NPS-AM-08-132

ACQUISITION RESEARCH SPONSORED REPORT SERIES

Study of the Mine Resistant Ambush Protected (MRAP) Vehicle Program as a Model for Rapid Defense Acquisitions

03 December 2008

by

Seth T. Blakeman, MAJ, USA

Anthony R. Gibbs, MJ, USA, and

Jeyanthan Jeyasingam, MAJ, USA

Advisors: Lawrence R. Jones, Professor

Michael W. Boudreau, Senior Lecturer, and

Brett A. Wagner, CDR, USN

Graduate School of Business & Public Policy

Naval Postgraduate School

Prepared for: Naval Postgraduate School, Monterey, California 93943

The research presented in this report was supported by the Acquisition Chair of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

To request Defense Acquisition Research or to become a research sponsor, please contact:

NPS Acquisition Research Program
Attn: James B. Greene, RADM, USN, (Ret)
Acquisition Chair
Graduate School of Business and Public Policy
Naval Postgraduate School
555 Dyer Road, Room 332
Monterey, CA 93943-5103
Tel: (831) 656-2092
Fax: (831) 656-2253
e-mail: jbgreene@nps.edu

Copies of the Acquisition Sponsored Research Reports may be printed from our website www.acquisitionresearch.org

Abstract

The purpose of this MBA Project is to analyze the procedures followed in the acquisition of the Mine Resistant Ambush Protected (MRAP) vehicle. The MRAP program, initiated in response to the improvised explosive device (IED) threat in Iraq and Afghanistan, is unprecedented in timeline and scale. As such, it provides a unique case study on the rapid acquisition of a major military system in response to an urgent operational need.

The objective of this research is to provide a guide for future rapid acquisition programs by documenting the conduct of the MRAP program from the initial needs identification and program start in 2006 through production and fielding at the time of this writing. The major analysis will focus on the program as a rapid acquisition within the context of the Acquisition Management and Joint Capabilities Integration and Development System (JCIDS) framework. The goal for analysis is to answer the following question: What are the key factors and decisions that contributed to program success, with success defined as meeting program objectives and warfighter needs? In addition, this report will address the key trade-offs made within the MRAP program and the potential long-term impacts of these decisions.

Keywords: Rapid Acquisitions, MRAP, Mine Resistant Ambush Protected Vehicle

THIS PAGE INTENTIONALLY LEFT BLANK

Acknowledgements

We extend our sincere gratitude to several individuals who supported us in this project. First, we would like to thank our loving families for their support and understanding during our time at the Naval Postgraduate School, and particularly as we worked on this project. We would also like to thank our advisors, Dr. Larry Jones, Professor Mike Boudreau, and Commander Brett Wagner for their guidance and insight. A very special thanks goes to Mr. Dave Hansen, Deputy Program Manager, MRAP Joint Program Office, for his assistance in our research. Without his patience in answering our countless questions and the access he provided, this project would have been incomplete. We would also like to thank Colonel John Rooney, Commander, Aberdeen Test Center; Captain Joseph Manna, Commander, DCMA-Atlanta; and Ms. Clarissa Tornai at the Joint Program Office for their immeasurable contributions to this project. Finally, we wish to thank Ms. Karey Shaffer and staff with the Acquisition Research Program for sponsoring and assisting with this project.

I would like to say a special thank you to my wife, Stephanie, and my two daughters for their patience over the last several months as I've worked on this project. I'd also like to thank my partners, Seth Blakemen and Jey Jeyasingam, for the great working relationship and hard work on this project.

Anthony Gibbs

I would like to offer my gratitude and appreciation to my wife Kim, who at my request, temporarily put her career on hold so that I could dedicate the required amount of time necessary for a project of this caliber; to my kids who gave me their support over the last 18 months; to the other 2/3 of our combined arms team, Jey and Tony, who gave me insight and direction when I needed it.

Seth Blakeman

My sincere thanks go to my partners, Tony Gibbs and Seth Blakeman, without whom I would not have reached this point. My deepest gratitude goes to my spouse and two sons for your support during the last 18 months. Thank you for letting me do what I do. Finally, a very special thanks to my mother-in-law, my father-in-law, and my parents for assisting with the children and adjusting to our lifestyles over the last few years.

Jeyanthan (Jey) Jeyasingam

THIS PAGE INTENTIONALLY LEFT BLANK

About the Authors

Seth Blakeman, Major, Acquisition Corps, has served in a variety of command and staff positions. He is a 1997 graduate of Frostburg State University and was commissioned a 2LT in the Engineer Corps. He is a graduate of the Engineer Officer Basic Course, the Armor Captain's Career Course, the Acquisition Basic Course and the Naval Postgraduate School, where he earned an MBA. His next assignment is in contingency contracting.

Anthony R. Gibbs, Major, Acquisition Corps, United States Army, earned an MBA at the Naval Postgraduate School (NPS) in December 2008. Prior to attendance at NPS, Major Gibbs served as an Infantry Assignment Officer with duty at the Army Human Resources Command in Alexandria, Virginia. He also commanded a rifle company in 1st Battalion, 501st Parachute Infantry Regiment during Operation Enduring Freedom. Major Gibbs earned a Bachelor of Science degree in Mechanical Engineering at the University of Missouri-Rolla in May 1997 and is married with two children.

Jeyanthan Jeyasingam, Major, Acquisition Corps, United States Army, received his Masters of Business Administration from the Naval Postgraduate School (NPS) in December 2008. Prior to accession into his functional area and selection for attendance to NPS, Major Jeyasingam served as an Army Armor Officer. His previous duty assignment was Battalion Operations Officer, 1st Battalion, 357th Infantry regiment, Fort Lewis, Washington. He also served as an Observer/Controller Trainer with 1-357 IN Regiment and Commanded Headquarters and Headquarters Company, 2d Brigade, 1st Infantry Division during Operation Iraqi Freedom II. Major Jeyasingam, a graduate of the University of Central Florida, is a Malaysia native via Florida, and is married with two children.

THIS PAGE INTENTIONALLY LEFT BLANK

NPS-AM-08-132

ACQUISITION RESEARCH SPONSORED REPORT SERIES

Study of the Mine Resistant Ambush Protected (MRAP) Vehicle Program as a Model for Rapid Defense Acquisitions

03 December 2008

by

Seth T. Blakeman, MAJ, USA

Anthony R. Gibbs, MJ, USA, and

Jeyanthan Jeyasingam, MAJ, USA

Advisors: Lawrence R. Jones, Professor

Michael W. Boudreau, Senior Lecturer, and

Brett A. Wagner, CDR, USN

Graduate School of Business & Public Policy

Naval Postgraduate School

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

Acronyms and Abbreviations List

A	
ACAT	Acquisition Category
AH	Armor Holdings (BAE)
AL	Aluminum
AO	Area of Responsibility
APBA	Acquisition Program Baseline Agreement
APOD	Aerial Port of Debarkation
APM	Assistant Program Manager
ARL	Army Research Lab
ASL	Authorized Stockage List
ASN RD&A	Assistant Secretary of the Navy for Research, Development and Acquisition
ASTM	American Society for Testing and Materials
ATC	Aberdeen Test Center
ATR	Above-threshold Reprogramming
B	
BAE	British Aerospace Systems
BMO	Battalion Maintenance Officer
BMT	Battalion Maintenance Technician
BSFV-E	Bradley Stinger Fighting Vehicle—Enhanced
BTR	Below-threshold Reprogramming
C	
C4ISR	Command and Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CAT	Category
CARC	Chemical Agent Resistant Coating
CBA	Capabilities-based Assessment
CDD	Capabilities Development Document
CECOM	Communications and Electronics Command
CENTCOM	Central Command
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CLS	Contractor Logistics Support
CONUS	Continental United States
COTS	Commercial Off-the-shelf
C-MNS	Combat Mission Needs Statement
CPD	Capabilities Production Document
CROWS	Common Remotely Operated Weapon System
CSIR	Council for Scientific and Industrial Research

D

DAGR	Defense Advanced GPS Receiver
DCMA	Defense Contract Management Agency
DLA	Defense Logistics Agency
DOT&E	Director, Operational Test and Evaluation
DoD	Department of Defense
DPAS	Defense Priorities and Allocations System
DPM	Deputy Program Manager
DT	Developmental Testing
DVE	Drivers' Vision Enhancer

E

ECP	Engineering Change Proposals
EDFP	Engineering Data for Provisioning
EFP	Explosively Formed Penetrator/Projectile
EOD	Explosive Ordnance Disposal
EPLRS	Enhanced Position Location and Reporting System

F

FAR	*Federal Acquisition Regulation*
FBCB2-BFT	Force XXI Battle Command Brigade and Below—Blue Force Tracking
FMS	Foreign Military Sales
FMTV	Family of Medium Tactical Vehicles
FN	Fabrique Nationale Manufacturing, LLC
FOB	Freight on Board (Origin)
FOB	Forward Operating Base
FOV	Family of Vehicles
FPII	Force Protection Industries, Incorporated
FRP	Full-rate Production
FSR	Field Support Representative
FTP	File Transfer Protocol
FY	Fiscal Year

G

GAO	Government Accountability Office
GDLS	General Dynamics Land System
GAO	Government Accountability Office
GFE	Government-furnished Equipment
GVWR	Gross Vehicle Weight Rating

H

HEMTT	Heavy Expanded Mobility Tactical Truck
HMMWV	High-mobility, Multi-purpose Wheeled Vehicle

HVAC	Heating, Ventilating and Air Conditioning
I	
ICD	Initial Capabilities Document
IDIQ	Indefinite Delivery, Indefinite Quantity
IED	Improvised Explosive Device
IMG	International Military and Government, LLC
IOT&E	Initial Operational Test & Evaluation
IPT	Integrated Product Team
IP	Issue Point
ISO	International Organization for Standardization
IWN	Immediate Warfighter Needs
J	
JCD	Joint Capabilities Document
JCIDS	Joint Capabilities Integration and Development System
JERRV	Joint Explosive Ordnance Disposal Rapid Response Vehicle
JIEDDO	Joint IED Defeat Organization
JLTV	Joint Light Tactical Vehicle
JP-8	Jet Propellant
JPO	Joint Program Office
JRAC	Joint Rapid Acquisition Cell
JROC	Joint Requirements Oversight Council
JUONS	Joint Urgent Operational Needs Statement
K	
KBR	Kellogg, Brown & Root
L	
LAR	Logistic Assistance Representatives
LAV	Light Armored Vehicle
LRIP	Low Rate Initial Production
M	
MARCORSYSCOM	Marine Corps Systems Command
MATLCV	MRAP All Terrain Light Combat Vehicle
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MCTAGS	Marine Corps Transparent Armor Gun Shields
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Programs
MDT	Mean Down Time
MEAP	MRAP Expedient Armor Program
MEP	Mission Equipment Packages
MIPR	Military Interdepartmental Purchase Request
MNF-W	Multi-National Forces West

MRAP	Mine Resistant, Ambush Protected
MTBF	Mean Time between Failure
MTTF	Mean Time to Failure
MTTR	Mean Time to Repair
N	
NBC	Nuclear, Biological and Chemical
NDAA	*National Defense Authorization Act*
NSN	National Stock Numbers
O	
OEF	Operation Enduring Freedom
OEM	Original Equipment Manufacturer
OGPK	Objective Gunner Protection Kit
OIF	Operation Iraqi Freedom
O&M	Operations and Maintenance
OMB	Office of Management and Budget
ONS	Operational Needs Statement
OR	Operational Readiness
OSD	Office of the Secretary of Defense
OT	Operational Testing
OTC	Oshkosh Truck Corporation
P	
PDU	Pilot Display Unit
PL	Public Law
PLL	Prescribed Load Listing
PM	Program Manager
PMCS	Preventive Maintenance Checks and Services
POM	Program Objective Memorandum
PPBES	Planning, Programming, Budgeting and Execution System
PPBS	See PPBES
PQDR	Product Quality Deficiency Report
PVI	Protected Vehicles, Inc.
Q	
QAR	Quality-assurance Representative
R	
RDC	Rapid Deployment Capability
RDECOM	US Army Research, Development, and Engineering Command
RDT&E	Research, Development, Test and Evaluation
REF	Rapid Equipping Force

RFP	Request for Proposal
RGS	Requirements Generation System
ROVER III	Remotely Operated Video Enhanced Receiver
RRAD	Red River Army Depot
RRP	Rapid Response Process
RSA	Regional Support Activity
RWS	Remote Weapon Station
S	
SDD	System Design and Development
SFI	Steel Fabrication, Inc.
SINCGARS	Single-channel Ground and Airborne Radio System
SOCOM	Special Operations Command
SOP	Standard Operating Procedure
SPAWAR	Space and Naval Warfare Systems Command
SPOD	Sea Port of Debarkation
SSA	Service Support Area
SVML	Standard Vehicle-mounted Launcher
T	
TACOM	Tank-Automotive and Armaments Command
TARDEC	Tank-Automotive Research, Development, and Engineering Center
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TIWG	Test Integration Working Group
TOCNET	Tactical Operations Center Intercommunications System
TOW	Tube Launched, Optically Tracked, Wire Guided
TRADOC	US Army Training and Doctrine Command
TRA	Technology Readiness Assessment
TRANSCOM	Transportation Command
TSG	Technical Solutions Group
U	
UCA	Undefinitized Contract Action
USMC	United States Marine Corps
UUNS	Urgent Universal Needs Statement
USDAT&L	Undersecretary of Defense for Acquisition, Technology, and Logistics
W	
WALK	Warrior Aid and Litter Kit
WC	Windchill
WRAP	Warfighter Rapid Acquisition Process
WAWF	Wide Area Work Flow

THIS PAGE INTENTIONALLY LEFT BLANK

I. Introduction

In late 2006, the Department of Defense (DoD) launched a major acquisition program to rapidly procure thousands of Mine Resistant Ambush Protected vehicles (MRAPs)[1] for use in Iraq and Afghanistan. With a raised, V-shaped, armored hull, MRAPs provide improved protection against Improvised Explosive Devices (IEDs)–the insurgent weapon of choice and greatest casualty producer in Iraq–when compared to up-armored, high-mobility, multi-wheeled vehicles (HMMWVs) and other flat-bottomed vehicles. The unprecedented scope of the MRAP program, combined with its rapid execution, presents an opportunity to study a major rapid acquisition program.

In standard DoD acquisitions for major systems, the source-selection process typically results in a contract award to one manufacturer. This provides a common design that simplifies training and sustainment operations. In the case of the MRAP program, however, mounting casualties from IEDs made the program the number one DoD acquisition priority. Consequently, decision-makers emphasized getting the capability into the hands of warfighters at the earliest opportunity. Because no single supplier had the capacity to quickly build the required number of vehicles, the program used multiple vehicle designs from multiple manufacturers to meet the requirement. Although this makes the fullest use of the defense industrial base and provides the fastest production in the short run, it comes at the expense of maintainability and lifecycle costs in the long run.

---

[1] It has become common for the acronym “MRAP” to connote “Mine Resistant Ambush Protected vehicle” (with the word “vehicle” being implied in the acronym). The use of “MRAP” in this project reflects this widespread terminology, and the MRAP vehicle is sometimes referred to simply as “the MRAP.”

A. Purpose

The purpose of this research is to document and analyze the process of acquiring the MRAP vehicle from the Operational Needs Statement (ONS) in 2005 to the time of this writing (October 2008). The objective is to focus on all aspects of rapid procurement and to identify key elements that contributed to the program's success. The results will serve as a guide for the future development of other rapid acquisition initiatives and assist future acquisition leaders in decision-making.

B. Research Objectives

The first objective with this research is to provide a guide for future rapid acquisition programs based on the limited time under which the MRAP vehicle was procured. This report will document the conduct of the program from the initial needs identification and program start in 2006 through production and fielding at the time of this writing. The major analysis will focus on the MRAP program as a rapid acquisition within the context of the Acquisition Management and Joint Capabilities Integration and Development System (JCIDS) framework. The goal of this analysis is to answer the following question: What are the key factors and decisions from this program that contributed to success, with success defined as meeting program objectives and warfighter needs? In addition, this report will address the key trade-offs made within the MRAP program and the potential long-term impacts of these decisions.

C. Methodology

This report focuses on three broad areas within the MRAP program. First, it addresses the program management and contracting issues. This includes an overview and analysis of the needs identification, generation of required capabilities, source selection, contracting actions, budget and finance actions, and the program management organization. The second focus area covers testing and evaluation, resource constraints, Defense Contract Management Agency (DCMA) involvement and contractor certification, manufacturing, quality control, and integration of

Government-furnished Equipment (GFE). The third and final focus area details the program fielding and support strategy, training plan, logistics, and transportation plan.

The framework for this analysis involves identifying the key factors that contributed to success in each of the three focus areas. The research draws on documents available from open sources such as major news reports, the Government Accountability Office (GAO) and other government reports, academic and research papers, and information provided by the program office. The analysis also includes interviews with the Program Manager (PM) and others from the Joint Program Office (JPO), key program participants from DCMA, the Commander of Aberdeen Test Center (ATC), senior officials at Space and Naval Warfare Systems Command (SPAWAR) involved in the integration effort, and interviews with senior managers for two MRAP producers and one major subcontractor to the effort.

D. Limitations of Research

This research identifies the key aspects of the MRAP program that contributed to its success. It does not, however, identify every factor that contributed to the program; therefore, it is not a comprehensive overview of the program from the perspective of all stakeholders. For example, the research does not include feedback from users in Iraq and Afghanistan, and it draws on visits and interviews with only two of the five MRAP manufacturers. In addition, this research does not provide the perspective of the program's largest customer, the US Army.[2] Finally, considering the unique nature and large scale of this program, this report does not provide a comprehensive view of all rapid defense acquisitions.[3]

---

[2] Numerous unsuccessful attempts were made to interview MRAP program representatives at the US Army Tank-Automotive and Armament Command (TACOM).

[3] The majority of acquisition programs considered rapid are much smaller in scale (Acquisition Category (ACAT) II—IV) and do not have the same political or senior DoD-level emphasis.

THIS PAGE INTENTIONALLY LEFT BLANK

II. Background and Literature Review

In many ways, September 11, 2001, marks a transition point for the United States military. This infamous day not only ushered in a new era of conflict against terrorist organizations, but it also began a continuous process of transformation within the military Services, particularly the Army and the Marine Corps. Instead of facing a clearly recognizable enemy on a well-defined battlefield, the US now fights a patient enemy who waits for battle on its own terms. This enemy is constantly studying tactics, techniques, and procedures to exploit weaknesses and avoid situations in which the US has a technological or military advantage. This has forced a continuous process of adaptation in response to this ever-changing enemy. The new emphasis on counterinsurgency warfare, as documented in the recently published *Army Field Manual, FM 3-24* (Counterinsurgency), clearly demonstrates this shift in how the US Army fights.

The evolving battlefield brought more than just a change in warfighting doctrine; it also demanded changes in the hardware the US military has used for decades. A simple examination of readily available photos of currently deployed forces compared to those from early in the conflict reveals the changes. The Army now wears a new uniform, body armor, helmet, and other individual gear and employs heavily armored vehicles, robots, and jamming devices. With an all-volunteer military, force protection is arguably more important now than in previous wars. As such, much of the new equipment is for added Soldier survivability. The single, most important stimulus in these hardware upgrades is the current enemy's weapon of choice and greatest killer: the improvised explosive device or IED. Accounting for roughly half the US casualties in Iraq and about a third of those in Afghanistan, the IED created the need for the MRAP vehicle. Given the rapidly evolving battlefield and materiel requirements, speed in defense acquisition is arguably more important now than at any time since World War II.

With this emphasis on speed in defense acquisitions in response to warfighter needs, significant research effort has been dedicated to rapid acquisitions in recent years. This chapter reviews the outcomes of that research, the regulatory framework regarding rapid acquisitions, and presents a summary of the key factors that apply to the MRAP program.

A. General

MRAPs are a family of vehicles produced by a variety of domestic and international companies that generally incorporate a V-shaped hull and armor plating designed to provide protection against mines and IEDs. The DoD is procuring three types of MRAPs: Category I (CAT I) vehicles, weighing about 7 tons and capable of carrying 6 passengers; CAT II vehicles, weighing about 19 tons and capable of carrying 10 passengers; and CAT III vehicles, intended to be used primarily to clear mines and IEDs, weighing about 22.5 tons and capable of carrying up to 12 passengers. The Army and Marine Corps first employed MRAPs in limited numbers in Iraq and Afghanistan in 2003—primarily for route clearance and explosive ordnance disposal (EOD) operations. These route-clearance MRAPs quickly gained a reputation for providing superior protection for their crews, and critics suggested that MRAPs might be a better alternative for transporting troops in combat than up-armored HMMWVs (Feickert, 2007, p. 1).

B. MRAP Overview

1. History

MRAP technology is not new. It was developed in South Africa in the early 1960s to mid-1970s for the armed forces of various South African nations in combating the same type of IED threat that US forces face today (Walsh, 2008a, August 6). Engineers of that era concluded that mine blasts could be directed out and away from a vehicle by elevating the chassis and creating a V-shaped hull along its base. Variants based on this original MRAP technology have been in production outside the United States since that time by subsidiaries of General Dynamics Land

Systems (GDLS) and BAE Systems. The United Nations has relied upon these vehicles for mine and route clearing operations in southern Africa and eastern Europe.

As a result of combat operations in Afghanistan and Iraq (Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF)), warfighters identified a need for a series of vehicles designed to survive the catastrophic threats posed by the Improvised Explosive Device (IED), as well as from conventional mine and ambush tactics. These vehicles were collectively described as MRAP-capable and would be specifically built to defeat these threats.

The MRAP vehicle's success at protecting its passengers was widely known prior to the 1990s but only recently recognized by the United States DoD. The DoD first tested the MRAP in FY 2000. Following testing, the Army purchased an additional 10 vehicles for contingency purposes that were subsequently used in the Global War on Terror, primarily by EOD teams. These vehicles were the Joint Explosive Ordnance Disposal Rapid Response Vehicle (JERRV) and the Buffalo, both manufactured by Force Protection Industries, Incorporated (FPII) (Inspector General, 2007, pp. 4-7). Given the success of these vehicles against IEDs, the DoD quickly recognized them as an effective materiel solution.

