committee is looking forward to seeing this strategy by the end of 2011 and looks forward to working with the Army to ensure that its research and development investments in robotic ground vehicles will meet current and future needs.[32]

The Army may have had some difficulties in creating the requested strategy as this issue was again addressed in the Senate Report on the National Defense Authorization Act for Fiscal Year 2013 (Senate Report 112–173) "the committee expects the Army to complete and approve this UGS Campaign Plan in 2012 and to be briefed no later than December 31, 2012".[33] This language indicates that the Senate is not satisfied with the Army's emergent strategy to acquiring UGV capability and reflects their judgment that a deliberate strategy document is required. This directive from the U.S. Senate indicates that the Army will complete a deliberate UGV strategy by year's end.

Business Strategy Framework -

When discussing strategy in a military context references are often made to Sun Tzu, the ancient Chinese military general and theorist who wrote *The Art of War* circa

500 B.C.; Carl von Clausewitz, the Prussian officer and strategist who wrote *On War* in the 1800's; or perhaps Ulysses S. Grant, the U.S. Army General and 18th President of the United States. These men theorized about military grand strategy and although the acquisition of UGVs has an impact on the construct and implementation of such strategy, it is more appropriately described as DoD and DA acting to acquire a material solution to enable Joint and Army forces to gain a competitive advantage and accomplish their missions. In light of this, it may be more prudent to consult the writings of strategic thinkers in the domain of business, who address material acquisition for competitive advantage more directly.

In 1971, Kenneth R. Andrews wrote his classic book, *The Concept of Corporate Strategy*, in which he defined strategy as a match between what a company can do within the universe of what it might do. The company's internal capabilities were defined to be its strengths and weaknesses and its external environmental circumstances were considered opportunities and threats.[34] Andrew's strategy analysis framework focuses on these strengths, weaknesses, opportunities, and threats. This is referred to as "SWOT Analysis" and is taught in almost every college business program. A criticism of this approach to strategy analysis is that classifying internal factors as strengths and weaknesses and external factors as threats and opportunities is imprecise. It is possible that a given company capability can be seen as both a strength and a weakness when evaluating the firm's internal capacity. This is also true when considering a firms external environment in that a given factor can be classified as both a threat and an opportunity.[35] Whether a factor is a strength, weakness, opportunity or threat is likely determined by the strategy pursued rather than its internal or external

relationship to the firm. For example, the significant financial resources provided to the Army could be identified as a strength, if a financially conservative strategy is pursued, while the increase in the government budget deficit caused by provision of these same resources could be identified as a weakness if a financially aggressive or status quo strategy is pursued. These financial issues could also be categorized as opportunities or threats, if the resourcing process which is driven by DoD, the Office of Management and Budget (OMB) and the Congress is viewed as being external to the Army and achieving the strategy pursued requires more or less financial resources. This challenge of "SWOT" analysis makes it a less than optimal framework for conducting this analysis.

In 1980, Michael E. Porter offered another technique for analyzing business strategy in his book *Competitive Strategies: Techniques for Analyzing Industries and Competitors*.[36] This technique is based on the forces that exist in a given industry and is called the "Five Forces Model". This model is generally used to determine competiveness of an industry and the attractiveness of entering a market. The criticism of this analytical approach is that it fails to account for a firm's internal capability; instead it has a focus on a firm's competitive position within a given industry. Further, the assumptions that underlie the model: an industry consists of unrelated buyers, sellers, substitutes, and competitors that do not interact or interact minimally, and that uncertainty is low, enabling the firm to predict its rivals' behavior and choose the potential strategy correctly.[37] These criticisms make this approach unsuitable for the analysis in this paper because the Army possesses substantial internal capability with regard to UGVs, has significant interaction with its suppliers, and has partnership

agreements with other nations' armies who could be considered competitors. Finally, the environment in which the Army operates is characterized by a great deal of uncertainty. Thus, Porter's construct does not appear suitable for this entire analysis.

In 1991, Robert M. Grant in *Contemporary Strategy Analysis* proposed a tool for strategy analysis that models strategy as the link between a firm and its industry environment. The framework is based on four factors which appear to be conducive of success. These factors are simple, consistent, long term goals; profound understanding of the competitive environment; objective appraisal of resources; and effective implementation. To arrive at the figure below, the first three factors are attributed to the firm and the industry environment is defined as the firm's relationship with its customers, competitors, and suppliers. Analysis using this framework involves treating the strategy as a link between the firm and its industry environment and determining if the firm's decisions for deploying its resources within its environment and the firm's organization for implementing the strategy will satisfy its long-term goals. For a strategy to have the potential for success, it must be consistent with the firm's external environment and its internal environment.