Warfighters initially requested MRAPs as early as 2003. However, due to time, budgetary considerations, and the general optimism and belief in a short conflict in Iraq, senior defense officials focused their efforts on up-armored HMMWVs and other anti-IED efforts such as bolt-on armor kits. As the conflict progressed, and the enemy shifted tactics from road-side bombs to buried, under-body attacks, it became apparent that up-armored HMMWVs did not provide the necessary level of protection (Hansen, 2008, June 10). MRAP requests increased, and in late 2006, the Joint Requirements Oversight Council (JROC) validated a requirement for 1,185 vehicles. The first request for proposal (RFP) for the MRAP was released November 9, 2006, and the JPO was subsequently established December 6, 2006 (Mann, 2008, slide 4). Given the Marine Corps' lead in the program, the JPO was established within Marine Corps Systems Command (MARCORSYSCOM), and Mr. Paul Mann was transferred from Naval Sea Systems Command to serve as the PM. Although initially an Acquisition Category (ACAT) III program, it received high-level attention from the start with the Assistant Secretary of the Navy for Research, Development and Acquisition (ASNRD&A), Dr. Dolores Etter, serving as the program's first Milestone Decision Authority (MDA) (Owen, 2008, p. 5).

2. Capabilities and Characteristics

The generic MRAP is a diesel (JP-8)[4] powered, 3-5 ton capacity, four-wheel-drive vehicle with a V-shaped hull and heavy armor encapsulating the crew and passenger compartments. It is approximately 19 feet long, 9 feet wide, and 8.6 feet tall and is equipped with an automatic transmission. In addition to the driver and vehicle commander, the vehicle has seating for four to eight passengers, depending on the variant. The vehicle is equipped with driver and commander doors, a rear door or ramp for the passenger compartment, and a single vehicle accessibility hatch on the roof. Some variants also have a gunner's turret placed close to the front of the vehicle.

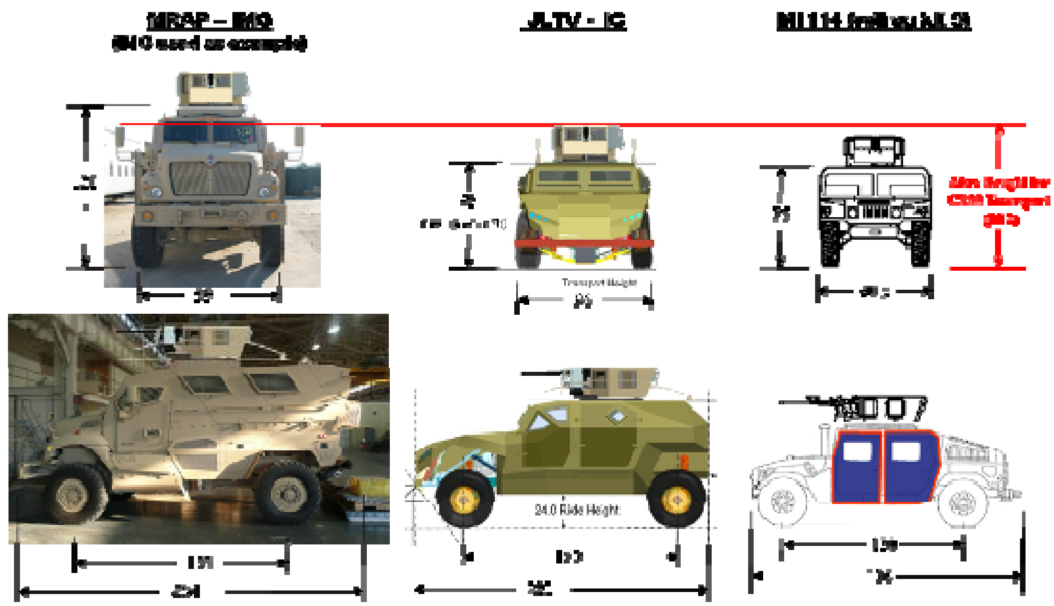
MRAPs are equipped with heating and air conditioning units; they are Nuclear, Biological and Chemical (NBC) over-pressure and filter protected, and are equipped with a winch capable of recovering an identical vehicle. The minimum hard-bottom fording depth is 36 inches, and the vehicle is capable of both on- and off-road travel. It is equipped with run-flat tires that are monitored by a central tire inflation system. All variants are transportable by the C-17 Starlifter and the C-5 Galaxy transport aircraft. The armor package on the MRAP provides all-around coverage, while the glass is multi-strike resistant. These characteristics protect the crew from blast, shock, fragments, and the acceleration effects of mine blasts

---

[4] JP-8 is a kerosene-based fuel common to a variety of US military vehicles to include aircraft, trucks, and armored vehicles.

(MRAP JPO, 2006). The V-shaped hull is specifically designed to redirect the blast out and away from the vehicle's passenger area. While the vehicle may be disabled by the explosion, the intent is to keep the passengers alive and, ideally, to allow vehicle recovery and repair.

The figures below depict how the most widely produced MRAP, the International Military and Government, LLC (IMG) MaxxPro, compares in size to both the Joint Light Tactical Vehicle (JLTV) currently in development and to the HMMWV. These figures show that the increased survivability is gained at the expense of a significant increase in size and weight, as well as a corresponding reduction in maneuverability.



MRAP JLTV HMMWV

Transport	No C-130 due to height No helo transport	1 x C-130 at GVW 1 x CH-47 at ECC (ext)	2 x C-130 at GVW 1 x CH-47 at GVW (ext)
Weight Curb Payload GVW	 35,504 lbs 5,564 lbs 41,068 lbs*	 16,560 lbs 6,580 lbs** 23,140 lbs	 10,900 lbs 5,500 lbs*** 15,400 lbs
Mission Profile	45/40/15	30/30/40	30/30/40

*ECP Variant Payload ~ 49,000 lbs with automotive performance degradation **Payload includes B-Kit armor ***Payload includes frag kit armor

Note: Mission Profile numbers represent primary/secondary/x-country terrain

Figure 1. MRAP Compared to the JLTV and the HMMWV
(Hansen, 2008, June 4, slides 13-14)

3. Need

In February 2005, Marine Corps Brigadier General Dennis Hejlik, Deputy Commander of 1st Marine Expeditionary Force, submitted an urgent need request. The six-page document stated, “There is a need for the MRAP vehicle capability to increase survivability and mobility of Marines operating in a hazardous fire area against known threats. The ‘expanded use’ of roadside bombs, rocket propelled grenades, and small arms fire in Al Anbar province requires a more robust family of vehicles” (Sherman & Castelli, 2007). His request went unfilled for four months, and the issue surfaced again in a June 10, 2005, status report indicating that the Marine Corps was holding out for a "future vehicle," presumably the JLTV—more mobile than the MRAP, but more protective than the HMMWV. This vehicle was not expected to be available, however, until 2012 (Eisler, Moorison & Vanden Brook, 2007).

In May and July 2006, the Multi-National Forces West (MNF-W) Commander in Iraq submitted urgent universal need statement (UUNS) requests for 185 and then an additional 1,000 vehicles. Those requests were combined and designated as a Joint Urgent Operational Needs Statement (JUONS) by the Central Command (CENTCOM) commander in October 2006. After the JROC validated that initial request, MARCORSYSCOM released the initial RFP on November 9, and the MRAP JPO was established within MARCORSYSCOM shortly thereafter on December 6. To illustrate the early uncertainty in the program, we note that the initial 1,185 requirement grew to 15,374 vehicles by September 2007 (Mann, 2008, slide 3). By March 2007, the Marine Corps Commandant, James Conway, called the vehicle his "Number 1 unfulfilled warfighting requirement" (Eisler, Moorison & Vanden Brook, 2007). In May 2007, the Secretary of Defense, Mr. Robert Gates, made MRAP the top DoD acquisition priority. In addition, Secretary Gates assigned the program a DX rating (priority rating reserved for the top acquisition programs) in June 2007, and by September of that year, the program was designated an ACAT 1D Program, placing oversight in the hands of the Office of the Secretary of Defense (OSD) (Miles, 2007).

4. Manufacturers

The source-selection process resulted in the procurement of MRAP vehicles from five different manufacturers: BAE Systems (BAE); Armor Holdings (AH) (now owned by BAE Systems); General Dynamics Land Systems (GDLS); Force Protection Industries, Inc. (FPII); and Navistar's International Military and Government, LLC subsidiary (IMG) (now called Navistar Defense). Although limited commonality exists in engines, transmissions, tires, and axles, it was not a major concern in the source-selection decision, demonstrating the program emphasis on procuring vehicles quickly from multiple manufacturers at the expense of long-term sustainability and lifecycle costs.

C. Literature Review

1. The Joint Capabilities Integration and Development System (JCIDS)

The Joint Capabilities Integration and Development System (JCIDS), which is normally a methodical and sequential process, provides the framework under which all joint, top-driven acquisition programs are conducted. The MRAP program, although rapid and unique in nature, was conducted within this framework, albeit in a highly tailored manner. This section provides an overview of the JCIDS process as it is relevant to the MRAP program.

JCIDS is the most current procedure used by the DoD to articulate warfighter needs and establish a basis for future defense acquisition programs. The JCIDS replaced what was formerly known as the Requirements Generation System (RGS) and, with that, the costly redundancies that each Service required within its own Service-specific stove-pipe. The purpose of JCIDS is to provide the guidelines for generating required capabilities and identifying joint needs. This top-down approach to decision-making determines if a required capability exists, then assigns a resource sponsor within the DoD for acquisition (Jones & McCaffery, 2008, pp. 569-570).

Three key processes within the DoD must work hand-in-hand to ensure that warfighter needs are met. As illustrated in Figure 2, they are the requirements process (JCIDS), the acquisition process, and the Planning, Programming, Budgeting and Execution System (PPBES). To provide systems that meet the needed capabilities, these three processes must be synchronized to support decision-making (Chairman of the Joint Chiefs of Staff, 2007, p. 2). This synchronization is complicated by the differing nature of the three processes. While PPBES is calendar-driven, the JCIDS and acquisitions processes are event-driven.

In the case of an immediate need, the JCIDS process can quickly validate a capability gap and identify a suitable materiel solution. Constrained by the calendar-driven PPBES process, however, the acquisition process may be unable to make the procurement until the next budget cycle is complete. This process can take up to two years, depending on what time of year the need is identified. Because of this time lapse, JCIDS is unresponsive to immediate needs unless funds are made available through non-standard means such as reprogramming actions or emergency supplemental appropriations.

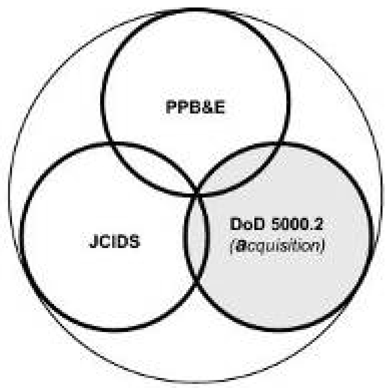


Figure 2. Major Decision Support Systems
(Nalwasky, 2007, slide 5)

The JCIDS process was developed not only to identify joint warfighting requirements but also to prioritize them. While the central objective of JCIDS is to attend to the shortfalls of joint operations as defined by combatant commanders, the primary objective is to ensure that warfighters receive what is needed to accomplish their mission. The decision authority for the capabilities requirements is the JROC, which reviews, validates, and makes recommendations on acquisition programs based on their categories and key performance parameters. The JROC prioritizes acquisition programs and validates capabilities as well as performance criteria for these programs. The JROC review and validation is a key factor in the milestone decision authority's decision to initiate a development program (Chairman of the Joint Chiefs of Staff, 2007, pp. 2-3).

The first step in initiating the JCIDS process is to conduct a capabilities-based assessment (CBA) that identifies the capabilities required, performance criteria, and shortfalls of existing systems to meet those requirements. This process results in a Joint Capabilities Document (JCD) or Initial Capabilities Document (ICD) that validates the need to address a capability gap and verifies that affordable and technically feasible solutions exist to address those requirements. Following validation, the JCD or ICD becomes the basis for further analysis by the assigned action Service or agency. This analysis results in a Capabilities Development Document (CDD) that identifies the best technical approach. CDD approval by the JROC validates the key performance parameters of the selected approach, assesses the risk with respect to cost, schedule, and technology maturity, and assesses the affordability of the system based on available resources. JROC approval of the CDD is one of the key factors involved in the decision to initiate a program (pp. 2-3).

The JROC's role during the entire process and in approving the ICD, CDD, and the Capabilities Production Document (CPD) is to make certain that the system being developed meets the required capability, does not stray from the original requirement as defined in the JCD or ICD, and remains affordable. The JCIDS process has been continually refined since its inception, and the information required at each level is well scrutinized to ensure that effective and appropriate decisions are made. The following passage from the executive summary of the JCIDS overview document summarizes the process's intent:

> The JCIDS process was designed to be a robust process to support the complex decisions required of the JROC and the acquisition community in identifying and procuring future capabilities. Recognizing that not all capabilities/weapon systems require the same level of consideration, the JCIDS process is tailorable. The JROC has identified several alternative paths to allow accelerated identification of capability gaps and potential solutions, and to allow them to enter into the JCIDS process at the appropriate stage to deliver those capabilities more rapidly. (Chairman of the Joint Chiefs of Staff, 2007, p. 3)

As this project will demonstrate, the flexibility offered by this tailorable approach was a key factor in the rapid execution of the MRAP program. The synchronization required between the JCIDS, acquisition, and PPBES processes demonstrates that a large-scale, rapid acquisition program will likely require a non-standard source of funding to enable truly rapid procurement.

2. Rapid Acquisition Processes

Although obvious in its utility, the ability to rapidly react to changing battlefield needs is not inherent in the acquisition system. This deliberate and methodical process can take years and even decades to progress from need identification to fielding of a new system. In recognition of this, the overarching DoD acquisition directive (*DoD Directive 5000.1*) states the following:

> There is no *one* best way to structure an acquisition program to accomplish the objective of the Defense Acquisition System. MDAs and PMs shall tailor program strategies and oversight, including documentation of program information, acquisition phases, the timing and scope of decision reviews, and decision levels, to fit the particular conditions of that program, consistent with applicable laws and regulations and the time-sensitivity of the capability need. (Under Secretary of Defense, 2003a, p. 3)

As a result of this directive and of prior efforts to streamline the acquisition process, each of the Services and Special Operations Command (SOCOM) have developed procedures to rapidly place needed capabilities into warfighters' hands.

In his 2006 thesis, Michael W. Middleton describes these Service rapid acquisition processes, providing overviews of the Marine Corps Urgent Universal Needs Statement (UUNS), the Navy Rapid Deployment Capability (RDC), the Army Rapid Equipping Force (REF), the Air Force Rapid Response Process (RRP), and the SOCOM Combat Mission Needs Statement (C-MNS). Although different in execution, they are similar in their efforts to meet urgent warfighter needs. Middleton states:

> Many of the Service rapid acquisition systems are limited to existing Service budgets and affect only that Service's materiel portfolio. These Service

> initiatives allow increased flexibility and are managed by existing acquisition staffs that are implementing existing Service acquisition strategies. The Services also manage the long-term rapid acquisition of the materiel and may incorporate it more fully where feedback dictates. (2006, pp. 11-12)

In addition, these procedures apply only to ACAT II, III, and IV programs, thereby limiting the program scope to $140 million for research and development and $660 million for procurement (in FY2000 dollars) (Under Secretary of Defense, 2003b, p. 21).

To further demonstrate the emphasis on rapid acquisitions in support of urgent operational needs, the Deputy Commanding General, US Army Research, Development, and Engineering Command (RDECOM), COL(P) Peter N. Fuller, summarized five distinct processes in the Army alone that provide robust capabilities to warfighters. The JUONS, validated through the Joint Staff, applies to requirements that support more than one Service. The ONS is similar to the JUONS but is used only for requirements unique to the Army. The Joint IED Defeat Organization (JIEDDO) provides solutions to mitigate IED threats, typically in response to JUONS requirements. The JCIDS system, referred to as the PM Informal process, attempts to adjust system performance requirements in existing acquisition programs based on direct contact between field commanders and PMs. This direct warfighter-to-PM coordination takes advantage of existing development work and, in effect, starts the program before formal approval. The final process, the Rapid Equipping Force (REF), involves forward-deployed teams evaluating needs and rapidly fielding solutions to those needs, largely through commercial-off-the-shelf (COTS) items. The existence of these overlapping and mutually supporting processes demonstrates the need for and emphasis on rapid acquisitions, but it sustains inefficiencies in addressing evolving changes in requirements precipitated by rapidly changing threats. As Fuller points out, however, these processes nevertheless incorporate considerable innovation and flexibility to speed acquisitions when compared to the conventional JCIDS process (2008).

3. Regulatory Framework Governing Rapid Acquisitions

Legislative authority for rapid acquisition comes from two primary sources: Section 806 of the *Bob Stump National Defense Authorization Act* (*NDAA*) for Fiscal Year 2003 (US Congress, 2002) and Section 811 of the *Ronald Reagan National Defense Authorization Act* for Fiscal Year 2005 (US Congress, 2004). A thorough knowledge of both is essential to an understanding of the legal limitations on a rapid acquisition program.

The first piece of legislation, Section 806 of the Bob Stump *NDAA,* required that the Secretary of Defense establish a process for rapid acquisition and deployment of items that: 1) are currently available or under development, and 2) are urgently needed to react to an enemy threat or to respond to significant and urgent safety situations. The law further requires establishment of procedures to streamline communication of warfighter needs, procedures for demonstrating, rapidly acquiring, and deploying capabilities that meet these needs, and procedures for adequately testing these items and incorporating test results into decision-making. The law limits the scope of this authority by limiting the quantity of items procured using these procedures to the number established for low-rate initial production (LRIP) for the system (US Congress, 2002). This definition is somewhat vague in its meaning, however; the LRIP quantity can differ by system type, and the MDA holds significant latitude in determining the LRIP quantity (Under Secretary of Defense, 2003b, p. 13).

Section 811 of the Ronald Reagan *NDAA* provides additional authority with respect to rapid acquisition by directing the Secretary of Defense to appoint a senior official within the DoD to oversee the acquisition of equipment to eliminate a combat capability deficiency that has resulted in combat fatalities. This official is authorized to waive any provision of law, policy, directive, or regulation concerning the establishment of need; the requirement for research, development, testing, and evaluation; and the source selection and contract award for procuring the equipment. The official's responsibility is to facilitate rapid acquisition and deployment of the needed equipment, with a goal of 15 days for awarding the acquisition contract. Again, this law seeks to limit this authority—this time by establishing a maximum of $100 million as the aggregate limit for an item during a fiscal year (US Congress, 2004).

4. The Warfighter Rapid Acquisition Process (WRAP)

The Warfighter Rapid Acquisition Process (WRAP) is an Army program that predates the OEF- and OIF-inspired initiatives such as the ONS and JUONS. The WRAP was "directed at accelerating procurement of systems identified through TRADOC[5] warfighting experiments as compelling successes which satisfy an urgent need" (Department of the Army, 1997, Paragraph 5-5). Where current processes focus on eliminating capability gaps for warfighters in an operational environment, the WRAP, formalized by Army Regulation in 1997, was a peacetime process designed to streamline the acquisition process for the most promising systems under development. Consequently, the benchmark for a rapid acquisition process was much slower than is acceptable in the current environment. Many of the lessons learned from this program still apply, however, and are relevant to current rapid acquisition processes.

The Bradley Stinger Fighting Vehicle—Enhanced (BSFV-E, now known as the Bradley Linebacker) was the first program managed under the WRAP. This program, which filled an urgent air defense capability need for the Army, was an ACAT IV program costing $20.1 million. It was also a non-developmental program that focused on modifying GFE components such as the Bradley Fighting Vehicle and Stinger air defense missile standard vehicle-mounted launcher (SVML). In essence, a Stinger missile launcher replaced the TOW (tube-launched, optically tracked, wire-guided) missile launcher on an M2A2 Bradley turret. This, along with

---

[5] TRADOC is the US Army Training and Doctrine Command.

added targeting- and fire-control capabilities, were the only requirements for the system integration (Jones, 1996, pp. 33-34).

In his 1996 Master's Thesis, Walter Jones conducted a case study on the WRAP process based on the experience of the BSFV-E. Although relatively simple in terms of the development effort, this program provides key lessons for a successful rapid acquisition. First and foremost, it demonstrated the importance of funding. Although this seems an obvious point, the program was approved for the WRAP program, but the Army did not budget money toward the effort. This program only succeeded because the Program Executive Officer for Tactical missiles personally sponsored the program, funding it from within his own organization (pp. 55-60). As Jones pointed out, the PPBS (since renamed the PPBES for Planning, Programming, Budgeting, and Execution System) is not structured to rapidly fund WRAP programs (p. 57). This indicates that for rapid acquisition programs to be successful, they must acquire funding from a non-standard source such as reprogrammed funds or supplemental appropriations.

Jones also determined that the WRAP process cannot be applied to every acquisition program. In summary, he concluded that the WRAP process can be successfully applied to programs with five specific characteristics. First, a working solution must exist that meets an urgent Army need using mature technology or a non-developmental item such as a COTS solution. Second, the program must be small in size and potentially allow for reprogramming of funds. Third, the materiel solution must be supported by strong advocates from both the user and developer communities. Fourth, the program must utilize fixed-type price contracts and contract incentives associated with key program or milestone events to spur contractors forward. Finally, the program must be low production quantity or use exercisable contract options as a means of building upon success (pp. 71-72).

5. A Recent Case Study on an Accelerated Acquisition

In their 2005 MBA Professional Report, James Conatser and Vincent Grizio detailed the accelerated acquisition and deployment of the Force XXI Battle Command Brigade and Below—Blue Force Tracking (FBCB2-BFT) system in support of Operations Enduring and Iraqi Freedom. In simplified terms, this system provides an integrated, digital command-and-control capability across all battlefield functional areas and from the squad/platform to the brigade/regimental level (p. 9).

This program provides a different scenario for rapid acquisition in which the need was previously identified; a requirements document was already approved, and the system was progressing through the development process. In this case, the combination of operations in Iraq and Afghanistan, along with capability demonstrated in limited user tests and advanced warfighting experiments, effectively made the capability an urgent operational need. Rather than use the approved LRIP run to conduct the Initial Operational Test & Evaluation (IOT&E), the Army instead chose to immediately field more than 1,000 systems to deployed and deploying units.

Conatser and Grizio (2005) determined that the success of this accelerated effort relied on four program characteristics. First, this program had a relatively mature technical solution to fill a capability gap. Second, user representatives were willing to accept a useful solution in the short term while the program management office continued to develop the system to its desired end-state. Third, the effort had the support of senior military leadership at the Service Chief, Combatant Commander, and MDA level. Finally, the program had a sufficient funding stream in both the short- and long-term. Although this program was at a point in development that facilitated its transition to rapid deployment, Conatser and Grizio (2005) feel that these four criteria apply to any rapid acquisition effort in support of contingency operations (pp. 49-50).

6. The Value of the Joint Rapid Acquisition Cell (JRAC)

Based on legislative guidance and the Service-specific limits of the Service rapid acquisition processes, the Office of the Secretary of Defense moved to establish an overarching process to meet Immediate Warfighter Needs (IWNs) of a joint nature. IWNs are Joint Urgent Operational Needs that require resolution and fielding in 120 days or less. As described by Middleton, Deputy Secretary of Defense Paul Wolfowitz directed the formation of the Joint Rapid Acquisition Cell (JRAC) in September 2004 and subsequently moved to formalize the procedures that the group would follow. This process culminated on July 15, 2005, with Chairman of the *Joint Chiefs of Staff Instruction 3470.01* (*CJCSI 3470.01*) (Middleton, 2006, pp. 13-19). This instruction "establishes policy and procedures to facilitate assessment, validation, sourcing, resourcing, and fielding of operationally driven urgent, execution-year combatant commander needs" (Chairman of the Joint Chiefs of Staff, 2005, p. 1). It also describes the role of all stakeholders—with emphasis on the JRAC, which is responsible for resolving combatant commander-validated IWNs and for providing a single point of contact and accountability on the OSD staff for tracking the timeliness of actions (pp. 1-4).

The JRAC process applies only to joint needs that are outside the scope of existing *DoD 5000* Series and previously discussed Service processes. It is intended to complement, rather than to replace or compete with, any existing Service or joint process. As with the others, the JRAC process has limits and can only be used to field ACAT II, III, or IV programs (p. 2).

Middleton (2006) conducted a thorough review of the JRAC process by providing its detailed history, a breakdown of the cell members, and a recent case example in which the process was used to meet a JUONS. He analyzed the process from the perspective of 10 value centers. His analysis determined the JRAC process is value-added in several areas. First, it holds powerful budgetary options and an ability to access all colors of money.[6] Second, the process is handled directly by senior-level officials, thereby eliminating several layers of bureaucracy. Third, the process provides portfolio balance that reduces Service overlap. Fourth, it provides an acquisition strategy that aligns closely with overarching DoD strategies such as JCIDS and COTS procurement. Fifth, it provides impartiality since funding follows the solution. Sixth, the process provides focus based on the JRAC's involvement only with rapid acquisitions. Finally, the process acknowledges the evolving nature of war as it shows the DoD can adapt quickly and provide needed capabilities rapidly. He found the process non-value-added in terms of lifecycle costs given the lack of analysis on long-term maintenance, training and resourcing, and based on the lack of a mechanism to incorporate feedback from the warfighter. In terms of acquisition speed, he found the process value-added in that it establishes deadlines for immediate warfighter need validation and solution but is non-value-added in that it sets no limit or goal for fielding nor any penalty for not meeting limits or goals (Middleton, 2006, pp. 57-59).

D. Summary

Based on the research assessed, several trends are evident in successful rapid acquisition programs, both prior to and since the start of the Global War on Terror. First, this research indicates that a materiel solution must be present as a COTS or non-developmental item to allow rapid procurement. Second, the solution must be accepted by both the senior leadership within the DoD and by the user community. Finally, the program must have a reliable funding stream. All of these have been critical to the MRAP's success.

This research also reveals another issue of even more significance to the MRAP program: the limits placed on all current rapid acquisition processes by law

[6] "Color of Money" is a term commonly used within DoD to identify appropriations by type (e.g., Operations and Maintenance, Procurement, RDT&E, Military Personnel Expenses, and Military Construction). Once Congress appropriates funds into these separate accounts, money cannot be transferred between accounts without being re-appropriated (Jones & McCaffery, 2008, pp. 350-351).

and DoD acquisition regulations and instructions. As all processes are limited to ACAT II and lesser programs, the ACAT I-level MRAP program was forced to progress under the standard Acquisition Management and JCIDS framework, albeit in a highly tailored manner and with rare, non-standard Congressional funding actions. As we will demonstrate, however, the principles behind existing rapid acquisition processes can be successfully applied to ACAT I-level programs, provided the need is urgent.

THIS PAGE INTENTIONALLY LEFT BLANK

III. Program Management and Contracting Strategy

A. Early Program History

On October 26, 2006, CENTCOM combined two separate Urgent Universal Needs Statements (UUNS) for 185 and 1000 vehicles, respectively, into a single Joint Universal Operational Needs Statement (JUONS) for 1185 MRAPs. Two weeks later, on November 9, MARCORSYSCOM released the first RFP to industry and on December 6, 2006, officially established the MRAP JPO. Ten manufacturers responded to the proposal and submitted bids. Nine of those manufacturers were subsequently awarded IDIQ[7] contracts on January 26, 2007, with immediate production orders for a minimum number of prototype vehicles for testing. Of the nine awarded contracts, two failed to meet contract requirements and were removed from the program prior to testing. The initial test phase started for at least one manufacturer in February 2007 and continued through that April for other manufacturers. This initial testing, conducted at Aberdeen Proving Ground, MD, focused heavily on threshold survivability requirements and eliminated two more manufacturers due to failure in meeting minimum survivability or usability

---

[7] Indefinite Delivery Indefinite Quantity (IDIQ): The indefinite-delivery contract may be used to acquire supplies and/or Services when the exact times and/or exact quantities of future deliveries are not known at the time of contract award. The IDIQ contract offers the following advantages:

Flexibility in both quantities and delivery scheduling

Ordering of supplies or Services after requirements materialize

Indefinite-quantity contracts limit the Government's obligation to the minimum quantity specified in the contract

Requirements contracts may permit faster deliveries when production lead time is involved, because contractors are usually willing to maintain limited stocks when the Government will obtain all of its actual purchase requirements from the contractor

Indefinite-delivery contracts may provide for any appropriate cost or pricing arrangement. Cost or pricing arrangements that provide for an estimated quantity of supplies or Services (e.g., estimated number of labor hours) must comply with the appropriate procedures (DoD, 2008, p. 396). All MRAP IDIQ contracts were firm-fixed-price (FFP) contracts.

requirements. The early decision to use multiple manufacturers proved sound because the increasing requirement outpaced the industrial capacity of any one manufacturer to produce that many vehicles. By May 2007, the requirement grew to 7,774 vehicles; by September of that year, the requirement increased again to 15,374.

1. Need Identification

In the months following the March 2003 US-led invasion of Iraq, the military transitioned into an occupying force responsible for establishing security and assisting in government reconstruction and nation-building efforts. Shortly thereafter, insurgents turned to the improvised explosive device (IED) as their weapon of choice against US and coalition forces. IEDs were cheap, unsophisticated, plentiful, easy to employ, and often produced devastating and catastrophic results. By 2005, IED-related casualties were the number one killer in Iraq, prompting the DoD to find a solution.

In 2006, consensus began to form within the Marine Corps and CENTCOM that MRAPs were needed in response to the IED threat. On May 21, 2006, the MNF-W Commander in Iraq submitted an urgent universal need request for 185 MRAP vehicles and followed with another request for 1,000 additional vehicles on July 10, 2006. Designation of these requests as a JUONS by the CENTCOM commander on October 26, 2006, clearly established the warfighters' need and effectively started the MRAP program.

The perceived reluctance within the DoD to accept the MRAP as a materiel solution to the IED threat is one of the most controversial and criticized aspects of the MRAP program. Such criticisms, however, overlook the escalating actions the DoD took from 2004 through 2006 in response to the numerous escalating threats. Lieutenant General (Retired) Joseph L. Yakovac, Jr., the former Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology, points out that the DoD undertook numerous initiatives early-on to include fragmentation kits, up-armored HMMWVs, bar armor, and the JIEDDO in response to the range of threats. In addition, no consensus existed within the user community, and particularly within the Army, on how to best address the IED threat (personal communication, October 1, 2008). Regardless, the purpose of this research is not to analyze the acquisition process before, but rather to examine the process after the need was validated and the MRAP program was established.

2. Requirement validation

The JUONS designation led to program start-up and release of the first RFP on November 9, 2006, followed shortly thereafter by official establishment of the JPO in December 2006. Figure 3, below, shows the chronology of the requirements validation from the initial 1,185 to the final total of 15,374 vehicles in September 2007. This demonstrates the explosive growth and initial uncertainty as the program transitioned from an ACAT III program to an ACAT ID program and one of the largest in the DoD.

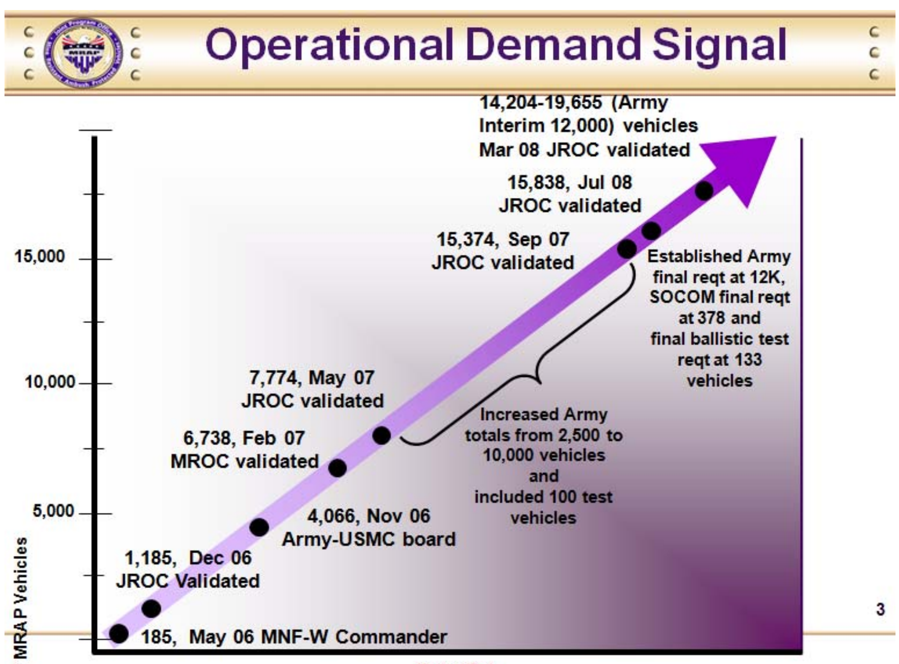


Figure 3. Chronology of Requirement Validation
(Mann, 2008, slide 3)

On May 2, 2007, the JROC, chaired by Admiral Edmund Giambastiani, the Vice Chairman of the Joint Chiefs of Staff, approved an MRAP Capability Production Document (CPD), formally setting the size of the required MRAP fleet at 7,774 vehicles. This approval, which precedes procurement actions for standard programs, came less than two months after the military Services detailed their collective need for MRAP vehicles, an extraordinarily rapid pace in formalizing a new need for a large weapon system program (Sherman, 2007, May 17). Even more extraordinary, however, was that at this point in the MRAP program, testing was underway for seven competing manufacturers, and production contracts had already been awarded to five companies.

B. Program Strategy

1. Acquisition Strategy

The acquisition strategy was formed in support of three primary program objectives: first, field survivable, mission-capable vehicles; second, field them as rapidly as possible; and third, grow the industrial base while simultaneously managing all aspects of the acquisition process. The PM considered all other factors trade-able in support of those objectives. The JPO planned to achieve this through parallel execution of as many elements of the acquisition framework as feasibly possible. Given the nature of the requirement and the dire need for a survivable system, the decision was made not to restrict innovation by demanding a single COTS solution, but to solicit industry and see what different solutions an expanded industrial base could provide (Hansen, 2008, May 30). To incentivize multiple vendors, the strategy included use of multiple IDIQ contracts followed by phased, rapid testing focused on threshold requirements. This phased testing served as a form of source selection that led to rapid award of multiple production orders. The use of multiple manufacturers required an intensive contractor management effort and centralized integration process. Finally, the rapid fielding without sustainment systems in place required a contractor logistics support (CLS) approach (Owen, 2008, pp. 6-8).

If a vendor chose to develop a new design, the JPO stipulated that it had to be produced within 60 days of contract award. One manufacturer, IMG, did design and produce a new and different testable prototype within the 60-day window. The remainder of the manufacturers chose a modern adaptation of a mature, COTS, 30-year-old materiel solution, based on the BAE RG-31.

2. Tailored Acquisition Approach

By January 31, 2007, the MRAP program had grown into an ACAT II program, a designation that would keep the procurement under the Navy's purview. However, by February 8, then-Under Secretary of Defense for Acquisition, Technology and Logistics (USDAT&L), Kenneth Krieg, recognized the scope of the MRAP program would grow significantly. Accordingly, he directed the Navy acquisition executive who was overseeing the MRAP program, Dr. Delores Etter, to plan for MRAP transition to ACAT ID status (Sherman, 2007, March 15). ACAT-ID designations are reserved for programs with procurement costs greater than $2.19 billion (FY 2000 constant dollars), and are overseen by the OSD (Under Secretary of Defense, 2003b, p. 21). Dr. Etter said she approved a "tailored plan" for the MRAP program documentation and added that "the MRAP office is making progress to get all program documentation in place to support a joint acquisition by the Army and Marine Corps" (Sherman, 2007, March 15). The tailored plan granted leeway to the MRAP program, allowing simultaneous execution of all facets of the DoD acquisition framework.

Despite the MRAP program's tailored approach, it was not granted waivers for any of the normal DoD acquisition documentation or required processes. DoD acquisitions are characterized by slow, deliberate and well-documented processes intended to ensure a thorough and complete system design. In many ways, the MRAP program was no different, despite its rapid execution. As an example, all programs require a Technology Readiness Assessment (TRA) prior to the Milestone C decision to verify that a system is technologically mature and ready for fielding. Due to the rapid nature of the MRAP program and its use of vehicles considered

COTS, the JPO did not complete a technology readiness assessment and requested a waiver of this requirement. For rationale, the JPO argued that MRAP was a mature design based on 30-year-old technology—it is basically an armored truck. The MDA and OSD staff declined the waiver, requiring the JPO to petition the Office of Naval Research for a TRA on a system that was already fielded and proven in use in Iraq and Afghanistan (Hansen, 2008, May 30).

C. Program Execution

The JPO implemented its acquisition strategy through a tailored approach to the acquisition framework. It began by leveraging FPII's existing, active production line with a sole-source contract for immediate production. This started production on a proven vehicle design and expanded the industrial base by ramping up a production facility. Next, an RFP was released to industry in an attempt to get as many respondents as possible, with the intent of leveraging their combined production capabilities as quickly as possible. Upon receiving bids from ten manufacturers, the JPO performed a technical review and assigned risk to the various manufacturers and their designs. IDIQ contracts were subsequently awarded to nine companies with immediate production orders for test vehicles.[8] In addition, the JPO awarded larger production orders under LRIPs[9] 1 and 2 in

[8] The initial production orders called for two prototypes per vehicle category (CAT I and II only) per manufacturers. (9 manufacturers x 2 prototypes x 2 categories = 36 vehicles in the initial production orders.)

[9] As defined by AR 70-1, LRIP (Low-rate initial production) is:

1. The first effort of the Production and Deployment (P&D) phase. The purpose of this effort is to establish an initial production base for the system, permit an orderly ramp-up sufficient to lead to a smooth transition to full-rate production (FRP), and to provide production representative articles for Initial Operational Test and Evaluation (IOT&E) and full-up live-fire testing. This effort concludes with a Full-rate Production Decision Review (FRPDR) to authorize Full-rate Production and Deployment (FRP&D).

2. The minimum number of systems (other than ships and satellites) to provide production representative articles for Operational Test and Evaluation (OT&E), to establish an initial production base and to permit an orderly increase in the production rate sufficient to lead to full-rate production (FRP) upon successful completion of operational testing (OT). For major defense acquisition programs (MDAPs), LRIP quantities in excess of 10% of the acquisition objective must be reported in the Selected Acquisition Report (SAR) (Department of the Army, 2003, p. 82).

February 2007 to the five manufacturers considered low-risk. These orders, placed prior to testing, represent deliberate risk acceptance by the PM in an effort to initiate production on vehicles considered likely to meet minimum requirements. The high-risk manufacturers, on the other hand, did not receive LRIP contracts until they successfully passed the threshold requirements of the initial test phase. Testing included survivability, automotive, safety, and user tests; results were subsequently used in part as source-selection criteria. The manufacturers that successfully passed threshold requirements for the first test phase (DT-C1) were awarded production orders under a series of LRIP contracts. Figure 4 shows a comparison of the tailored MRAP acquisition approach with the traditional acquisition framework.

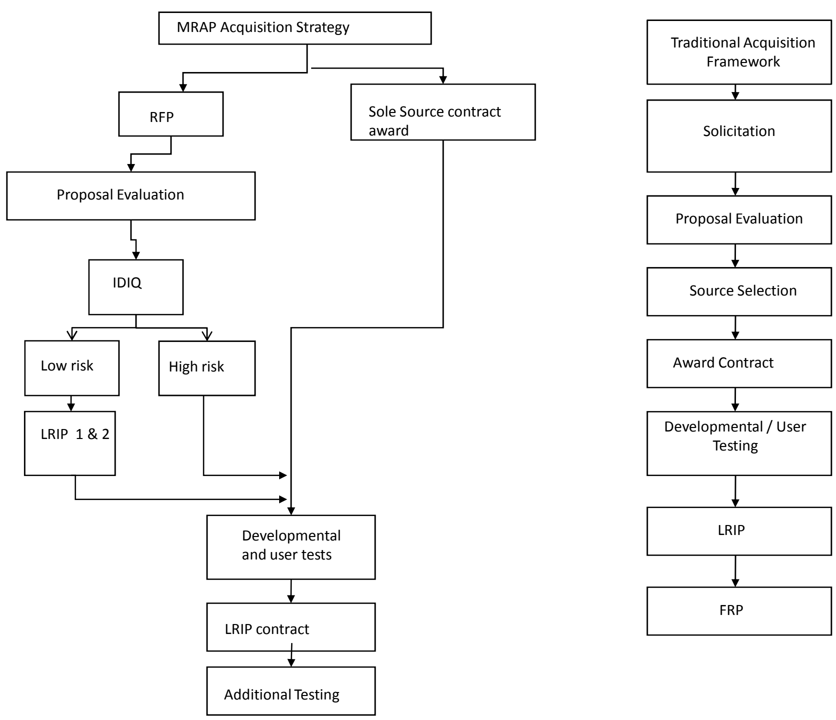


Figure 4. Comparison of MRAP Acquisition Strategy and a Traditional Acquisition Framework

On May 2, 2007, Secretary of Defense Gates designated the MRAP as the number one DoD procurement priority (Young, Greenwalt & Hoover, 2007, p. 2). This effectively made MRAP the widely accepted materiel solution at a time when the warfighter and user communities were not yet in consensus on a single solution, let alone the MRAP. In a sense, the top-driven emphasis placed the requirements-generation process in the hands of the acquisition community, rather than in the hands of the users. This represents a trade-off in that not all users got the solution they wanted. In addition, warfighters did not necessarily get the best overall solution because of this lack of defined requirement. As the Joint Program Manager Paul Mann stated, the MRAP program was, “a program of adequacy. Adequacy in this sense is good” (personal communication, September 8, 2008).

On June 1, 2007, Secretary Gates assigned the MRAP program a “DX” rating under the Defense Priorities and Allocation System (Young et al., 2007, p. 5). Together, the prioritization and DX designation gave the MRAP program the highest priority concerning parts and material suppliers in the government and private sector. Combined with the early risk acceptance and tailored acquisition approach, Secretary Gates’ emphasis further streamlined the MRAP program and mobilized all resources in its support. This section of the report focuses on the execution of the program from its start through the time of this writing, with specific emphasis on the key aspects of the tailored MRAP acquisition approach.

1. Concurrency

“The early program objective to have significant numbers of MRAP vehicles fielded by the end of calendar year 2007 forced the program to plan for and manage all aspects of the process simultaneously rather than sequentially. That included contracting, testing, integration, transportation to theater and fielding” (Owen, 2008, p. 6). Within the defense acquisition framework, from concept refinement through disposal, each step is designed to be executed in series. The MRAP program executed all steps in parallel, making it faster but very difficult to manage. For example, the MRAP program simultaneously conducted developmental testing, operational testing, production, integration, fielding, and disposal, while also refining requirements to account for an increasing Explosively Formed Penetrator (EFP) threat and greater need in the restrictive terrain of Afghanistan. This complicated management because the JPO could not focus on any one phase within the acquisition framework at any given time. Additionally, milestones could not be followed in their normal, sequential manner. Yet, all processes and documentation were still required (Hansen, 2008, June 10).