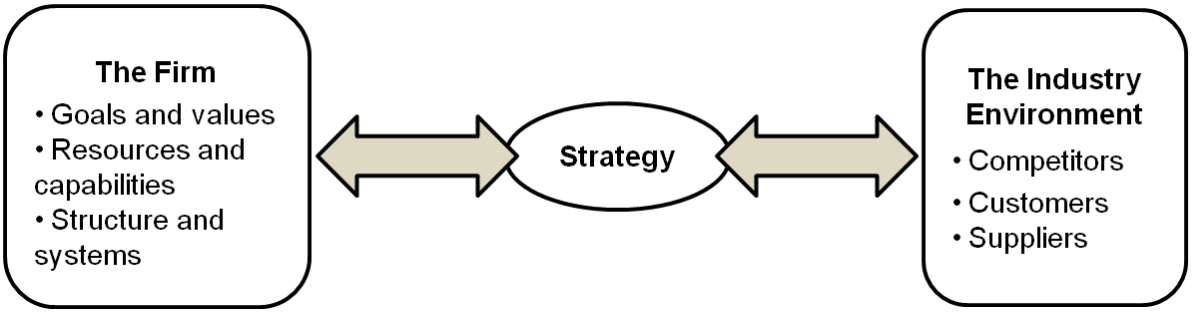

Figure 1 – Basic Strategy Framework[38]

This model facilitates the analysis of the firms internal and external environments without the shortfall identified earlier in "SWOT Analysis". This is because the criticism

of SWOT analysis, illustrated using the example of financial resources, is not present in this framework. Resources are defined as being internal to the firm rather than being characterized as a strength or weakness.

In addition to the basic strategy framework above, Grant incorporates an approach for analysis of the firm's industry environment which builds off of Political, Economic, Socio-cultural, and Technological (PEST) analysis. Grant adds the natural environment and demographic structure to the basic PEST analysis in order to address the issues related to long term sustainability of a business venture. When using a tool like PEST analysis or Grant's framework, it is appropriate to conduct the industry analysis prior to conducting the strategy analysis. This order allows one to focus the analysis on the environmental factors relevant to a firm's relationship with its customers, competitors and suppliers rather than all six possible factors.[39] This is the order which will be followed in this paper with an analysis of the environmental factors relevant to the UGV industry the Army must engage to gain the desired capability conducted prior to the strategy analysis. Following this industry analysis a strategy analysis using the Grant strategy analysis framework (Figure 1) will be provided. This strategy analysis will focus on the strategic vision contained in the in the USIR FY11-36 and 2011 UGSR.