Typically, ACAT I programs have an Acquisition Program Baseline Agreement (APBA) approved by the MDA prior to entering the procurement phase; this was not the case for the MRAP program due to its extraordinarily rapid maturation as an ACAT I program. The APBA that was approved at the lowest level–by Vice Admiral Steve Stanley, Director, Force Structure, Resources and Assessment for the Joint Staff, who was not the MDA–was not linked to any requirement. Secretary Young, the USDAT&L, ultimately approved the program's APBA on June 16, 2008, but by that time requirements for only 1,595 of the total 15,374 remained unfilled. Programs revolve around money, and programs cannot plan their budgets or Program Objective Memorandum (POM) forecast unless they have a valid requirement (Hansen, 2008, June 10). Without the APBA, there is no link to a requirement for which to justify a budget; yet, the MRAP program was able to purchase nearly the full production run without an approved APBA or full-rate production (FRP) decision.

The MRAP program CPD approval provides an additional example. The CPD, a requirements document needed prior to the Milestone C decision, precedes acquisition actions such as the FRP decision. Yet, for the MRAP program, testing was underway for seven manufacturers, with production contracts awarded to five companies for over 2,000 vehicles, before approval of an MRAP CPD. Such "leaning forward" and tailoring of the acquisition process was common throughout the program.

2. LRIP vs. FRP

Acquisition programs require an FRP decision by the MDA prior to entering into full production. Until that decision is approved, programs are limited by regulation to producing no more than 10% of their total acquisition objective. Two requirements for this decision are the operational test and evaluation reports and live-fire test and evaluation reports. As of May 30, 2008, the MRAP program did not have those reports and, therefore, did not have an FRP decision. However, of a production objective of 15,374 vehicles, 14,146 were either already produced or on contract, greatly surpassing the LRIP restriction of 10% (Hansen, 2008, May 30). The JPO accomplished this through a series of MDA-approved LRIP purchases, another example of the tailored approach. Despite moving forward with production without the normally required documentation, the JPO nevertheless committed to producing that documentation for future reference by working with the appropriate agencies, such as the Director of Operational Test and Evaluation (DOT&E), to produce the required documentation. As the Deputy PM, Dave Hansen noted, following the conflicts in Iraq and Afghanistan and despite the lack of a long-term sustainment plan for the MRAP, the Services will keep some MRAP vehicles. The FRP documentation, with live-fire and operational test and evaluation data, will give hard, factual evidence for which vehicles are worth keeping in the inventory (Hansen, 2008, June 10).

The history of LRIP purchases of MRAP vehicles is as follows:

January 26, 2007	Award of nine competitive IDIQ contracts
February 9, 2007	Milestone C Decision
February 14, 2007	LRIP 1, contract awarded for 215 FPII and BAE vehicles
February 23, 2007	LRIP 2, contract awarded for 180 OTC (Oshkosh Truck Company), PVI (Protected Vehicles, Inc.) and GDLS vehicles
April 23, 2007	LRIP 3, contract awarded for 1,000 FPII vehicles
June 19, 2007	LRIP 5, contract awarded for 471 FPII and IMG vehicles
June 28, 2007	LRIP 6, contract awarded for 441 BAE vehicles

July 13, 2007	LRIP 7, contract awarded for 1,925 AH and IMG vehicles
August 10, 2007	LRIP 8, contract awarded for 725 FPII and GDLS vehicles
September 6, 2007	Program designated ACAT 1D
October 18, 2007	LRIP 9, contract awarded for 2,400 FPII, BAE and IMG vehicles
December 18, 2007	LRIP 10, contract awarded for 3,126 FPII, BAE, BAE-TVS,[10] and IMG vehicles
March 14, 2008	LRIP 11, contract awarded for 2,243 FPII, BAE, BAE-TVS, and IMG vehicles
May 2, 2008	LRIP 11, contract awarded for 40 BAE vehicles (Mann, 2008, slide 31)
July 17, 2008	LRIP 12, contract awarded for 773 GDLS vehicles
September 4, 2008	LRIP 13, contract awarded for 822 IMG vehicles
	(D. Hansen, personal communication, October 14, 2008)

LRIPs 12 and 13 consisted of the relatively small GDLS RG-31 Mk5e and the smaller, lighter, more maneuverable version of the IMG MaxxPro vehicle known as the MaxxPro Dash. Destined for the restrictive terrain of Afghanistan, these vehicles were selected based on the need for better off-road capability and greater maneuverability in that environment. These final LRIP orders also demonstrate the evolving requirement that shifted from focus on the threat in Iraq to the increased threat in Afghanistan.

[10] Following BAE purchase of Armor Holdings (AH), AH vehicles were produced under the BAE Tactical Vehicle Solutions (BAE-TVS) subsidiary.

3. Source Selection

The MRAP source-selection process included two phases. The first phase consisted of a technical evaluation conducted by a source-selection panel–not unlike the source-selection process for any normal program. The criteria consisted of an engineering design review, cost-realism determination, a fair-and-reasonableness cost determination, manufacturing processes and facilities evaluation, and past performance review. The source-selection committee assigned risk to the manufacturers based on the technical evaluation. For example, Oshkosh Truck Company (OTC) was rated low-risk because it offered a low-risk design; its cost and pricing information was determined fair and reasonable; it had modern and adequate manufacturing facilities; and it had favorable recent and relevant performance in government contracts. IMG, on the other hand, was rated a higher risk because of both its unique and unproven bolt-together design, and because it had no governmental past performance record. In addition, IMG had no experience with armored vehicles and depended on a foreign supplier as its source of armor. Based on the source-selection analysis and because the urgent nature of the program demanded many vehicles, the PM awarded IDIQ contracts to nine of the ten competing manufacturers, including even high-risk manufacturers such as IMG. The IDIQ contracts included immediate production orders for a minimum number of prototype vehicles for testing. Only one manufacturer was eliminated at this point based on the committee's determination that it had no chance of successfully contributing to the program.

The second component of source selection consisted of the first phase of developmental testing, known as DT-C1. Focused heavily on survivability—with a minimum level of user, safety, and automotive testing—this phase served as a screening process for the first round of large LRIP orders. Of the nine manufacturers on contract to deliver test vehicles, two failed to provide the vehicles within the 60-day requirement, and two more failed to pass threshold survivability specifications. One low-risk manufacturer, OTC, was eliminated from the program in this phase of testing—whereas IMG passed and, following further testing, went on to become the largest MRAP producer. Of the five manufacturers that successfully passed the DT-C1 requirements, all were awarded large LRIP orders. This source-selection approach allowed the JPO to quickly identify suitable vehicles, get them into production, and then steer future production orders to certain manufacturers once future phases of testing could better inform the source selection.

The decision to maximize participation and the associated competition was arguably costly; however, it improved the end product by bringing innovation to the program. IMG, which was initially deemed a high-risk manufacturer, brought both an innovative design and a manufacturing capability unequalled in the program, providing the best example of a successful and rapid expansion of the industrial base in support of the requirement. OTC failure in the first phase of testing and subsequent removal from the program demonstrates the inherently increased risk involved with relying only on low-risk manufacturers in a rapid program.

4. Contracting Strategy and Management

The contracting strategy mirrored the acquisition strategy by executing as many steps of the contracting process as possible in parallel rather than in series. The MRAP JPO contracting team started the process by awarding a sole-source contract to FPII for 288 Cougar vehicles, while simultaneously issuing an RFP to industry. The JPO did this in order to leverage an active production line and start production immediately, while also beginning to mobilize the industrial base. This competitive approach provided several important benefits. For one, it spurred innovation in that the JPO accepted different designs as long as they could meet or exceed a minimum survivability requirement. In addition, a $100,000 incentive per vehicle for early delivery of test vehicles motivated the manufacturers to deliver test vehicles earlier than their proposed schedules (2008, Owen, p. 11). The JPO contracting office also incentivized speed in delivery by establishing the order of testing based on order of delivery. For example, the first manufacturer to deliver vehicles for testing, FPII, was the first to begin DT-C1 testing. The first manufacturer to complete this testing was also the first awarded an LRIP contract. To further add leverage, the JPO made no guarantee that all manufacturers that did deliver would be awarded a production contract, thereby creating a winner-take-all possibility. Although all manufacturers that eventually passed testing were awarded LRIP contracts, manufacturers did not know that there would be multiple contracts at the time of testing. In fact, each contract had a 4,100 vehicle ceiling per year, with the intent of having enough production capacity under any one contract for the possible award of the entire requirement (then 4,066 vehicles) to a single manufacturer (Owen, 2008, p.11). This further incentivized the manufacturers to deliver first.

The initial approach of issuing IDIQ contracts followed by production orders to low-risk manufacturers prior to testing, although costly, accomplished two tasks. First, by buying all rather than a portion of the minimum amounts from each manufacturer, the Government fulfilled the obligations of the IDIQ contracts. This reduced the risk of protest or complaint over unfilled orders. Second, assuming the low-risk manufacturers would pass testing, the early production orders enabled easy transition into full production because those manufacturers were already ramping up for production. Of the nine manufacturers awarded IDIQ contracts for test vehicles, the source-selection committee assessed five as acceptably low in risk to receive LRIP contracts prior to testing. Although two of these manufacturers ultimately failed, three of the five that did meet DT-C1 requirements completed that phase of testing more prepared for production than if starting from scratch. This example demonstrates the risk acceptance and associated trade-off with this aspect of the acquisition approach. In exchange for an accelerated ramp-up of three MRAP manufacturers, the program bought 160 vehicles from OTC and Protected Vessels, Inc. (PVI), at a cost of $23 million, that it couldn't ultimately use (Hansen, 2008, June 10).

An additional aspect of the contracting strategy—intended to maximize program participation—allowed contractors to mitigate some of their production risks, performance risks and start-up costs by including all those costs up-front in higher per-vehicle prices for lower order quantities. This stepladder pricing was considered one of the most valuable business attributes of the contracting strategy; yet, it is a practice not condoned in traditional acquisition programs. In addition, it helped limit the Government's liability in the event of a contract termination (Owen, 2008, p. 11). Alpha[11] contracting was another tool used successfully in that it saved both time and money by establishing costs and prices with vendors up-front. This became apparent with the large volume of undefinitized contract actions (UCAs), engineering change proposals (ECPs), amendments, and modifications because time-consuming negotiations did not have to be conducted for each change, variant, or vendor. Additionally, it helped create a long-term partnership rather than the win-lose adversarial relationship that can occur with traditional negotiations.

The multiple-award, IDIQ, test and production acquisition strategy effectively implemented the concept of "competitive prototyping" to expedite vehicle delivery, foster competition and innovation, and provide the maximum amount of ordering flexibility available. In short, competitive prototyping sped delivery of MRAP vehicles to warfighters and led to an ever-improving product. Recognition of the advantages produced by competitive prototyping have since resulted in a mandate by the USDAT&L, John Young (2007), that all acquisition strategies requiring USDAT&L approval will require competitive, technically mature prototyping through the milestone B decision.

In spite of the contracting strategy successfully employed for the MRAP program, the lead JPO contracting officer pointed out the challenges involved. Primarily, the program lacked enough trained people to do contract work given the size of the task (L. Frazier, personal communication, July 28, 2008). At peak

---

[11] There is no formal definition of Alpha Contracting. It is a theory of acquisition reform and, in the case of the MRAP program, applied in a hybrid form due to the use of multiple manufacturers. Defined by Clements (2002, p. 58), "Alpha Contracting is a method of sole-source contracting that capitalizes on the teaming of the Government and the contractor early and throughout all stages of the acquisition process. It differs from the traditional sole-source contracting method in that it includes the contractor in the planning and development of the contract from the beginning of the process, thereby reducing the overall time to contract award."

operation, 23 personnel were on staff in the JPO contracting office, three of whom were administrative rather than contracting specialists. After peak operation, the number dropped to 14, putting significant work load on the remaining personnel. Navy contracting personnel also rotated in and out of the JPO assignment every two months (Mann, 2008, slide 6). In an effort to assist with getting trained and competent people in the contracting office, the JPO employed contract specialists under contract from two different organizations. In addition to providing personnel, these contractors also provided buildings and office space.

Another challenging aspect of the contracting process involved managing amendments (L. Frazier, personal communication, July 28, 2008). The dynamic nature of the program required numerous amendments in the three broad categories of logistics, testing, and ECPs. These three amendment categories, combined with five different manufacturers, each with multiple variants, increased the amount of contract work dramatically. Examples of contract amendments for the MRAP program were as follows:

Logistics–Initial contracts included no logistical plans due to the speed with which they were awarded. The contracts were amended after the initial award.

Testing–Changes due to testing included additions to product verification testing and plans for successive test phases. These changes were necessary due to the evolving nature of the test and evaluation master plan (TEMP).

ECPs–All ECPs were executed as a form of letter contract or UCA, meaning the contractors were awarded a contract for immediate production with all cost and pricing data agreed to as a “not-to-exceed” amount. This amount had to be definitized or finalized at a later specified date.

5. Program Evolution

Sustainment for the MRAP program was initially contracted from each manufacturer through a contractor logistics support (CLS) agreement to include parts and field service representatives (FSRs). Within a short amount of time, the requirement for the number of MRAPs grew from 1,185 to 4,066 vehicles, and then again quickly changed to 7,774. With projections of an eventual requirement for more than 10,000 MRAPs, the JPO realized by the early summer of 2007 that a pure CLS approach would not be feasible given the widely decentralized operations in Iraq. This necessitated contract renegotiations for factors such as Engineering Data for Provisioning (EDFP) and cross-training of FSRs to work on all vehicle variants as the strategy changed to reflect a hybrid/organic approach to sustainment.

Vehicle modifications dealt mostly with GFE initially. As GFE packages stabilized, modifications required during integration were incorporated at the manufacturer level, streamlining the integration effort. For example, IMG vehicles initially took up to four days for a full GFE integration, making it one of the most time-intensive integration requirements. IMG implemented approximately 30 ECPs based on interaction with SPAWAR, the GFE integrator, reducing the integration time to approximately four hours per vehicle (Major, 2008, August 22). As the program progressed, it also implemented changes based on soldier feedback and design flaws brought to light in the harsh operational environment of Iraq.

The MRAP program also grew and adapted to reflect the changing tactics of the insurgents in Iraq. Even before the end of the first phase of testing, insurgent use of EFPs increased sufficiently to warrant additional survivability measures for MRAP vehicles. The MRAP JPO responded with the MRAP expedient armor program (MEAP), which basically added additional armor to the sides of the vehicles (Hansen, 2008, June 10). The JPO implemented a three-pronged approach to the problem. First, it added additional armor to the existing MRAPs in-theater. Second, the JPO worked with MRAP manufacturers to modify the vehicle designs to allow for quick MEAP installation and to handle additional weight. The additional armor required an increase in the gross vehicle weight rating (GVWR) and an upgrade in suspension components. Third, the JPO solicited industry again with an RFP in an MRAP II competition, with the requirement of providing survivability against IED and

EFP attacks. Although the JPO contracted for and tested MRAP II vehicles, it did not make production orders for a number of reasons, to include the additional size and weight, the diminished threat in Iraq through 2008, and the added capability given existing MRAP vehicles by the MEAP program. As the most recent evolution of the MRAP program (as of this writing), the JPO is preparing to release another RFP to procure an even smaller and lighter MRAP vehicle. This program, called MRAP All Terrain Light Combat Vehicle (MATLCV), is expected to involve procurement of about 2,000 additional vehicles and require an approximate $3 billion in additional funding (Sherman, 2008).

D. Budget and Finance

The high-profile and politically charged MRAP program has been funded primarily through timely, non-standard methods—namely, supplemental appropriations, emergency appropriations, and reprogramming actions. This is extraordinary because most defense acquisition programs are funded long-term through the PPBES and the Program Objective Memorandum (POM) process and short-term through the base DoD budget. The MRAP program was not included in the FY 2007 or FY 2008 base budget because it had not been forecast, and, therefore, the Services had no long- or short-term plan for funding. In addition, through September 2007, the total requirement kept changing, making it impossible to provide an accurate budget estimate for FY 2008. For these reasons, the MRAP program relied on reprogramming actions, emergency additions to the defense appropriations, and supplemental appropriations.

A potential issue for the Army and Marine Corps concerning the MRAP program is the potential effect on funding for the JLTV program, which is intended to replace the HMMWV. Concerns over redundancy in wheeled vehicle programs led the White House Office of Management and Budget (OMB) to request a long-term strategy update in this regard. As addressed in the DoD Tactical Wheeled Vehicle Strategy released in July 2008, both the Army and Marine Corps intend to place the majority of their MRAP vehicles in war reserves and pre-position stocks (Feickert, 2008).

When a program under consideration for procurement has no long-term plan, financing that effort through normal channels such as the President's Budget or POM can be difficult, if not impossible. However, MRAP had the political backing of key members of Congress, namely Senator Joe Biden (D-DE) and Representative John Murtha (D-PA), Chairman of the House Appropriations Subcommittee on Defense who, among others, assisted in funding the MRAP program though supplemental appropriations. In addition to supplemental funding, the MRAP program received money reprogrammed from other systems. All told, despite not having a long-term plan that linked to a formal budget, the MRAP finance office has managed to execute nearly $20 billion in the form of supplemental funding, emergency funding, and reprogramming from other, lower-priority programs (Cresswell-Atkinson, 2008a).

1. Funding Actions

A list of funding actions in support of the MRAP program follows:

March 28, 2007. Tina Jonas, the DoD comptroller approved shifting $498 million from select Army and Marine Corps procurement accounts into others designated "to accelerate the procurement" of MRAP vehicles. This reprogramming action tapped into seven budget lines, diverting from programs such as the Army HMMWV program, the Marine Corps amphibious assault vehicle, and the Blue Force Tracker program (Sherman, 2007, April 26).

April 26, 2007. Senator Joe Biden introduced an amendment (#739 to the Senate Version of the 2007 *Supplemental Appropriation Bill*) to accelerate $1.5 billion in funds for the MRAP program. The amendment subsequently passed (Biden, 2007).

July 17, 2007. The JPO requested reprogramming actions of $1.165 billion among various defense appropriations to accelerate the procurement of additional MRAP vehicles (Cresswell-Atkinson, 2007).

July 31, 2007. The White House requested $5.3 billion to purchase 1,520 MRAP vehicles and provide additional parts for other MRAPs already on order. The funding request was added to the DoD's $141.7 billion request for military operations in Iraq and Afghanistan for the budget year beginning October 1, 2007 (Towell, Dagget,& Belasco, 2008, pp. 21-22).

October 3, 2007. Senator Joe Biden introduced an amendment authorizing an additional $23.6 billion for MRAP vehicles (2008, p. 67*).* Senator Biden's strong and persistent support is notable in that it coincided with his unsuccessful run for the presidency.

October 8, 2007. The chairman of the Senate Appropriation Defense Subcommittee pledged to pay for all MRAP vehicles the DoD requested. At that point, the DoD had asked Congress for $16.8 billion in FY 2008 for the MRAP program, enough for 15,374 vehicles. Of the requested MRAP funding, $5.2 billion was secured in a continuing resolution, a temporary budget stopgap for the new fiscal year that continued the previous year's funding levels until the defense appropriations bill was signed into law (Rutherford, 2007).

October 22, 2007. The President asked Congress to consider amendments to the Presidential budget request for FY 2008 that would provide additional resources for ongoing military and intelligence operations in support of OIF, OEF, and other selected international activities. This included $11 billion for the production, fielding, support, and continued advancements of MRAP vehicles under equipment, force structure, and facilities improvements (Nussle, 2007).

These examples show both the continuous efforts to establish and support the MRAP program's requirements, as well its significant political support. This political support was instrumental in the rapid funding the program received through non-standard actions, (i.e., Congressional approval of reprogramming, supplemental appropriations, and emergency additions to the base defense appropriation). Figure

5 provides the breakdown of all funding requests and appropriations through FY 2008.

MRAP Vehicle Program Funding Requests & Appropriations (RDT&E, Procurement and O&M)

$B	FY06/ Prior Funds	FY07 Bridge Supp	FY07 Bridge BTRs	FY07 Bridge ATR	FY07 Supp Request	FY07 Supp Request Amendment (Increase)	FY07 Supp Cong Add	FY07 Supp ATR	FY08 Supp Request	FY08 Supp Request Amendment Increase #1	FY08 Supp Request Amendment Increase #2	FY09 Bridge Supp Request
USMC	$0.043	$0.603		$0.428	$0.468	$0.250	$0.585	$0.119	$0.090	$2.694	$0.020	$0.436
USA	-		$0.020	$0.070	$0.520	$0.250	$0.447	$0.798		$1.764	$11.028	$1.883
USN	$0.130	$0.060			$0.129		$0.008	$0.107	$0.223	$0.093	-	$0.109
USAF	-	-			$0.015		$0.124	$0.031	$0.128	$0.630	-	$0.106
SOCOM	-	-			$0.223		$0.036	$0.110		$0.160	-	$0.076
TOTAL	**$0.173**	**$0.663**	**$0.020**	**$0.498**	**$1.355**	**$0.500**	**$1.200**	**$1.165**	**$0.441**	**$5.342**	**$11.047**	**$2.610**

$22.4B Appropriated Thru FY08

Multiple Supplemental Budget Requests, Amendments, ATRs, BTRs, Congressional Adds and Cash Flowing ensure Program Financial Success

Figure 5. MRAP Vehicle Funding Requests & Appropriations (Cresswell-Atkinson, 2008b).

2. Budget Complexity

The MRAP Vehicle program has been funded by more than $20 billion in appropriations across multiple sources and Services. Because of the size and urgency of the program, financial management has received and required a great deal of attention from Congress, OSD, the Services and the JPO. The very nature of this circumstance brings several key challenges, one of which is the magnitude and pace of the program, including its many changes. Engineering changes can happen rapidly, as often as the threat forces employ innovative approaches to out-maneuver DoD anti-IED efforts. This ultimately affects the funding requirements. Often in DoD acquisitions, this appropriation and apportionment process can take months, but all phases were conducted in parallel and, thus, were compressed into weeks, days, or hours for the MRAP program. Execution of this large magnitude of funding across multiple funding accounts must occur carefully and quickly to ensure that funds are received and obligated appropriately and in a timely manner to support mission requirements at the same time that requirements are changing. In just two fiscal years, the MRAP program executed nearly $22 billion for procurement of vehicles, GFE, logistics support, upgrades, facilities, transportation to theater and testing across multiple Army, Navy, Marine Corps, Air Force and SOCOM funding accounts. Until June 2008, and because there was no APBA, all funding obligations legally required separate OSD-level approval prior to execution (Cresswell-Atkinson, 2008c).

As previously discussed, the MRAP program did not have an approved APBA in place prior to entering the procurement phase. Key personnel instead worked quickly to develop a streamlined process to receive OSD Obligation Authority and to ensure that urgent funding documents were not delayed. Once the APBA was signed by the MDA in June 2008, the program no longer required Obligation Authority signature from the OSD (M. Cresswell-Atkinson, personal communication, July 29, 2008). As of this writing, $22.4 billion has been appropriated to the program ($5.6 billion through FY 2007 and $16.8 billion in FY 2008) for 15,374 MRAP vehicles. Of the total appropriations, $22.0 billion has been transferred to the program for obligation. Total program funding status is shown in Figure 6 and is further broken down by funding line and Service in Figure 7.

Funds Received To Date							
$M	USMC	USA	USN	USAF	SOCOM	TOTAL	
RDT&E	$258	$40				$298	
Procurement	$3,902	$14,354	$690	$887	$765	$20,598	
O&M	$289					$289	
O&M Transportation	$151	$538	$38	$46	$57	$830	
Total	**$4,600**	**$14,932**	**$728**	**$933**	**$822**	**$22,015**	Transferred to Date
						$400	Still in Transfer Fund
						$22,415	Total Appropriated

Figure 6. Program Fund Status by Per Budget Line
(Cresswell-Atkinson, 2008a, p. 1)

Funding Status- Per Budget Line							
$M	Budget Plan 15,805 Vehicles COA 1	USMC	USA	USN	USAF	SOCOM	Total Spent
Proc- Vehicles	$8,247	$1,771	$5,196	$317	$289	$215	$7,787
Proc- Prog/Other	$181	$18	$40	$0	$4	$83	$145
Proc- Autom Testing	$108	$74	$19				$93
Proc- Initial Spt/Spares/BDAR	$4,659	$381	$2,214	$50	$82	$45	$2,774
Proc- GFE	$3,505	$682	$1,684	$143	$169	$207	$2,884
Proc- Fielding/Fac	$325	$0	$277				$277
Proc- Spirals	$3,036	$243	$1,950	$33	$44	$25	$2,295
RDT&E- MRAP I	$125	$124	$19				$144
RDT&E- MRAP II	$49	$37					$37
RDT&E- Spirals	$124	$66	$20				$86
O&M- Log/Facilities	$299	$272					$272
O&M- Transportation	$830	$120	$438	$25	$10	$57	$650
Total	**$21,488**	**$3,789**	**$11,857**	**$568**	**$597**	**$632**	**$17,444**
% Comm/Service		**82%**	**79%**	**78%**	**64%**	**77%**	**79%**
Total Obligated/Service		**$3,480**	**$9,866**	**$540**	**$533**	**$508**	**$14,927**
% Oblig/Service		**76%**	**66%**	**74%**	**57%**	**62%**	**68%**

Figure 7. Program Fund Status by Service and Type
(Cresswell-Atkinson, 2008a, p. 1)

3. MRAP Approach to Funding

In an effort to ensure complicated MRAP transactions occurred in a timely fashion, communication and financial processes were streamlined across key JPO, Service, OSD and Congressional financial personnel—allowing for major funding processes and funding obligations to occur in days, and in some cases, hours. For example, several multi-million dollar contract awards were obligated by the JPO within 2 hours of OMB/OSD funding apportionment. This is remarkable given the appropriation of funds to each of the Services rather than to the JPO. The program's priority status and high-level attention allowed transfer and consolidation of these funds within a matter of minutes (Cresswell-Atkinson, 2008c).

Another key to the MRAP finance office success was the ability to successfully estimate costs and to request, receive, and execute almost $20 billion in less than 18 months. Joint cost estimating was carefully managed to understand program financial requirements, noted as a critical success by the JPO Director of Budget and Financial Management (M. Cresswell-Atkinson, personal communication, July 29, 2008).

One of the non-routine fiscal initiatives the MRAP finance office created was a special "purple account," or joint transfer account allowing for fiscal severability. This account, called the MRAP Vehicle Fund, was authorized with the passing of *Public Law 110-116*, the *FY 2008 Defense Appropriation Act*. In addition to appropriating $11.6 billion in emergency funding for the MRAP program, Section 8122[12] of this law officially granted authority to the Secretary of Defense to transfer

[12] PL 110-116, SEC. 8122. (a) Notwithstanding any other provision of law, and in addition to amounts otherwise made available by this Act, there is appropriated $11,630,000,000 for the ''Mine Resistant Ambush Protected Vehicle Fund,', to remain available until September 30, 2008. (b) The funds provided by subsection (a) shall be available to the Secretary of Defense to continue technological research and development and upgrades, to procure Mine Resistant Ambush Protected vehicles and associated support equipment, and to sustain, transport, and field Mine Resistant Ambush Protected vehicles. (c)(1) The Secretary of Defense shall transfer funds provided by subsection (a) to appropriations for operation and maintenance; procurement; and research, development, test and evaluation to accomplish the purposes specified in subsection (b). Such transferred funds shall be merged with and be available for the same purposes and for the same time period as the appropriation to which they are transferred. (2) The transfer authority provided by this subsection shall be in addition to any other transfer authority available to the Department of Defense. (3) The Secretary of Defense shall, not less than 5 days prior to making any transfer under this subsection, notify the congressional defense committees in writing of the details of the transfer. (d) The amount provided by this section is designated as an emergency requirement and necessary to meet emergency needs pursuant to subsections (a) and (b) of section 204 of S. Con. Res. 21 (110th

funds for procurement, research, development, testing and evaluation (RDT&E), and operations and maintenance (O&M) for the program (110th Congress, 2007). This account and associated procedures developed by the JPO finance office allowed for movement of funds to the required Service execution accounts with only a five-day notice to OMB and Congress. In June 2008, at the request of the JPO finance office, Congress also provided language in the *2008 Supplemental Appropriations Act, Public Law 110-252*[13], which allowed the JPO to transfer funds back into the MRAP Vehicle Fund for later transfer into other Service appropriation accounts (110th Congress, 2008). The flexibility of the MRAP Vehicle Fund and the transfer back/retransfer ability was a key factor in the program's financial success. It allowed the JPO financial manager to move financial resources into the right Service and appropriation accounts in response to changes in program requirements, with continual dialogue in the form of monthly program briefings to Congressional appropriation staffers to ensure Congress was kept informed (M. Cresswell-Atkinson, personal communication, July 29, 2008).

Prior to the creation of the MRAP Vehicle Fund, monies dedicated to the MRAP program were restricted to their respective appropriation accounts or "color of money." For example, money dedicated or "colored" specifically for procurement could not be used for testing and evaluation (T&E), but the program office did just that prior to the creation of the special fund. The "color of money" restrictions would not allow blending of funds from one account into another because these controls are intended to ensure that each dollar is spent for the purpose appropriated by Congress. This was restrictive at best and unacceptable in a fast moving, highly political program such as MRAP. The appropriation to the "purple" MRAP Vehicle

---

Congress), the concurrent resolution on the budget for fiscal year 2008. This division may be cited as the ''Department of Defense Appropriations Act, 2008'' (110th Congress, 2007, p. 47).

[13] PL 110-252, SEC. 9108 amends section 8122(c) of Public Law 110–116 by adding at the end the following: ''(4) Upon a determination that all or part of the funds transferred under paragraph (1) are not necessary to accomplish the purposes specified in subsection (b), such amounts may be transferred back to the 'Mine Resistant Ambush Protected Vehicle Fund' '' (110th Congress, 2008, p. 83).

Fund gave the JPO flexibility and earned the trust of Congress, allowing the JPO to transfer and obligate funds as needed in support of procuring MRAPs. Figure 8 shows the differences in fund flow for FY 2007 versus FY 2008 with fiscal severability and the MRAP Vehicle Fund.

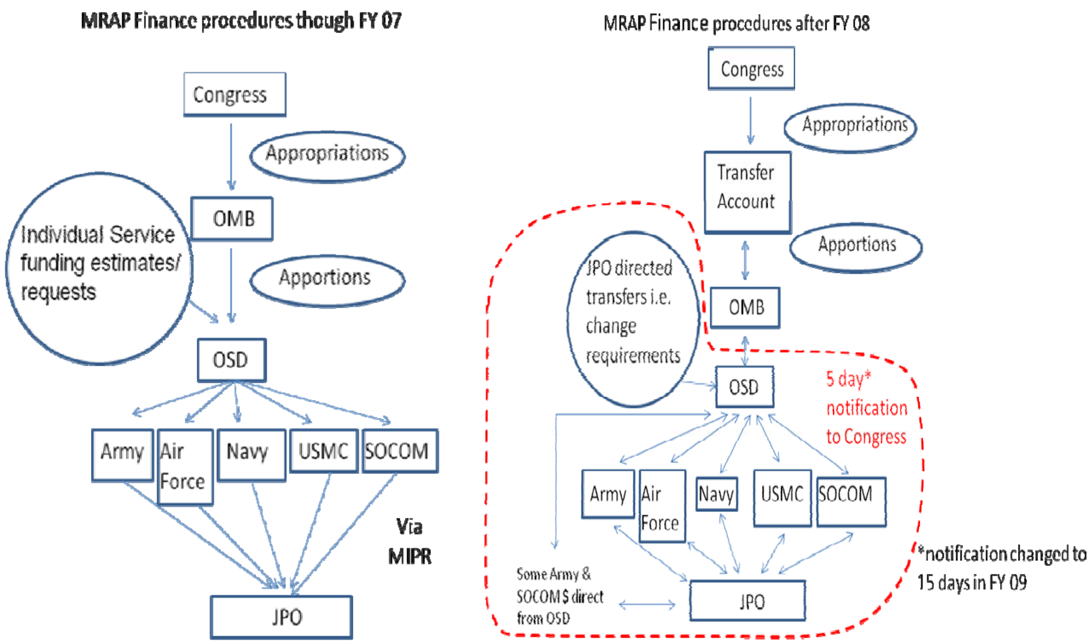


Figure 8. FY07 versus FY08 Finance Procedures
(M. Cresswell-Atkinson, personal communication, July 29, 2008)

Figures 9 and 10 summarize all contract actions for the MRAP program through July 2008.

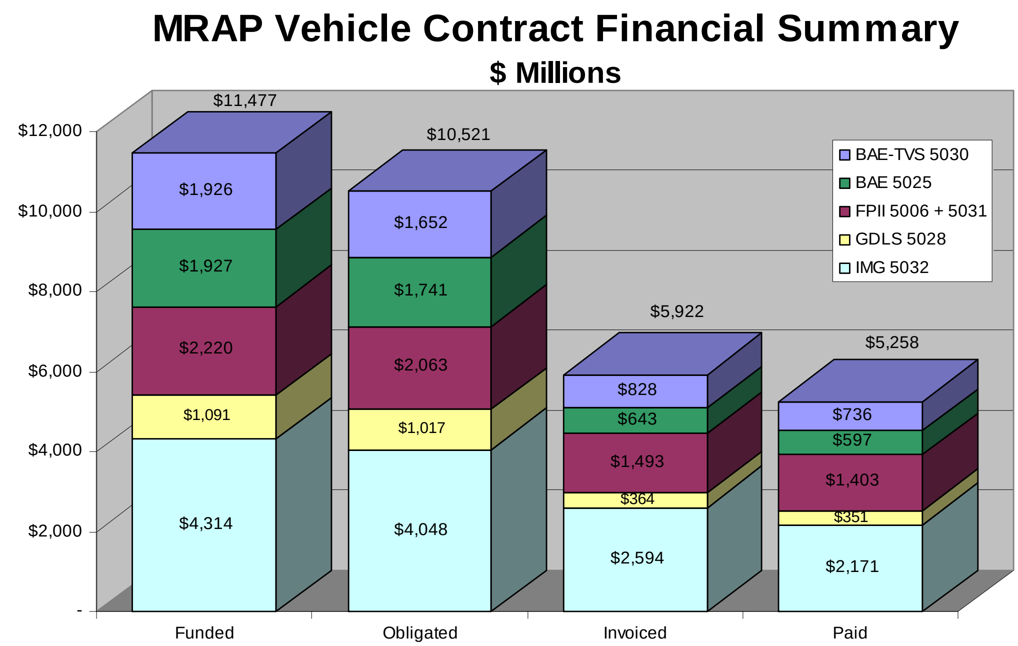


Figure 9. MRAP Vehicle Contract Financial Summary
(Cresswell-Atkinson, 2008a, p. 4)

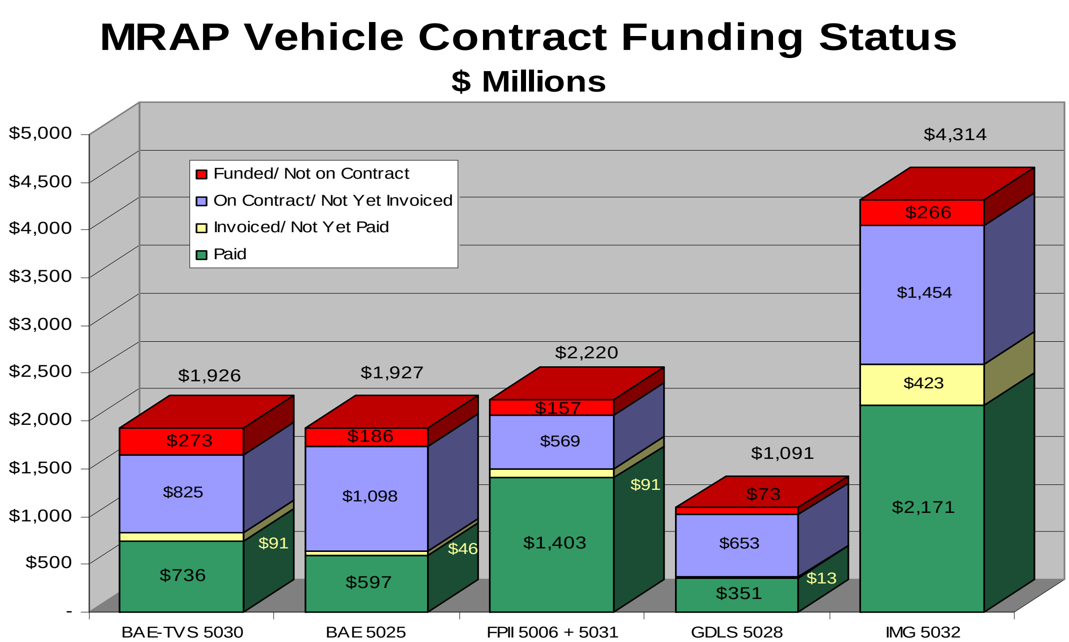


Figure 10. MRAP Vehicle Contract Funding Status
(Cresswell-Atkinson, 2008a, p. 4)

Above-threshold Reprogramming (ATR) and Below-threshold Reprogramming (BTR) techniques were used to keep production going in FY 2007 and to avoid production breaks. When Congress appropriates funding, it is for specific programs and items as represented in the budget exhibits. If the Service funding needs change, they process a reprogramming request to transfer funds from one account to another. There is a cumulative threshold per appropriated account below which Services can reprogram funding without Congressional approval—this transfer is affected via a BTR form. If the reprogramming need exceeds the threshold, then Congress must approve the transfer of funds.

The BTRs and ATRs ensured the MRAP program had sufficient FY 2007 funding to procure the maximum production rates from all qualified vendors for vehicle deliveries through February 2008. The JPO had to procure production through February 2008—while in FY 2007—because of production lead times. Vehicles procured with new FY 2008 funding (not available to the program until October 2007) would not be delivered until March 2008. Therefore, to procure production through February 2008 and prevent a break in production, while in 4th Quarter FY 2007, the JPO relied on ATR and BTR reprogramming (M. Cresswell-Atkinson, personal communication, July 29, 2008).

E. Key Factors and Trade-offs

Analysis of the programmatic and contracting processes applied in the MRAP program indicates several factors critical to the JPO success in meeting the program objectives. Chief among these factors was the multiple award, IDIQ, test-and-production acquisition strategy that was designed with the focused intent of rapidly meeting urgent warfighter needs. This acquisition strategy included a tailored approach to the acquisition process, allowing concurrent, rather than sequential, execution of all acquisition phases. It applied competitive prototyping to expedite vehicle delivery, foster competition and innovation, and provide maximum ordering flexibility to the PM. It used threshold testing as an initial means of source selection, and it accepted a multiple-manufacturer approach as a way of rapidly expanding the industrial base and maximizing production capacity. Finally, the strategy involved identifying low-risk manufacturers and awarding production orders prior to testing as a way of ramping-up production capacity.

From a contracting perspective, the JPO used multiple IDIQ contracts with immediate production orders and performance incentives to motivate manufacturers and maximize industry participation. The contracting strategy also included the use of stepladder pricing to allow manufacturers to mitigate start-up, production, and performance risk by charging higher per-vehicle prices for smaller orders. Finally, the MRAP contracting team employed alpha contracting as a way of minimizing the negotiations involved with UCAs, ECPs, amendments, and other contract modifications that were prevalent in the program. These contracting techniques not only decreased the risk of protest and liability for the Government, but also assisted in creating long-term partnerships for the program.

From a budgeting and finance perspective, the MRAP program obviously would not have been possible without the tremendous political support of Congress and the president, reflected in more than $22 billion in program funding through FY 2008. This political support also led to the creation of one of the most important fiscal initiatives implemented by the JPO finance office. The special transfer account, known as the MRAP Vehicle Fund, allowed money normally appropriated to specific accounts to be allocated and mixed together without regard to specific appropriation controls at the discretion of the program office, permitted by the underlying support of Congress, OMB and the DoD comptroller. This allowed the JPO to quickly obligate funding from all Services and provided the flexibility needed to quickly react to the changing program requirements.

The aforementioned factors, which by no means represent a comprehensive list of the elements critical to the program success, group into two broad categories. The first is the element of concurrency, which was a key component in the acquisition strategy. Simultaneous execution of the normally sequential acquisition phases, combined with concurrent and continuous activities within those phases, compressed the program acquisition timeline more than any other single factor. A few examples of concurrency were procurement actions prior to approval of an APBA, simultaneous developmental testing and production of vehicles, and continuous refinement of performance requirements in response to the evolving threat.

The second broad category enabling the MRAP program's rapid execution, which goes hand-in-hand with concurrency, is risk acceptance. The sequential and deliberate defense acquisition framework is designed to minimize risk. The strategy of concurrency, therefore, represents the most vivid example of risk acceptance in the MRAP program and forms the basis for very specific instances of risk acceptance. For example, by awarding production orders prior to threshold and user testing, the PM accepted the risk of procuring a small number of vehicles that were ultimately unusable. In addition, by using survivability-focused threshold testing as a form of source selection, the program accepted the risk of fielding vehicles that were unreliable and difficult to sustain in an operational environment.

Risk acceptance in any situation does not come without a reciprocal trade-off. The MRAP program, therefore, made numerous trade-offs in support of the program strategy. As a first example, the use of multiple manufacturers sped delivery of large quantities of vehicles to warfighters, but it did so at the expense of complexity in sustainment, increased training requirements for Soldiers and Marines, and higher lifecycle costs. As another example, the award of production contracts prior to threshold testing resulted in the procurement of 160 vehicles at a cost of $23 million that were ultimately determined unusable in Iraq or Afghanistan; this trade-off should be considered, however, with respect to the three successful manufacturers that were similarly awarded early production contracts and, therefore, sped vehicle deliveries to warfighters. Finally, the use of a commercially available solution, as opposed to full-scale development based on thorough analysis of a user-generated requirement, resulted in a vehicle that was adequate, but not ideally suited to the operational environment

In conclusion, the program's focus on concurrency and risk acceptance, enabled by its unprecedented political support, established the conditions necessary for success in meeting program objectives of fielding as many survivable vehicles as quickly as possible while expanding the industrial base. As subsequent analysis will show, these themes permeated every facet of the MRAP program.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. Testing and Evaluation (T&E)[14]

A. T&E Planning and Strategy

Concurrent with the release of the original MRAP RFP in November 2006, MARCORSYSCOM and the Marine Corps Operational Test and Evaluation Activity (MCOTEA) established a Test Integration Working Group (TIWG) with the Aberdeen Test Center (ATC), the Army Research Lab (ARL), and the Director, Operational Test and Evaluation (DOT&E). The purpose of the TIWG was to determine and discuss T&E and Title 10[15] requirements, T&E funding requirements, and the requisite reports needed for rapid fielding. Through the work of this group and interaction with component acquisition agencies, a modified T&E strategy and plan was developed, combining developmental, operational, and live-fire test events where possible. In addition, the JPO made an early commitment to develop a DoD-compliant test and evaluation master plan (TEMP) to capture the evolving requirements of the program. The initial cooperation between all stakeholders involved in the T&E effort was instrumental in the success of the program, and, Owen writes,

> the decision to construct an "evolving" TEMP, without the benefit of a program CDD or CPD, was instrumental in forging a unified MRAP T&E strategy and framework, managing initial T&E risk, and developing the overarching DT (developmental testing) and OT (operational testing) activities required by DoD regulation or statute. (Owen, 2008, p. 12)

In addition, early construction of this TEMP resulted in early cooperation between test agencies and conveyed the overall DT and OT plans to key DoD decision-makers, resulting in expedited funding for T&E resources.

---

[14] Unless otherwise cited, the information from this section was drawn largely from an interview with the Aberdeen Test Center Commander (Rooney, 2008, August 7).

[15] Title 10 of the *US Code* is the law governing all aspects of the armed forces.

The bulk of developmental testing for MRAP vehicles was conducted at the Aberdeen Test Center in Maryland. This test center is the lead DoD asset for automotive, manned and unmanned ground vehicle, gun and munitions, and live-fire vulnerability and lethality testing (Aberdeen Test Center, 2008, August 17). COL John Rooney, who took command of the test center in June 2005, was involved with the first bolt-on armor kits that were the initial solution to the IED threat. As such, he has been involved with the MRAP program from its start and has been instrumental to its success.