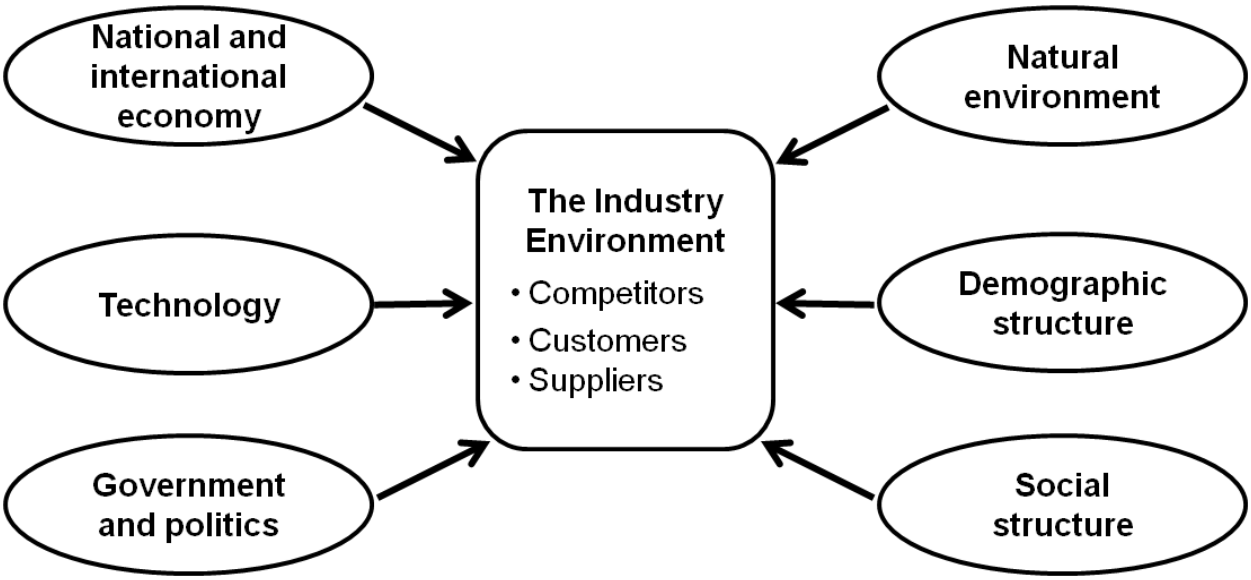

Figure 2 – Environmental to Industry Analysis Framework[40]

This Grant framework was chosen because it enables the analysis of the strategy and the industry in which the strategy will be pursued in one coherent framework and does not require additional work to overcome the criticisms of SWOT analysis and the Five Forces model.

Environmental to Industry Analysis

The industry analysis framework will be used initially to look at the how national and international economic and government and political factors influence the Army's customers, suppliers and competitors. These factors were chosen because they appear to be the factors which are currently placing the greatest demands on the current UGV strategy.

In its most recent report, the World Bank forecasts global economic growth in a range of 2.5% to 3.1% over the next two years. The bank also forecast a growth rate in the range of 1.4% and 2.1% for the world's developed economies.[41] The International

Monetary Fund (IMF) was slightly more optimistic with projections of global economic growth in a range of 3.3% and 3.9% worldwide for 2012 and 2013.[42] The IMF also projects United States economic growth to be in the range of 1.8% and 2.2%.[43] Both organizations stated that their latest projections had been revised downward from their previous projections. These downward revisions were attributed to the ongoing "Euro zone" financial crisis. The Congressional Budget Office (CBO), in the March 2012 update to its budget projections for Fiscal Years 2012 to 2022, was considerably more optimistic regarding U.S. economic growth over the same period as it projected U.S. economic growth at 3.7% for 2012 and 2.6% for 2013.[44] The CBO went on to project growth in U.S. government revenues. However, this growth in revenues is not projected to be sufficient to offset growth in government outlays and results in continued growth of the U.S. government deficit.

Should these projections come to pass, especially those related to growth in developed nations and growth of U.S. government deficits, there are a number of government and political dynamics which will have to be accounted for by the DoD UGV strategy. A decrease in the growth previously projected for the U.S. economy would cause a decrease in the growth of U.S. government revenues for 2012 and 2013 and would likely add to the increase in the U.S. national debt over that period. Increases in the national debt would increase political pressure for increased taxes to generate additional government revenue and/or spending cuts in 2013 and beyond. Should U.S. government spending be decreased, it is likely that these cuts would negatively impact the DoD and Army budgets. These impacts would be added to current and pending cuts to the DoD budget and total $900 billion (B) from the FY2011 budget position.

The currently adopted cuts announced by Secretary of Defense Robert M. Gates in January of 2011 would result in a $400B - $450B cut over twelve years. These cuts would cause the DoD baseline budget (exclusive of overseas contingency operations (OCO) funds) to grow by 1.5% during the period FY12-FY14 with zero growth in FY15 and 16.[45]

Additional pending cuts to the DoD budget are associated with the Budget Control Act of 2011 (BCA) and Joint Select Committee on Deficit Reduction's (JSCDR) inability to develop a deficit reduction plan that prevented sequestration mandated to supersede what was written in the BCA. The law allows the President to increase the debt ceiling by up to $2.8 trillion (T), while reducing the deficit by $2.3T over 10 years. To do this, $840 billion will be cut from discretionary spending over the next decade. Defense is included in the discretionary programs and the DoD share of the BCA cut is approximately $500B over ten years. Secretary of Defense Leon E. Panetta has stated that these cuts are untenable without significant changes to the National Military Strategy. In letters to Senators John McCain and Lindsey Graham the Secretary stated that the cuts associated with the BCA would result in the smallest ground force since 1940, the smallest navy since 1915, and the smallest air force in its history.[46] To achieve cuts of this magnitude DoD and the military services must have a designed strategy and plan, as existing plans are not sufficient.