COL Rooney first learned of the MRAP program in November 2006 during a conversation with Paul Mann, who became the MRAP Joint Program Manager that December. Upon learning of the scope, timing, and priority of the program, COL Rooney immediately began planning for the testing. He determined that an approximate 250-member team would be required, and he started building this team from within his 2,000-member organization, as well as hiring new personnel to backfill for these new positions. He also analyzed the scope of the program and determined two major shortfalls in the test center's capacity that would slow the test process: a limited number of survivability ranges and anthropomorphic test devices (test dummies). COL Rooney needed a $12 million investment in the survivability ranges, which he secured by leveraging the importance of the MRAP program. This allowed him to triple the center's test capacity between December 2006 and March 2007. In addition, he built, over time, the quantity of anthropomorphic test devices from eight at the program start to 45, at the time of this report. These facility and equipment upgrades were key to the program's success because of the time-intensive nature of the set-up and the data collection involved in survivability testing.

In conjunction with the MRAP JPO, COL Rooney's team developed an aggressive test program that fed directly into source selection. In effect, the program office established threshold specifications based primarily on survivability. As soon as manufacturers delivered test vehicles to Aberdeen, those vehicles were tested as per this plan. Manufacturers meeting initial thresholds for survivability as well as basic automotive characteristics were given production contracts. Although, as explained above, all vehicles meeting those standards were ultimately purchased, the process started as a competition of sorts—with the first vendor whose vehicle or vehicles successfully passed the testing program possibly receiving all of the initial orders. This screening process, heavily focused on survivability but much less on reliability and maintainability, introduced significant risk to the program, but it also added two notable benefits. First, the promise of multiple awards incentivized multiple manufacturers to participate in the process. Second, the promise of award to the first successful vehicle or vehicles, with additional incentives for delivery ahead of schedule, led manufacturers to deliver test vehicles quickly and to modify designs based on test feedback. The program manager accepted risk with the T&E plan but, in doing so, added speed to the procurement process. In addition, competition among manufacturers improved the quality of products available to the program in later contracts.

B. T&E Execution

The developmental test program was designed and conducted in three phases. Developmental Test C1 (DT-C1) consisted of threshold testing with an approximate ratio of 90% focus on survivability and 10% on automotive (Hansen, 2008, May 30). It also included a limited user test, in which a platoon of Soldiers and a platoon of Marines with operational experience conducted operational tests on the vehicles. Results of both the threshold and the user testing were immediately fed to manufacturers for potential changes that were quickly retested. To be considered a suitable MRAP, each vehicle had to complete DT-C1 with a green (no deficiencies) rating on survivability and green or amber (some minor deficiencies) in automotive and user tests. Of the seven manufacturers that submitted vehicles for testing during MRAP I, five had a vehicle in at least one class[16] that met the required

---

[16] Some manufacturers submitted vehicles for more than one category. IMG, for example, submitted Category 1 and 2 versions of the MaxxPro. Although the Category II version was rated green in

thresholds of DT-C1 and were determined suitable during user tests; all five manufacturers were subsequently awarded production contracts. A listing of DT-C1 activities is shown in Figure 11.

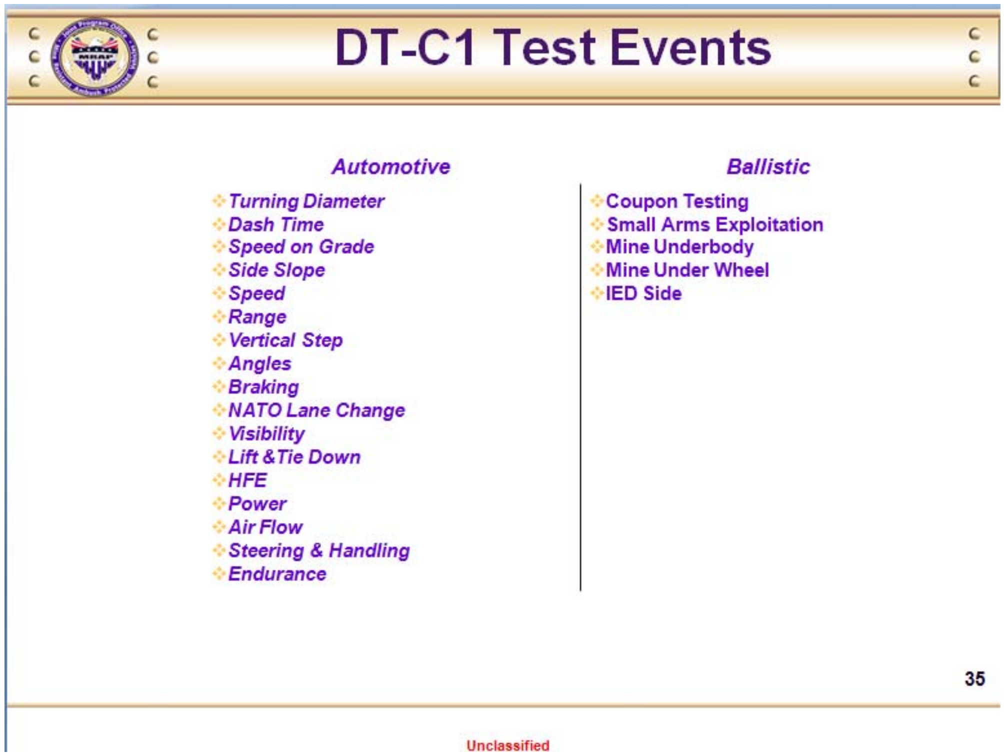


Figure 11. DT-C1 Test Overview
(Mann, 2008, slide 35)

One notable risk taken during DT-C1 involved the GFE, such as communications gear and IED jammers. At this early stage of the program, the GFE package for each Service and vehicle configuration was undetermined. Consequently, the vehicles were not tested in their exact operational set-up. To mitigate, the test team used surrogate weight for likely GFE equipment. Additionally, the test team worked closely with the integration team at SPAWAR in Charleston,

survivability, it was found unacceptable in terms of payload. The Category 1 version was rated green in both categories.

SC, to retest as necessary once the GFE packages were determined for each vehicle.

Developmental Test C2 (DT-C2), shown in Figure 12, consisted of more in-depth automotive and particular endurance testing, plus additional survivability testing.

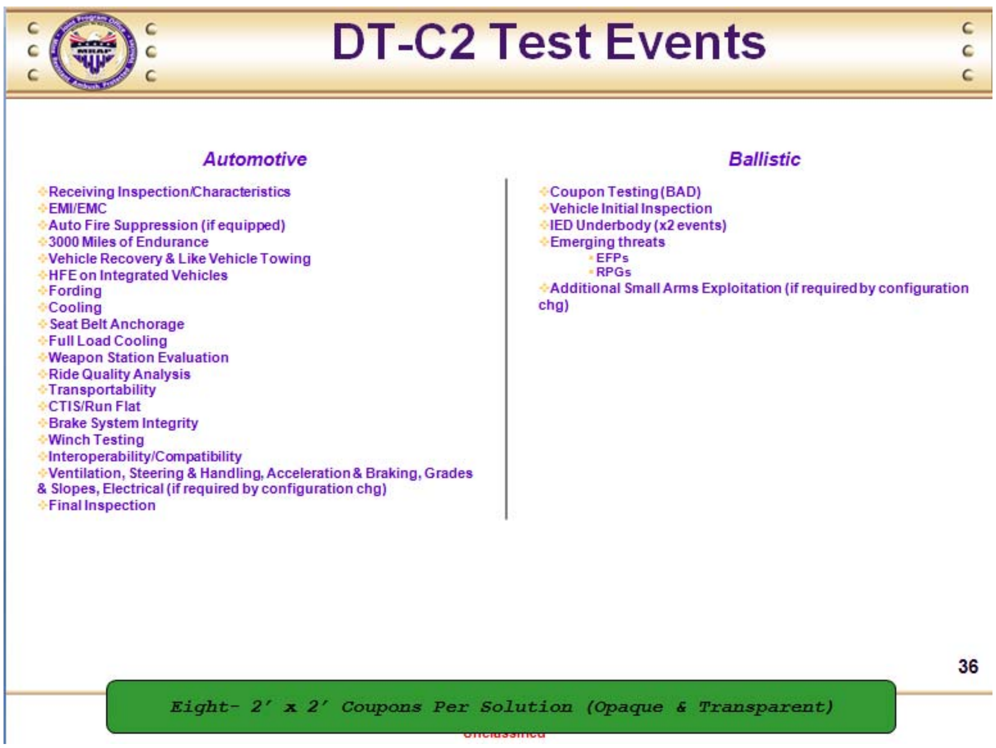


Figure 12. DT-C2 Test Overview
(Mann, 2008, slide 36)

Developmental Test C3 (DT-C3), shown in Figure 13, added yet another level of automotive and survivability testing and added non-ballistic survivability testing as well. Survivability testing includes extensive use of anthropomorphic test devices, which makes set-up and data collection both time and resource intensive, but it also provides an in-depth characterization of the vehicle and the protection it provides to every passenger in a vehicle.

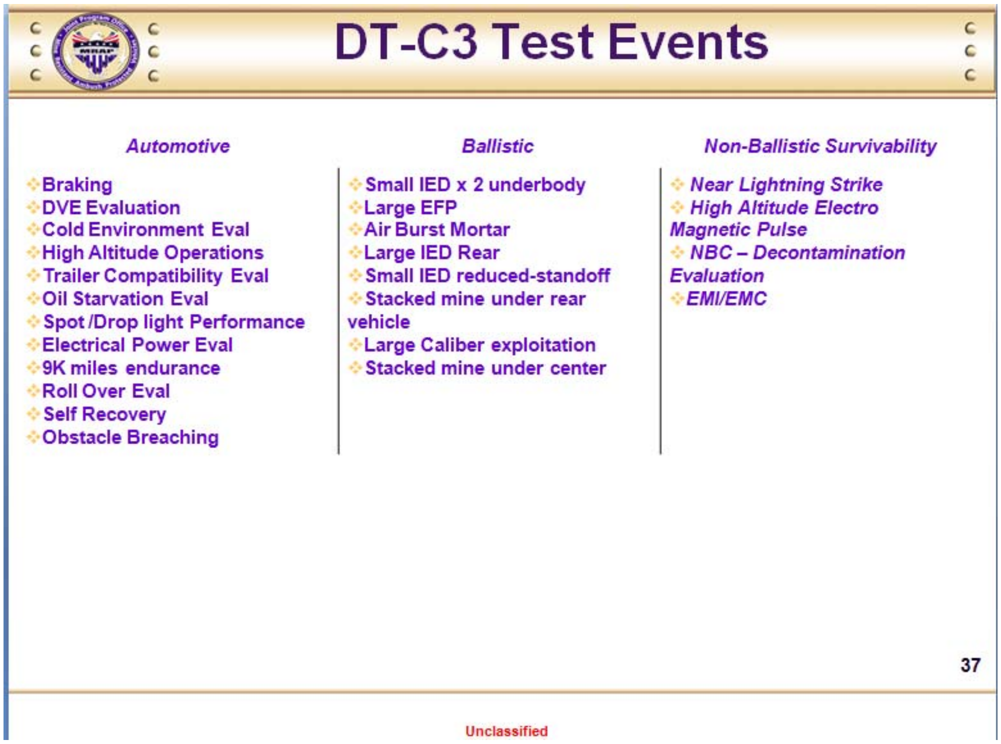


Figure 13. DT-C3 Test Overview
(Mann, 2008, slide 37)

Whereas DT-C1 focused on threshold testing for minimum acceptable performance, DT-C2 and DT-C3 focused more on objective requirements and, in some cases, testing to failure. This full test strategy, shown in Figure 14, allowed the PM to quickly determine which vehicles met minimum requirements and send them into production. After that, the DT-C2 and C3 tests were designed and used to provide full characterization of the vehicle for potential design changes, future procurement decisions, and for the long-term benefit of the vehicle's program office and users. This test strategy represents a hybrid approach in that it combines developmental, operational, and live-fire testing, rather than conducting them as separate phases of the test and evaluation program. Also notable is that given the urgent need and rapid fielding of these vehicles as they came off production lines, the program still conducted an initial operational test and evaluation (IOT&E). This month-long test, which provides required feedback for any FRP decision, was conducted in September 2007 at Yuma Proving Ground. At this point in the program, however, several thousand vehicles were already under contract with manufacturers ramping toward full capacity. This example demonstrates the unique nature of the MRAP program in that the T&E plan was fully executed (and continues to be), with a level of detail on par with any other major program. The difference and associated trade-off in this case, however, is that most of the production and source-selection decisions were made before the test results could fully inform the final design and production.

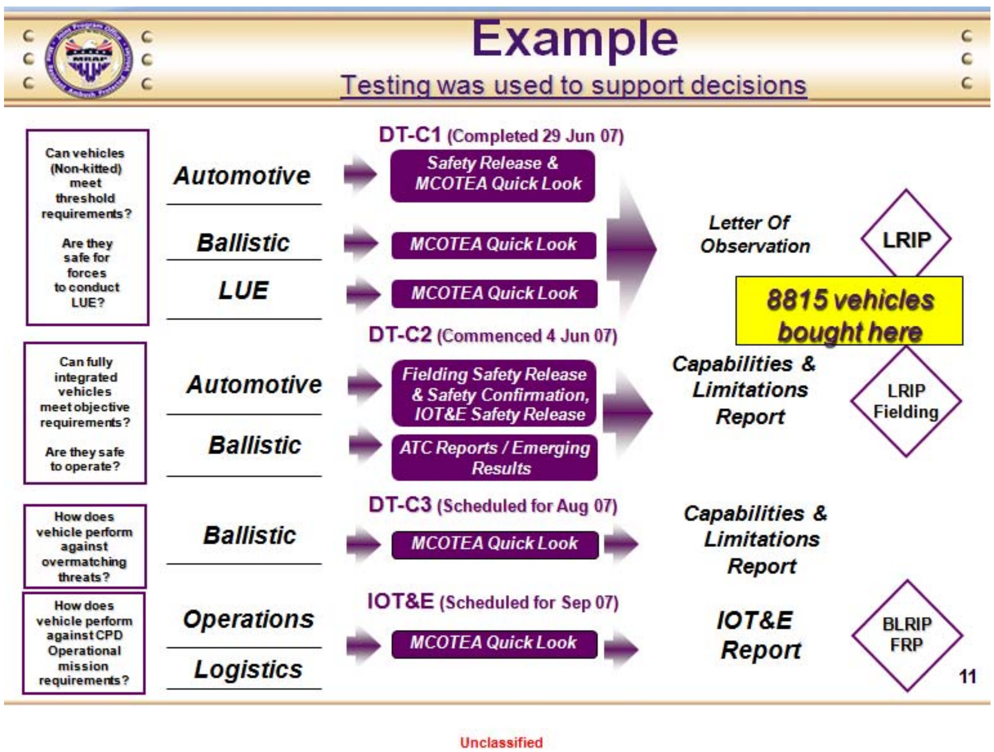


Figure 14. MRAP Test Overview
(Mann, 2008, slide 11)

C. Key Factors and Trade-offs

Testing for the MRAP program is unique in many ways. The unprecedented funding, political pressure from numerous sources, and emphasis by senior leaders in the DoD—including the Secretary of Defense—gave this program advantages that will be difficult to replicate in any situation other than emergency measures targeted at saving lives. These conditions allowed the rapid expansion of the test facilities needed to support the rapid testing. They also set the conditions whereby numerous vehicles would be available for testing. At the time of this report, 58 MRAP vehicles are present at the Aberdeen Test Center. Although this is unrealistic for most test programs, it is an integral part of the program plan, which enables concurrent survivability and automotive testing. Normally, prototype vehicles are limited such that all automotive testing must be done before proceeding with destructive survivability testing.

From COL Rooney's perspective, "No program has embraced testing more or better than MRAP" (2008, August 7). He attributes this to the constant JPO focus on the goal of getting the maximum number of survivable vehicles to warfighters in the shortest time possible. At least four factors were critical to the T&E effort for the MRAP program. First, the early formation of the TIWG fostered cooperation and frequent communication between all parties involved in the T&E effort. This structure enabled development of an effective and flexible TEMP and assisted the program in getting the resources needed in the effort. Second, the use of multiple manufacturers with constant on-site presence during the T&E fostered competition and rapid feedback of T&E into design changes. This enabled the JPO to determine the best materiel solution from across industry, and the on-site competition established an atmosphere of improvement among the manufacturers. Third, the presence of multiple test vehicles for each variant enabled the JPO to determine the capabilities and limitations of each variant faster and more thoroughly. Cases in which the test center has only one prototype require that destructive survivability testing be conducted after automotive testing, which slows the process. Multiple prototypes for the MRAP T&E allowed for a concurrent and continuous T&E effort. Finally, whereas some program managers dispute or are unreceptive to negative test results, the MRAP PM was fully committed to the test program. As a result, the JPO learned capabilities and limitations of each variant faster and more thoroughly. Although these factors are arguably due to the unique nature of the requirement as addressed earlier, the researchers believe that these lessons should be applied to the maximum extent possible in future programs, whether rapid or standard in nature.

As with all decisions, trade-offs were a necessary part of the T&E plan for the MRAP program. The first and most obvious trade-off in this case involved the heavy emphasis on survivability during DT-C1—at the expense of reliability, maintainability, and other supportability issues. The PM accepted significant risk in that some of the vehicles fielded, although survivable, may have been difficult to sustain and may have had low operational availability. A second trade-off involved the prioritization of the MRAP ahead of existing and ongoing acquisition programs. As a result of the un-forecasted MRAP T&E requirements, personnel and other resources were reallocated from some programs. Consequently, some schedules were adjusted, and programs had to replace reassigned personnel; however, no program missed an acquisition decision based on changes made at the Aberdeen Test Center due to MRAP T&E requirements. In addition, the MRAP program provided a silver lining for existing and future programs with the facility and equipment upgrades it brought to Aberdeen.

THIS PAGE INTENTIONALLY LEFT BLANK

V. Production and Integration

The MRAP production and integration process is best examined in terms of the value stream from subcomponents through the final integration effort and transportation to warfighters in Iraq and Afghanistan. This basic process, as shown in Figure 15, begins with the numerous suppliers to the five prime contractors manufacturing the vehicles. These suppliers produce the components and subassemblies such as engines, transmissions, axles, and seats. Within this supply base exists some of the bottlenecks associated with MRAP production, such as armor and, initially, tires. To demonstrate the complexity at this level, the JPO has identified 62 major Tier- 2 vendors[17] for 15 critical sub-assemblies (Hansen, 2008, June 4, slide 11).

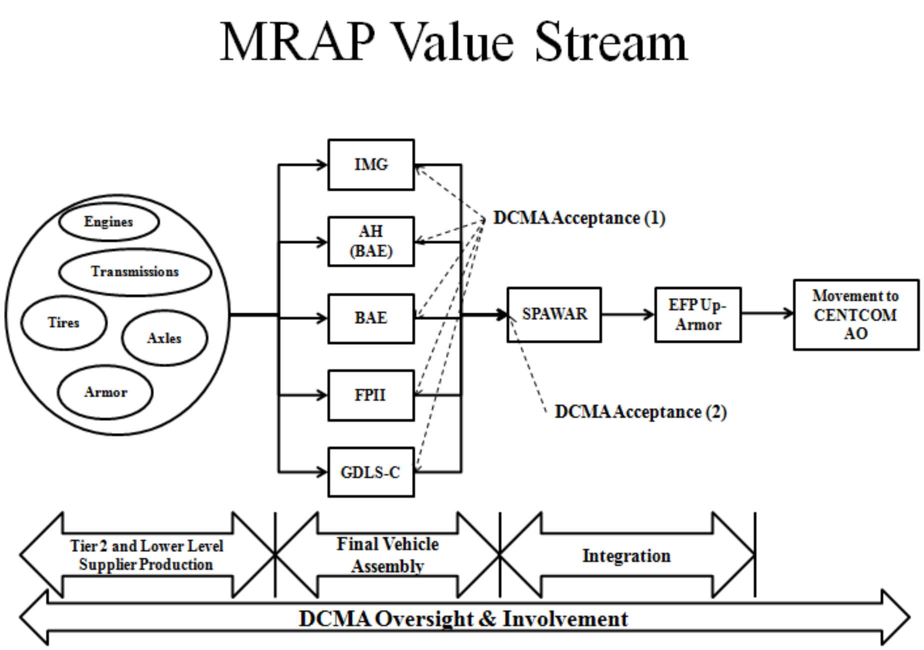


Figure 15. MRAP Production Value Stream

[17] Tier-2 and lower-level vendors refer to the supply chain below the prime contractors.

Following Tier-2 and lower-level suppliers, the value stream flows to the prime contractor level, in which the vehicles are assembled and receive the first DCMA acceptance inspection. Upon inspection, vehicles from all five manufacturers are delivered to SPAWAR in Charleston, SC, for integration and installation of GFE. At this site, DCMA conducts yet another acceptance inspection and works with the prime contractors to resolve any quality issues during the GFE integration and installation phase. Given the multiple vehicle variants and ever-changing GFE requirements that vary by Service, the integration effort at SPAWAR was an initial area of concern and bottleneck in the production process. Following integration, selected vehicles are fitted with MEAP (MRAP Expedient Armor Program)[18] armor at multiple facilities in the Charleston area and are then moved to the Port of Charleston or Charleston Air Force Base for movement to the CENTCOM area of operations (AO).

This next section of the report focuses on key processes within the value stream, starting with critical resource constraints at the supplier level and actions taken to mitigate these potential bottlenecks to production. It also provides an overview of the actual production process, with vignettes from two of the largest MRAP manufacturers, a major Tier-2 supplier, and the integration effort at SPAWAR. The interaction and quality assurance provided by DCMA is critical throughout this process and is also examined.

A. Resource Constraints

Some of the primary components and subassemblies supplied at the Tier-2 level include axles from three manufacturers, four different engines from three manufacturers, multiple transmissions from one manufacturer, and suspension components from nine manufacturers (Hansen, 2008, June 4, slide 11; MRAP JPO,

---

[18] MEAP is additional armor applied to the sides of MRAP vehicles as added protection against explosively formed penetrators (EFP) which became prevalent after the start of the MRAP program. It is installed in the Charleston area vice at the OEM (original equipment manufacturer) site due to its weight and bulk.