It is these economic and government and political factors impact that will be analyzed in looking at the UGV industry and military robotics market. The military robotics market can be into space, air, ground, and sea related segments. The unmanned ground vehicle market has existed for at least twenty years with a focus on

explosive ordnance disposal applications.[47] Growth in the ground segment has been driven by demands for products to support combat operations in Iraq and Afghanistan as well as increases in robotic technology and capability. Over the last ten years, this growth has resulted in at least 16 different manufactures providing UGV capability to the DoD.[48] Changes in DoD demand for UGV capability have the potential to profoundly influence the market

The projected low levels of world and U.S. economic growth and decreased DoD spending resulting from budget cuts and the end of OCO funding will decrease spending in the UGV market. This reduction in potential revenue will slow the growth in the UGV industry because fewer firms will be attracted to this market. Large cuts in spending may actually drive current UGV manufactures without sustainable sources of revenue, like large government contracts or growing commercial opportunities, out of the market or cause consolidation through mergers and acquisitions as firms attempt to strengthen their market position. The end result of this activity would be fewer competitors participating in the UGV market.

This smaller number of large competitors in the market may be able to exert additional leverage over their suppliers. This is because these larger firms will reap market share abandoned by firms leaving the market. Providing products to this increased market share would require additional raw materials for manufacturing. Purchasing greater quantities of raw materials from suppliers should result in volume discounts and increased bargaining power for the surviving competitors in the UGV market over their suppliers. This increased power over suppliers should enable industry

competitors to increase or sustain their profit margins and serve to stabilize the number of competitors in the UGV industry.

The smaller, but potentially stable, number of competitors in the UGV could exert additional power over their customers if the UGV market were a normally functioning oligopoly market. This is because customers would have a reduced number of firms from which to purchase UGV capabilities due to the reduced number of firms in the market. However, DoD is not a "normal" customer in the market. There are segments in the UGV market where DoD is the only customer interested in a capability. There are also segments of the market where DoD is the dominant customer and loss of DoD as a customer could result in the failure of a firm. Furthermore, DoD funds more than 40% of the research and development (R&D) in the unmanned system industry. As a result of this funding and government contracting regulations, DoD owns the intellectual property resulting from this R&D. Should a competitor in the market attempt to extract exorbitant profits from the DoD by charge unrealistically high prices for their product, it is possible DoD could license the intellectual property to a third party and create a new competitor for the price gouging firm and stabilize prices through increased competition.

This analysis and recent history shows that the UGV industry can support the current UGV strategy. It also appears that the industry would stabilize after cuts in spending in the UGV market related to slower world and economic growth and decrease DoD spending and continue its ability to support the result UGV strategy.

Analysis of DoD and Army UGV Strategy Using the Basic Framework

In this section the DoD and Army UGV strategy is analyzed to determine whether it provides a link between a these organizations and their industry environment that is

conducive to successfully attaining UGV capabilities. This is done by examining the DoD and Army goals, competitive environment, resources, structures and systems and effectiveness in implementing the strategy to date in order to determine the strategy's potential for success based on its consistency with the firm's external environment and its internal environment.

The DoD's goals in pursuing UGVs are to increase its technological advantage over its competitors and military capability to facilitate mission accomplishment and reduce military personnel injuries and deaths while efficiently utilizing its resources.[49] The U.S. military has long pursued a technological advantage over its competitors. The author Victor Davis Hanson theorizes that American cultural norms, based on U.S. history, the desire to fight abroad, an impatience and intolerance of loss, have caused the U.S. military to seek overwhelming firepower to win quickly without incurring fatalities in his essay *Military Technology and American Culture*.[50] This theory is further bolstered by language in the current National Security Strategy which states that "To succeed, we must also ensure that America stays on the cutting edge of the science and innovation that supports our prosperity, defense, and international technological leadership".[51]

To attain a technological advantage and ensure national security the U.S. has outspent every other nation in the world every year since World War II. In 2011, the U.S accounted for 41% of world military expenditures by spending $661B on its military efforts.[52] This long-term investment and the collective experience and capability inherent in the U.S. military have made it the acknowledged preeminent leader among the world's military forces.

This information also indicates that DoD possesses the financial resources to pursue its chosen strategy. In addition to financial resources, DoD and the Army have a demonstrated capability in developing, acquiring, and employing a varied and significant number of UGVs based on their more than ten year effort to acquire their existing capability.

There are many DoD and Army structures and systems involved in acquisition of UGV capability. The systems most often cited for criticism are: JCIDS, DAS, and PPBE system. Most of the criticism of these systems is related to the systems lack of agility and inability to cope the rapidly changing situations experience by a military force in combat. If these criticisms are valid, it is likely that the systems shortcomings are related to their design and the primary purpose of each system.

The JCIDS systems was designed to support Joint Requirements Oversight Council (JROC) and Chairman of the Joint Chiefs of Staff (CJCS) responsibilities in identifying, assessing, validating, and prioritizing joint military capability requirements.[53] The JCS recognized the JCIDS in ability to provide truly rapid solution generation. This is the reason for the development of the JUONS process discussed earlier. While this makes the system more responsive in a contingency, it does not allow thorough analysis of a solution. Currently, there are a number of UGV systems navigating their way through the JCIDS process and once combat operations terminate it is likely that the remaining capabilities sought to implement the UGV strategy will be acquired through the use of this process. Engagement by the ultimate users of the capability has the potential of achieving the desired capability and expediting the process. Time lapses caused by the JCIDS process will impact equipment suppliers and have the

potential to affect DoD and Army costs and impact when military capability is available to provide security to the American public.

The DAS is the management process that guides all DoD acquisition programs to provide effective, affordable, and timely systems to the users.[54] Again, this is a deliberate process and there are examples of acquisition programs which have taken more than ten years to achieve full operational capability. The DoD recognized the criticisms of the system and in 2007 updated the system to provide for rapid acquisition of COTS, communication, and information technology equipment in an attempt to make the system more responsive. Short of large scale acquisition reform the remaining IGV capabilities will be acquired through the use of the existing DAS. The spiral development process and closer collaboration between users and suppliers allowed by recent revisions to the acquisition process may improve the time lapse from acquisition approval to full operational capability and thereby positively impact the implementation of the UGV strategy. As the DAS governs the transactions between the DoD and Army and their suppliers, any ineffectiveness in the system will negatively affect them.

The PPBE process is how the DoD allocates resources. The process is used not only to develop annual budgets, but is also used for long-term financial planning such as developing the budget figures for the additional four years included in the Future Years Defense Plan (FYDP). The future year budget figures can be treated as a ceiling not to be exceeded. This complicates the resourcing of unprogrammed requirements. This has occurred in resourcing the current UGV fleet when OCO funding was insufficient to fund all related requirements for funds. Future budget numbers are also used as a baseline from which cuts are made during financial constrained decision

making. Both unprogrammed requirements and unplanned budget reductions require prioritizing programs in order to support decision-making. The Army will fund the acquisition of UGV through its budget and should have some control over this process. The current UGV strategy does not provide any prioritization and does not define service participation in acquisition and funding decisions this situation will need to be addressed to support effective implementation of the strategy. The funds provided the Army as a result of the PPBE process will fund transaction with UGV suppliers and will impact implementation of the strategy.

Conclusions and Recommendations

DoD and DA have made significant progress in acquiring warfighting capabilities associated with unmanned ground vehicles over the last forty years. This progress has been enabled by partners in government, academia, and industry and guided by a variety of strategies. Science and technology master planning and strategy drove the development of initial capabilities through experimentation and ultimately to a very limited number of niche capabilities in the 1990's.

The strategy that brought UGV development through the science and technology phase was not capable of providing the direction needed for greater implementation and continued development of this transformational capability. DoD at the direction of Congress established an overarching strategy for unmanned systems in 2007 and has update that strategy biennially since. The strategy provides a broad vision and serves to integrate the disparate activities of the military services, but it does not account for the dynamics of the environment external to the DoD and government in general. This lack of analysis regarding industry factors leaves the strategy prone to being

overwhelmed should changes in the industry environment occur. As demonstrated in this paper, a measured change in the economy could have a negative impact on political support and governmental funding of the entire DoD budget. A cut in funding may require a reprioritization of ongoing department activities and acquisitions. The current strategy does not contain an analysis of the macro-environment and consequently provides no recommendations should significant changes to ongoing activities be required. This shortfall must be addressed.

In addition, the strategy identifies the challenges to acquiring UGV capability, but does not prioritize these challenges or suggest a method by which they could be prioritized. This lack of priorities or a method for prioritizing potentially affects ongoing, routine decision making. This lack of a method for prioritization would need to be addressed when rapid changes to the UGV program are required and a harried situation is not the time to conduct thorough and thoughtful analysis of alternatives to establish priorities.

As directed by Congress, the Army will develop and brief a UGV strategy of its own within the year. The previously identified shortcomings in the DoD strategy along with other service specific issues must be addressed in that document to demonstrate to Congress that the Army has a strategy that addresses congressional concerns and facilitates effect implementation of the strategy to gain UGV capability.

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