2008, June 2). Of these items, as well as most other components, sufficient capacity existed within the defense and commercial industrial bases to meet the demands of the MRAP program. When added to existing demands from commercial businesses as well as other programs within the DoD, however, this spike in demand posed potential limits on production rates. These limits were in many cases unknown and dependent on how lower-level suppliers would react to the increased demand for their products. Some of the resource constraints were identified or clarified through industrial surveys conducted by the Office of the Deputy Undersecretary of Defense for Industrial Policy. These surveys helped to define production limits in steel and in the heavy tires needed for the vehicles (Hansen, 2008, May 30).

To mitigate these potential bottlenecks, three major actions were taken to prioritize and increase production of necessary components and materials for the MRAP program. First, on May 2, 2007, Secretary of Defense Robert Gates issued a memorandum stating the following:

> The MRAP program should be considered the highest priority Department of Defense acquisition program and any and all options to accelerate the production and fielding of this capability to the theater should be identified, assessed and applied where feasible. In this regard, I would like to know what funding, materiel, program, legal or other limits currently constrains the program and the options available to overcome them. This should include an examination of all applicable statutory authorities available to the Secretary of Defense or the President. (Owen, 2008, p. 14)

Concurrent with this memo, Secretary Gates directed the establishment of a DoD MRAP Task Force whose objective was to “get as many of these vehicles to our Soldiers and Marines in the field as is possible in the next several months” (Young et al., 2007, p. 2). Not only did this clearly establish the MRAP program as the top priority for all resources and effort within the DoD, the task force and its direct reporting line to the Secretary added an additional level of pressure to all program participants and stakeholders. In effect, the memorandum directed all officials involved in the program to identify any issues that might constrain the program and take action to mitigate them. One such example occurred on May 22, 2007, when Dr. Delores Etter, the Navy Acquisition Executive, approved an exception to Title 10 *US Code*, section 2533b, which "prohibits DoD from procuring end-items, or components thereof, containing specialty metals not melted or produced in the United States" (Young et al., 2007, p. 7). Such exceptions were made and waivers requested in many cases based on this direct guidance from the Secretary of Defense.

This top-level prioritization also provided emphasis and direction to industry, which had competing requirements in both government and commercial work. The effect of this public prioritization must also be considered within the context of the situation on the ground in Iraq. In May 2007, casualties were at their highest sustained rate of the war (Office of the Secretary of Defense, 2008). The combination of these two factors effectively created a moral imperative for industry to support the program.

The second action, which flowed directly from the prioritization, occurred on June 1, 2007, when Secretary Gates approved a DX rating under the Defense Priorities and Allocation System (DPAS) (Young et al., 2007, p. 5). As outlined in *Federal Acquisition Regulation (FAR)* Subpart 11.6, a DX rating is the highest priority rating and requires preferential acceptance and performance of contracts and orders supporting certain approved national defense programs (DoD, 2008). This rare step prioritized the MRAP program by law within American industry, requiring all MRAP-related orders to be filled first and ahead of existing orders, with the exception of other DX-rated orders.[19] The DX rating assisted FPII in eliminating a potential bottleneck in transfer case availability due to insufficient production

---

[19] DPAS provides two levels of priority for rated orders, DO and DX. DX-rated orders take priority over all unrated and DO-rated orders. Multiple DX-rated orders hold the same level of priority; therefore, multiple DX-rated orders are handled on a first-in, first-out basis. Based on the small number of DX-rated programs, the MRAP program did not encounter any conflicts with other DX-rated orders.

capacity of a specific tapered roller bearing (Walsh, 2008a, August 6). Although IMG had no significant sourcing issues, SFI Fabrication—a Tier-2 supplier—used the DX rating to buy welding equipment and a laser cutting machine within weeks when such acquisitions would typically take months (Carr, Collins & Daniel, 2008, August 22). These examples show that the DX rating is a very powerful tool for use in a rapid acquisition program. Although it varies in importance by manufacturer, it is critical throughout the supply chain.

As John Young,[20] then-MRAP Task Force Chairman, pointed out on November 8, 2007, "DX ratings provide the most important DoD programs priority access to scarce production resources; however, they do not resolve fundamental production capacity shortfalls" (Young et al., 2007, p. 5). This reality led to the third major action—direct intervention by the DoD in the areas of industry where production capacity did not meet the need. Specifically, this involved tires and steel. In July 2007, industrial surveys indicated a production capacity of tires for MRAP-class vehicles at less than 1,000 per month. With a planned production rate of 1,196 vehicles per month, this was well short of the needed capacity (p. 6). The DoD provided $4 million to the Defense Logistics Agency (DLA) to purchase additional tire molds for the then-sole-source supplier, Michelin, to expand production (Castellaw, 2007, p. 5). In addition, the DoD added Goodyear as a second source, increasing capacity to approximately 17,000 tires per month in January 2008 (Young et al., 2007, p. 6). This addition provided the capacity to meet not only new vehicle production but also the requirement for operational spares and replacements.

The second major capacity shortage—production of steel—also required considerable attention. The total DoD demand for steel is only a fraction of the US production capacity, but armor steel plate and thin gauge, quenched, and tempered steel required for MRAP vehicles are niche requirements within that industry. These

[20] The Honorable John J. Young, Jr., is the Undersecretary of Defense for Acquisition, Technology, and Logistics, current as of this writing.

specialty steels require unique processes and equipment that are available in only a few places (Young et al., 2007, pp. 6-7). To increase capacity, the JPO and MRAP Task Force advance procured two types of steel (P900 and High-hard), qualified additional sources of steel to increase the defense industrial base, and made a specification change (qualified ASTM 4330/4130 & AL521 steel as alternatives to MIL-A-46100 High-hard steel) to increase material options (Steinholtz, 2007, slides 6-7). The program also used the waiver process as described above to qualify and buy from overseas sources. These actions increased capacity from about 8,400 tons of the specialty steel per month at the program start to 20,900 tons per month by November 2007 (Young et al., 2007, pp. 7-8).

The resource constraints and actions taken to mitigate them demonstrate the range of tools available within the DoD for a rapid acquisition. By issuing clear guidance on priority, invoking the Defense Priorities and Allocation System, obtaining waivers to statutory requirements, and intervening where necessary in the supply chain, officials involved with the program virtually eliminated the bottlenecks in resources needed for desired production rates.

B. Manufacturer Vignettes

As previously discussed, nine manufacturers responded to the original request for proposal, with seven manufacturers' vehicles tested and five awarded production contracts. These manufacturers ranged from traditional US defense contractors such as BAE Systems (BAE), General Dynamics Land Systems (GDLS), and Armor Holdings (AH);[21] to niche manufacturer Force Protection Industries, Inc. (FPII); and to a subsidiary of a large commercial manufacturer with no recent defense business, International Military and Government, LLC (IMG). This section will provide an overview of two of those manufacturers, FPII and IMG, and their

---

[21] Armor Holdings' Caiman Vehicle is produced by its subsidiary Stewart and Stevenson, maker of the DoD's family of Medium Tactical Vehicles. Armor Holdings is now owned by BAE Systems and operates as BAE-Tactical Vehicle Solutions (BAE-TVS).

history in the program. It also provides insight at the lower levels of the supply chain with a vignette on an IMG supplier, SFI Fabrication.

1. Force Protection Industries, Incorporated (FPII)

Force Protection Industries, Incorporated (FPII) traces its roots to the civil wars of southern Africa in the 1960s and 1970s. Prevalent in these conflicts was the use of land mines and other explosive devices, very similar in nature to the threats that US and coalition forces initially faced in Iraq and Afghanistan. In response to significant casualties from these attacks, the South African Government tasked its Council for Scientific and Industrial Research (CSIR) with developing technologies to increase their soldiers' survivability. CSIR, formed in 1945, "undertakes directed and multidisciplinary research, technological innovation as well as industrial and scientific development to improve the quality of life of the country's people" (Council for Scientific and Industrial Research, 2008). Out of this research came the basic MRAP technology used today (Walsh, 2008a, August 6). Namely, this includes a monocoque, raised, V-shaped, armored hull to deflect the force of a blast outward from the vehicle.

A young chemist named Dr. Vernon Joynt was one of the lead scientists working on the counter-mine program for CSIR. In the mid-1990s, Dr. Joynt, along with a Rhodesian Special Air Service officer, Garth Barrett, brought the MRAP technology to the United States with the goal of capitalizing on the then-prevalent humanitarian de-mining operations being sponsored by the United Nations. They developed a three-vehicle concept for route clearance operations and in 1997 formed a company called Technical Solutions Group (TSG). Within this concept, one vehicle provided security, a second vehicle searched for mines or IEDs using ground penetrating radar and other sensors, and the final vehicle (the Buffalo) interrogated potential threats using its robotic arm and claw (2008a, August 6). In 2002, the company was purchased by Force Protection, Inc., and went public on the NASDAQ exchange.

The US Army first purchased an FPII (TSG at that time) vehicle in 2000, when Communication and Electronics Command (CECOM)—in an effort to find a mine-protected clearance vehicle—bought one Buffalo for testing under a Foreign Comparative Test Program.[22] In 2001, the Army bought another Buffalo for testing and, in 2002, bought 10 more for contingency purposes. Between then and 2006, the Army bought an additional 76 Buffalos, and the Marine Corps began purchasing Buffalos and a smaller MRAP variant and forerunner to the Cougar vehicle, the JERRV (Inspector General, 2007, pp. 5-6). This gradual build-up of sales enabled FPII to grow from 150 employees and $10 million in revenue in 2004 to 750 employees and nearly $200 million in revenue in 2006 (Walsh, 2008a, August 6). In addition, these early sales positioned FPII as the leader in the MRAP program that started in November 2006. Not only did FPII have the only products that had been tested and used in Iraq, they also had an active production base. For these reasons, the MRAP JPO accepted risk early in the program, awarding a sole-source contract for FPII Cougar and Buffalo vehicles, prior to the start of developmental testing at Aberdeen Proving Grounds.

FPII currently manufactures MRAP vehicles at its Ladson, SC, facility, operates a blast and ballistic testing facility at Edgefield, SC, and conducts research and development at a facility in Summerville, SC. In addition, FPII acquired a separate production facility in Roxboro, SC, and entered into agreements with other manufacturers to expand capacity if necessary. The company currently employs approximately 1,500 personnel, down from a peak of over 2,000 at the end of 2007 (Walsh, 2008a, August 6). Unlike other MRAP producers, FPII business is dedicated almost exclusively to MRAP vehicles. Consequently, the long-term sustainability of the current size and work force of FPII is uncertain given the expected short duration of the MRAP program.

---

[22] This program leverages foreign technology to meet requirements, thereby avoiding redundant research and development and lowering procurement cost and time (Office of the Secretary of Defense, n.d.).

The primary products from FPII are the Buffalo (CAT III) and Cougar family of vehicles (in CAT I and II versions), as shown in Figures 16 and 17. The company is also developing a smaller line of vehicles, called the Cheetah, which attempts to combine the survivability of the larger MRAPs with the size and mobility of the HMMWV. The DoD tested the Cheetah as part of MRAP II but has not procured any of those vehicles for fielding. The biggest FPII customer is the US DoD with the bulk of vehicles going to the Marine Corps. It has also sold vehicles through the Foreign Military Sales (FMS) program to Canada, the United Kingdom, Iraq, Italy, and France and is forming a partnership with a British company to streamline sales to the United Kingdom, effectively bypassing FMS (Walsh, 2008a, August 6).

Figure 16. FPII Buffalo Vehicle (Category III)
(Force Protection Industries, Inc., 2008)

Figure 17. FPII Cougar Vehicles (CAT II and I, respectively)
(Force Protection Industries, Inc., 2008)

The FPII manufacturing process is straightforward, with most fabrication done within the company. The Buffalo vehicle starts production as a chassis and cab from a major truck manufacturer such as Mack or Peterbilt. FPII then disassembles that truck and uses the engine and other drive-train components to build the new vehicle. Major processes include forming sheet armor into monocoque capsules that make up the cab and passenger compartments, welding of the monocoque components, and painting. The various fabricated parts are then integrated with the automotive components during final assembly. All Buffalo production, with the exception of capsule formation, is conducted at the Ladson facility (Walsh, 2008a, August 6).

Cougar production is very similar, except the process starts with direct OEM components such as Caterpillar engines and Allison transmissions rather than a chassis cab from a major truck manufacturer. Cougar production is spread between multiple facilities and among the FPII operating partners such as GDLS in Lima, OH, and Anniston, AL, as well as Spartan Motors in Charlotte, MI (2008a, August 6). A key characteristic of the FPII manufacturing process is the high percentage of fabrication work done in-house. This explains the relatively large workforce and lower production capacity as compared to IMG. The basic FPII production process is shown in Figure 18.

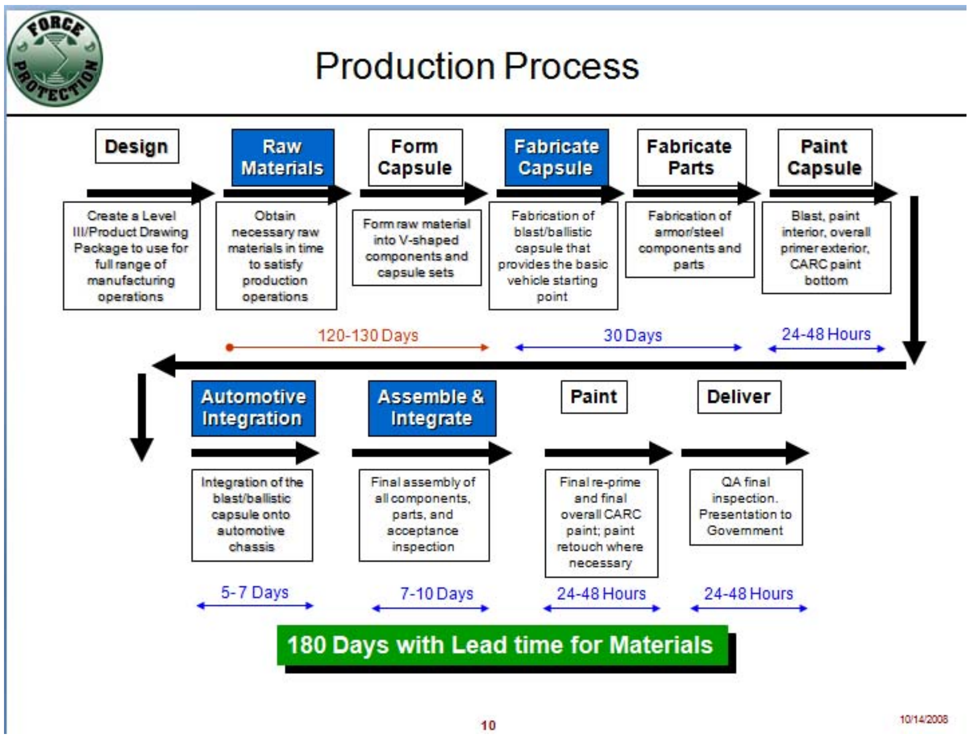


Figure 18. Basic FPII Production Process
(Walsh, 2008b, slide 10)

At the start of the MRAP program, supply managers at FPII identified no sourcing issues with the exception of a specific Timken tapered roller bearing required for transfer cases. The DX rating assigned to the program alleviated this concern; the company also worked with its axle supplier, Marmon Herrington, to increase capacity to meet the increased demand. Armor was not seen as a shortage item, although it was a long-lead item that took up to 120 days to procure, even with the DX rating (Walsh, 2008a, August 6).

The FPII management was willing to license vehicle designs for production by other defense contractors at the program start. The company entered a licensing partnership with General Dynamics, resulting in Cougars being produced by that company, as well as with BAE. FPII also partnered with Armor Holdings (now owned by BAE) and Textron, Inc., as a means of expanding production capacity. The company accepted risk at the start of the MRAP program, investing $50 million in long-lead items such as armor and axles in anticipation of contract awards and capacity expansion (2008a, August 6). The raw material investment turned out to be a low-risk decision and paid off for the company, but the production capacity expansion far exceeded the eventual contracts that the company received. This over-expansion is evident in the rapid growth in work force, followed by an approximate 25% reduction in 2008 when FPII did not receive the anticipated vehicle orders.

The FPII strategy was to create a network of capacity across multiple OEMs, capitalize on the existing fleet of Cougars and the company's history to secure the bulk of the MRAP market, get ahead and stay ahead of schedule, conduct strategic supply base purchases (at risk), and create a joint venture with a reputable defense contractor. However, the company has faced challenges based largely on the difficulties in rapidly transitioning from a small to a large business. Namely, their technical data packages were immature, unstable, and unable to quickly incorporate changes needed for large-scale production and licensing across multiple facilities and manufacturers. In addition, this growth brought tremendous challenges due to the lack of an enterprise resource planning system that integrated accounting, ordering, estimating, and other functions (2008a, August 6). Finally, the intensive in-house production process made ramp-up and expansion contingent on rapidly expanding the work force. That work force, consequently, may need to be further scaled down without substantial new business.

2. International Military and Government, LLC (IMG)

IMG, recently renamed Navistar Defense, is a subsidiary of Navistar International Corporation, the largest North American manufacturer of medium trucks, school buses, and diesel engines. Headquartered in Warrenville, IL, Navistar operates major engineering and manufacturing facilities throughout the US, Canada, and Mexico. Prior to the MRAP program, Navistar performed no major military work since the World War II era, when the company was known as International Harvester. In 2004, Navistar's CEO, Daniel Ustian, tasked another long-time Navistar employee and executive, Archie Massicotte, with establishing the IMG subsidiary as a means of expanding the company business into the military and government arena (Major, 2008, August 22). Since that time, IMG has established itself as a responsive and high-quality manufacturer, securing roughly 40% of all orders under the MRAP program, to include 100% of the final vehicle order for lighter, smaller MRAP vehicles to be used in Afghanistan (*Defense Industry Daily*, 2008).

The first major order for IMG actually came from Kellogg, Brown & Root (KBR), a major services contractor to the DoD, for an armored road tractor to be used in Iraq. In this effort, IMG teamed with Griffin Incorporated, the leading American manufacturer of armored vehicles for the non-defense market, producing 558 road tractors outfitted with 360-degree fully armored cabs. IMG built and delivered these vehicles, which they call KBR cabs, in five and a half months—demonstrating the ability to quickly ramp-up manufacturing capacity. This effort started effectively from scratch, with Griffin Armor acquiring and rehabilitating an old facility in West Point, MS, for the project. This same facility is being used for final assembly of the IMG MRAP vehicle, the MaxxPro, along with other vehicles produced within the IMG subsidiary. Griffin Armor continues to operate the manufacturing facility as an operating partner to IMG (Munro, 2008, August 22).

Following production of the KBR cab, which ended in June 2006, IMG solicited other orders, and Griffin Armor used the West Point facility to produce a batch of armored personnel carriers for the Israeli Defense Ministry. During this time, IMG developed a relationship with the Israeli company Plasan Sasa, which specializes in developing and manufacturing vehicle armor kits (Munro, 2008, August 22).

When MARCORSYSCOM released the original MRAP solicitation in November 2006, IMG initially developed a proposal in collaboration with a South African company. Approximately 72 hours before the proposal was due, however, a team from Plasan met with the IMG president and convinced him to change the plan. Over the next three days, the IMG team rewrote the proposal to incorporate the

Plasan-designed armor package, completing and submitting the new proposal on the due date (Major, 2008, August 22). At that stage, the IMG proposal for the MaxxPro represented a truck in concept only, with no existing prototype and detailed design and integration work yet to be done. Because of this and the lack of recent and relevant past performance information, the JPO considered IMG a high-risk manufacturer. Consequently, IMG was initially awarded only an IDIQ contract for four test vehicles. This is in contrast to other companies considered low-risk that were awarded IDIQ contracts and production orders prior to testing under LRIPs 1 and 2.

Following the initial contract award on January 26, 2007, IMG completed the detailed design, built prototypes, and delivered the first to the Aberdeen Test Center on March 10, 2007—beating all other manufacturers with the exception of FPII, which already had an operational assembly line (Aberdeen Test Center, 2008, August 11, slide 2). During the initial survivability testing of DT-C1, the MaxxPro performed poorly and was nearly eliminated from the competition. However, IMG and Plasan worked closely with the test officials, analyzed the test results and redesigned and modified the vehicle, delivering new prototypes for testing in fewer than two weeks. As the IMG MaxxPro program manager, John Major summarizes, “That was 10 days that really solidified the program” (2008, August 22). That version of the MaxxPro passed the threshold requirements of DT-C1 and led to the first large IMG contract for 1200 vehicles on May 24, 2007 (Owen, 2008, p. 23).

Unlike the monocoque capsule characteristic of MRAPs produced by FPII and the other manufacturers, the IMG MaxxPro consists of a modular design with a capsule that is bolted together in a series of steps. The design leverages other Navistar subsidiaries, using a severe service chassis[23] produced in Garland, TX. The vehicle is designed for multiple strikes, with the survivability capsule easily

[23] The chassis produced in Garland, TX, is in this case a heavy-duty drivable vehicle chassis complete with frame, drive-train, driver’s platform, and instrument panel.

moved from a destroyed chassis to a new one. The CAT I version of the MaxxPro is shown in Figure 19.

Figure 19. IMG MaxxPro (CAT I)
(Aberdeen Test Center, 2008, August 11, slide 2)

The modular design of the MaxxPro also contributes to manufacturability. In addition to the severe service chassis, the armor consists of three kits. The A-kit consists of the driver platform, firewall, windscreen, and door frames. The C-kit is the engine armory package. Both kits are incorporated into the pre-existing chassis assembly line in Garland, TX—allowing the MaxxPro chassis to leave the plant as a drivable chassis, which reduces rework at the final assembly plant in West Point. The B-kit, which forms the survivability capsule, is then added at West Point and effectively completes the vehicle. With the current set-up, IMG can produce up to 500 MaxxPro vehicles per month (Munro, 2008, August 22).

Unlike the FPII design and assembly process, which places the time- and labor-intensive manufacturing steps on the final assembly line, IMG traded complexity at the supply base for speed in final assembly. This reliance on its supplier base exposes IMG to additional risk, given the tight production timelines of the MRAP program, but it is also characteristic of a world-class manufacturer in the automotive industry. This reliance also allowed the company to expand capacity rapidly. As an example, at peak production of 500 vehicles per month, the West Point facility employed 920 personnel, compared to more than 2,000 personnel at

FPII for a lower production capacity. The IMG vehicle design, pre-existing operations, and partnering relationships enabled the company to take the MaxxPro from concept to fielding in larger numbers and significantly faster than any of its competitors.

In competing for the MRAP program, IMG took substantial risk as a corporation. As already stated, the JPO considered the company high-risk based on the lack of a working prototype and recent and relevant past performance information. As a result, IMG invested in excess of an estimated $20 million to support capacity expansion for engines, chassis, armor, and other raw materials before receiving the first production contract (Major, 2008, August 22). It also initially relied on a precarious supplier arrangement, with Plasan providing the armor by air from Israel. This risk acceptance paid off for IMG, however; out of a total of more than 15,000 vehicles procured under the MRAP program, more than 6,000 will be manufactured by IMG.

3. SFI Fabrication[24]

One of the major IMG armor fabricators is SFI Fabrication, a small company with plants in Memphis, TN; Conway, AR; and New Boston, OH. Prior to the MRAP program, SFI had an existing relationship with International School Bus, another subsidiary within Navistar. In the original IMG sourcing arrangement, Plasan Sasa supplied the fabricated armor for the MaxxPro vehicles, and through the International School Bus/SFI relationship developed SFI as a fabricator in their supply chain (2008, August 22). When Plasan Sasa proved unable to meet the supply requirements, IMG then developed its own domestic supply chain for armor and fabrication—retaining SFI as a major subcontractor. Although SFI currently conducts a large part of the fabrication for IMG, the armor plate sourcing is handled entirely by IMG.

[24] The information in this section was derived from a plant visit and group interview with company managers (Carr, Collins, & Daniel, 2008, August 22).

SFI did military work in the past, but the MRAP program was the first involving armor, which requires different procedures for welding and other fabrication. It also represents the first experience working under a DX rating. The large amount of work required an increase in work force, which was the biggest challenge. To fill new positions, SFI held numerous job fairs and started an in-house welding school to improve the skills of its welders. Concerning the DX rating, the company had to shift work between the three company facilities as well as outsource some work in order to establish the most efficient production mix. In some cases, pre-existing orders were delayed by the MRAP program, but other SFI customers were patient given the circumstances (Carr, Collins & Daniel, 2008, August 22).

An initial area of concern for SFI as work began on the MRAP program involved CARC paint, which is required for all military vehicles. Chemical Agent Resistant Coating (CARC) is not widely used within industry; few companies are certified in its application, and capacity is typically small for those that are. As of August 2008, SFI was sub-contracting work to four different CARC painters (2008, August 22). In addition, the use of multiple, geographically dispersed subcontractors introduced inefficiency in the supply chain, as fabricated components are shipped from the SFI facility in Memphis to places such as Fort Wayne, IN, and Huntsville, AL, for CARC paint, while the West Point MaxxPro plant is only 150 miles south of the SFI Memphis facility.

This look at SFI provides key insight at the lower levels of the supply chain. First, the industrial base can and does quickly respond to urgent, lifesaving DoD requirements. Obviously, financial incentive existed in this program for a company such as SFI, but managers also spoke of the moral imperative they felt to support this program. A second observation is that the SFI CARC paint issues demonstrate the detail in which the supply chain must be examined when attempting a rapid acquisition. SFI is one of several suppliers to multiple manufacturers, all competing for essentially the same resources. This requires consideration of seemingly obscure items such as paint, in addition to the obvious issues such as tires and steel.

C. Integration of Government-furnished Equipment (GFE)[25]

At the MRAP program outset, one of the initial areas of concern involved the integration of GFE. This effort involves the installation of an average of 10 additional systems per vehicle. These systems range from internal components such as radio mounts, intercom systems, and driver night sights, to external systems such as IED frequency jammers, spotlights, and antennae. To add to the complexity involved with adding these systems to multiple variants of vehicles from five manufacturers, each Service and SOCOM required unique packages of GFE. In addition, the GFE requirements have never stabilized, making the integration effort a process of continuous change and refinement. Figure 20, the current vehicle mix by Service, and Figure 21, the GFE packages by Service, clearly demonstrate the number of unique variations and complexity involved in this process. They also show the criticality of integration within the overall value stream.

[25] The majority of the information in this section is drawn from an interview with Peter Ward (2008, August 5), Industrial Engineer at SPAWAR Systems Center Charleston.

Figure 20. MRAP Variant Mix by Service
(Mann, 2008, slide 14)

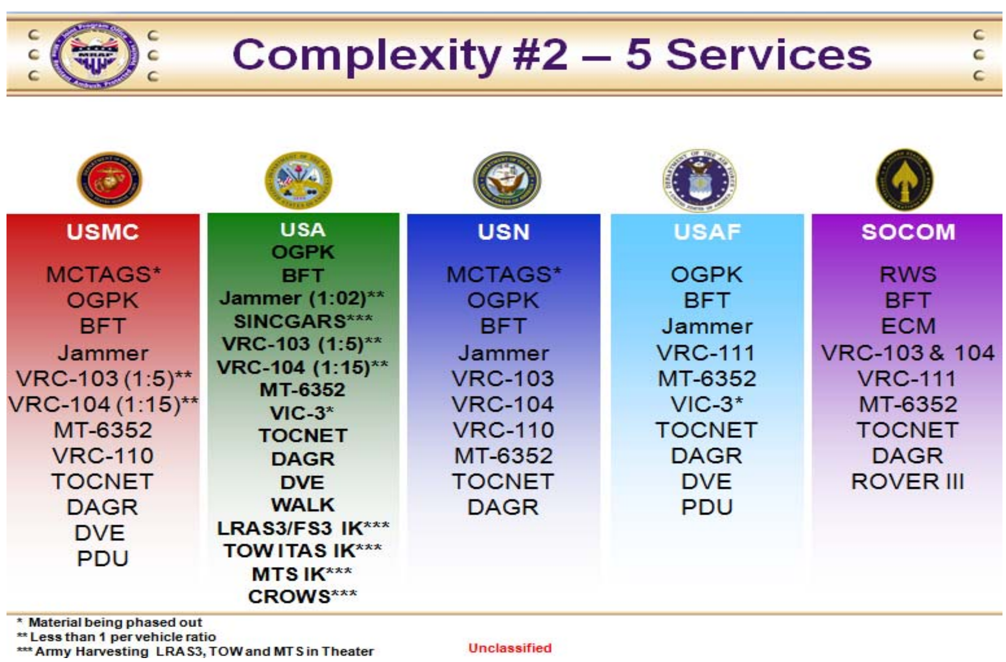


Figure 21. Government-furnished Equipment by Service
(Mann, 2008, slide 13)

The decision to use the Space and Naval Warfare Systems Center (SPAWAR) in Charleston, SC, was made at the MRAP program outset based on the previous integration effort with up-armored HMMWVs for the Marine Corps. Through work on HMMWVs, SPAWAR developed facilities, processes, and expertise in rapidly integrating multiple vehicles, thereby offering a unique capability at exactly the time it was needed. As a Navy asset, SPAWAR involvement as a major contributor to a ground combat system program seems unconventional. However, this effort is very much in line with the SPAWAR core mission, which revolves around engineering and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities. As Peter Ward, Industrial Engineer at SPAWAR points out, the organization focuses on those capabilities and how they can be applied on any platform (2008, August 5). In that respect, the SPAWAR core mission encompasses the types of systems included in MRAP integration. Additionally, SPAWAR involvement reflects the recent focus on "joint-ness" in warfighting and in acquisitions. As embodied in the JCIDS process, the MRAP program brings the best capabilities from across the DoD.

In addition to the prior integration work and engineering capability, SPAWAR offered a number of other advantages that made it the logical choice for the effort. First, the SPAWAR location in Charleston positions it near a railhead, a major Air Force Base with a C-17, wing and a secure seaport, all of which add efficiency in the value stream. Charleston Naval Weapons Station is also home to the Army 841st Transportation Battalion, which would oversee the transportation from the continental US into the CENTCOM AO no matter where the integration occurred. Second, SPAWAR provided precisely the testing capability needed for rapid integration prototyping with its Poseidon Park facility. This facility is one of only a few in the US that enables three critical tests needed for this effort,[26] reducing

[26] The Poseidon Park facility is used for: (1) co-sight interference testing to determine interference between GFE components, (2) hazard-to-personnel testing to determine whether GFE combinations created unacceptable levels of radiation for users, and (3) antenna pattern testing. All are necessary to determine safe and effective combinations and positioning of GFE on the vehicles.

timeframes to 30 or fewer days—a process that can sometimes take years (Ward, 2008, August 5).

The integration process at SPAWAR consists of two steps: prototyping and full-rate integration. The prototype process is an engineering design process that involves a team of engineers who take each variant and determine the optimal fit for the required equipment. On average, this process takes the team 30 days and includes testing as described above for each prototype. The engineers, all government employees, take the approved design and create installation manuals. These installation manuals are then passed to the SPAWAR lead contractor, which oversees GFE installation in the full-rate integration process. Government quality assurance representatives (QARs) work with the contracted employees to ensure the installations are being done in accordance with the instruction manual intent and that every installation is tested to ensure it functions as designed. The location of prototype engineers, integrators, and QARs under one roof, with test facilities close by, were key in the rapid prototyping and continuous changes needed for the program (Ward, 2008, August 5).

With the large number of MRAP variants, ever-changing GFE combinations, and incorporation of feedback from warfighters, the full-rate integration process is constantly evolving. Because of this, the 25 production lines at SPAWAR were not able to simply replicate tasks in assembly line fashion. At one point, each line had an average turnover of four variants per week. The organization has since found ways to control that variation, and the integration process now falls somewhere between a job shop and assembly line operation. Each installation crew is now cross-trained on three to four variations, enabling better control of manufacturing tasks. SPAWAR also implemented a Lean Six Sigma program to track key production metrics and implement continuous process improvements.

As previously explained, the scale of the integration effort and the unknown production capacity at SPAWAR was a major area of concern at the start of the MRAP program. With the process improvements discussed—as well as with continuous partnering efforts with vehicle and GFE manufacturers to shift labor intensive tasks such as bracket installation, welding, and painting farther up the value stream—SPAWAR built capacity to match or exceed the flow of vehicles from manufacturers. Although integration time varies by vehicle, as of this writing, the SPAWAR average of about 10 days per-vehicle far exceeds the original goal of 30 days per-vehicle (Ward, 2008, August 5).

Success in the integration effort can be attributed to four key factors. First, the focus on partnering between all members of the value stream enabled SPAWAR to work with vehicle and GFE manufacturers in implementing changes throughout the production process in order to speed the integration effort. Second, the top-down focus on parallel and concurrent processes fostered continuous installation, regardless of test status during the integration process. Although this focus added expense and the possibility of rework, it also increased the importance of rapid defect correction to prevent large amounts of rework. The drawback was that some defects may have been discovered further along in production than would have been the case in a more deliberate process. Third, the JPO focus on the overall program strategy and objectives (as many survivable vehicles as quickly as possible) permeated every part of the value stream to include the integration effort. This translated into increased cooperation between all participants in the process, as well as a higher level of dedication and commitment from the integration team, which conducted continuous operations on a seven-day-per-week schedule with major emphasis on improving throughput. Finally, the SPAWAR location and capability made it the ideal location for the effort.

D. DCMA Involvement[27]

A critical participant in the MRAP program, from its start through final vehicle delivery to warfighters, has been the Defense Contract Management Agency

[27] This section draws largely from an interview with Capt. Joe Manna, Commander of DCMA Atlanta (Manna, 2008a, August 5).

(DCMA). Capt. Joseph Manna, Commander of DCMA Atlanta, summarized the MRAP effort by stating: "If we would have followed normal bureaucratic procedures, we would have failed the mission" (2008, August 5). The first DCMA work on the program included assistance to the JPO in completing industrial and pre-award surveys. These core functions enabled the JPO to determine, at the outset, the industrial capacity for vehicle production, as well as the responsibility of each manufacturer. Following contract award, DCMA focus shifted to contract administration and quality assurance, with oversight on the value stream from the lowest-tier suppliers to movement into the CENTCOM AO.

Given the MRAP program status as the highest DoD acquisition priority, DCMA developed a strategy to reflect this. The strategy included the following efforts:

- work closely with the JPO and OEMs to preclude or fix acceptance issues early in the production process;
- execute thorough process proofing for new production and integration lines;
- influence prime and sub-contractors to smooth delivery schedules;
- survey critical supplier inventories and deliveries daily; team with the JPO to validate new vendors;
- issue letters of delegation to target DCMA support at key facilities;
- provide feedback from SPAWAR to OEMs on identified deficiencies; and,
- participate in integration cut-in efforts at OEM. (Manna, 2008, September 8, slide 15)

All efforts were made with a focus on speeding delivery of vehicles to warfighters, while providing quality assurance and enabling flexibility in the ever-changing process. Key in these efforts were the close interactions between DCMA and all stakeholders involved in production. To facilitate these efforts, Capt. Manna focused on teaming arrangements between DCMA staff, manufacturers, and the integration team at SPAWAR. This team relationship differed from the sometimes adversarial relationship between DCMA and contractors (Manna, 2008, August 5).

A vital characteristic of the MRAP program is the emphasis on concurrency. This involves keeping vehicles moving down the line—taking corrective action and/or implementing ECPs as the vehicles continue moving toward the ultimate transportation point. For the MRAP program, this meant conditional acceptance of vehicles at the two primary DCMA inspection and acceptance points: following production at the manufacturer facilities and upon arrival for integration at SPAWAR. This conditional acceptance applied only to minor deficiencies and non-critical parts shortages and came with a mutually agreed-upon plan for correction, a suspense date, and any necessary contract remedies.[28] Compared to standard acquisition programs of a non-rapid nature, this conditional acceptance is unique; DCMA would normally require correction of all deficiencies prior to acceptance. In addition, conditional acceptance inherently adds risk due to the addition of tracking requirements and the chance that deficiencies can be passed to the user. In the case of the MRAP, however, the need was of such importance that continuous flow of the vehicles toward warfighters was the primary concern (Gregory, 2008, August 5). The MRAP JPO, therefore, implemented a process to make this continuous flow of vehicles possible, allowing small deficiencies to pass through with the understanding that the manufacturers would correct those deficiencies before final delivery to users. This should not be considered a best practice for most programs, however, because even small deficiencies can cause the user to lose confidence in a product, and conditional acceptance will inevitably result in some of these deficiencies reaching the user.

---

[28] The PM detailed the conditional acceptance policy in a program policy letter. This policy limited conditional acceptance to minor deficiencies or non-critical parts shortages. Any deficiencies related to safety, survivability, drivability, or HVAC system operation were generally not authorized for conditional acceptance; authority for conditional acceptance in these cases was held at the PM level. Such vehicles were considered shipped in place, with deficiencies corrected before shipment from the manufacturer facility (Mann, 2007).

A notable feature of the DCMA quality-assurance program for the MRAP vehicle is that it attempted to identify all defects prior to shipment overseas, rather than waiting for the Product Quality Deficiency Report (PQDR) process that would eventually identify defects in the field. Any quality issues are captured in written form as part of the PQDR Process; an investigation is performed to determine the root cause of the issue; the results are screened for validity, and the PM then takes any necessary action to resolve the problem (Marine Corps Logistics Command, 2008). In the MRAP program, however, DCMA personnel inspect every vehicle, finding issues that would normally be addressed in the PQDR process and fixing them through teaming arrangements with manufacturer field service representatives (FSRs). DCMA typically tries to do this in all production efforts; the difference for the MRAP program is that its production cycle will end before the PQDR process can provide useful feedback. In this way, DCMA provides the only timely quality-assurance feedback for the MRAP program.

Another notable trade-off made in order to maximize industry participation in the program and speed production was the initial acceptance of immature quality systems among the manufacturers. The MRAP contracts contained essentially the same quality system requirements as any program—to include compliance with ISO 9001 standards or an equivalent system. The difference for the MRAP program was recognition that rapid capacity expansion for some of the manufacturers would result in quality issues that would not be addressed as fast as the desired production rate. This held true for manufacturers with immature processes and quality systems, such as FPII. This decision led to the full inspection of every vehicle, rather than spot inspection and lot acceptance. In the case of FPII, it also allowed a small manufacturer to participate in a program in which the quality system requirement may normally have prevented it. Although this increased risk in the process, the DCMA involvement mitigated this risk throughout the value stream, ensuring quality through end-item inspection and on-site quality control monitoring (D. Hansen, personal communication, November 6, 2008).

This brief overview covers only a portion of the DCMA effort involved in the program, but it shows the level of involvement by an agency already stretched thin on personnel. Given the MRAP program priority, DCMA shifted personnel from other oversight projects—such as at FN Manufacturing, where M-240 machine guns, M-249 squad automatic weapons, and M-16 rifles are produced (Manna, 2008, August 5). This again points to the trend of risk acceptance throughout the MRAP program. In this case, not only were personnel removed from oversight positions supporting other programs, these personnel were re-assigned to oversee work outside their areas of expertise.

E. Key Factors and Trade-offs

This in-depth look at the production value stream provides insight to the factors that made the MRAP program successful from a production and integration perspective. The program priority, as communicated by the Secretary of Defense and executed by the JPO, is evident throughout the process. Accordingly, a number of key factors contributed to success in meeting the overall program objectives of fielding as many survivable vehicles as fast as possible. First, the use of multiple vehicle manufacturers was a critical trade-off that allowed maximum expansion and use of the industrial base. This allowed the program to leverage the strengths of each participating manufacturer and pre-established supply chains. Attempts to focus on a common design would likely have resulted in increased competition for limited resources and a corresponding reduction in capacity. In addition, this decision brought in manufacturers that may have been less likely to commit resources given an all-or-nothing outcome. Finally, the competition brought about by multiple manufacturers allowed the Government to determine the best vehicles and shift production in that direction later in the program.

A second key factor in the production and integration effort involved the detailed DoD look at the entire supply chain, which allowed identification of key resource constraints such as tires and steel, and allowed for the implementation of efforts to mitigate these constraints. It also demonstrated the range of tools available to assist a rapid defense acquisition, such as a DX rating under the Defense Priorities and Allocation System. This powerful tool gives the Government priority status for materials needed for the program, as well as resources needed to manufacture the product.

A third factor evident in this effort, as well as the entire MRAP program, was the focus on concurrent processes. As discussed under T&E, this factor introduced risk into the program as it increased the chance of rework or of fielding a vehicle difficult to sustain. The benefit, however, was that concurrency again contributed to the overall program strategy and sped the capability to warfighters.

A fourth factor evident throughout the production and integration phases was the focus on partnering. These efforts, fostered by the JPO and DCMA, teamed MRAP manufacturers with test officials, DCMA representatives, and system integrators at SPAWAR. This teaming effort led to increased communications throughout the value stream and resulted in continual product and process improvement.

Finally, the use of SPAWAR as the systems integration facility proved one of the key program factors. By leveraging the SPAWAR capability and location, the program turned a potential bottleneck into one of the greatest successes.

As discussed throughout, key decisions that enabled success based on program strategy carried trade-offs that must be considered. Throughout all phases of the program, one in particular is pervasive. That trend, a trade-off of logistical sustainability in favor of maximized production, is the focus of the next section of this project.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. Program Logistics

A. Manpower & Personnel

Prior to the MRAP program establishment in December 2006, only three personnel within MARCORSYSCOM were assigned to oversee the limited amount of MRAP vehicles that had been previously procured. These three were the program manager, the contracting officer, and an administrative assistant. Following the designation of the MRAP requests as a JUONS, an Integrated Product Team (IPT) was formed to draft a RFP to solicit manufacturers who could produce and deliver these vehicles rapidly. As the program started to gain momentum, there was still little growth in personnel numbers up until July 2007. Up until this point, there was a two-pronged approach to program expansion. The Army set up its own program office for the MRAP vehicle with eight to ten personnel from TACOM whose purpose was to focus on MRAP issues and participate on IPTs. At the same time, the Marine Corps established a staff of 25 personnel that included logisticians, contract specialists, and financial managers. Some of these personnel were also well experienced in program and project management. Additionally, about 60 contracted personnel provided support services. In total, until July 2007, less than 100 personnel worked on the MRAP program[29] (D. Hansen, personal communication, October 15, 2008).

During this time (as discussed above), nine different manufacturers received contracts for the production of MRAP vehicles, seven of which eventually delivered prototype vehicles for testing. These manufacturers were IMG, FPII, BAE, AH, OTC, PVI, and GDLS. The program office had one individual overseeing each of the three categories of these vehicles, as well as the manufacturers offering vehicles within that category. For individuals directly involved with the program, this meant long

[29] This does not include the approximate 250 previously mentioned personnel on the T&E team at Aberdeen Proving Ground.

working hours, working outside their expertise, and multi-tasking. After reorganizing the program office in August 2007, the JPO assigned an Assistant Program Manager (APM) to oversee each manufacturer product.

The JPO also managed to enlist the services of personnel from the Air Force and the Navy who are not assigned to the program but still contribute by sharing the workload and providing expertise. As of this writing, the Army alone has over 200 personnel from TACOM and the Tank Automotive Research, Development, and Engineering Center (TARDEC) who contribute to the MRAP program. Although these Army personnel are task organized to the program, they are not assigned and remain separated not only by distance, but also by culture and lack of a formal program of record. The organizational structure shown in Figure 22 displays the positions within the JPO as of this writing, and demonstrates the growth in the program in less than two years (D. Hansen, personal communication, October 15, 2008). This chart was the basis for "right-sizing" of the program.

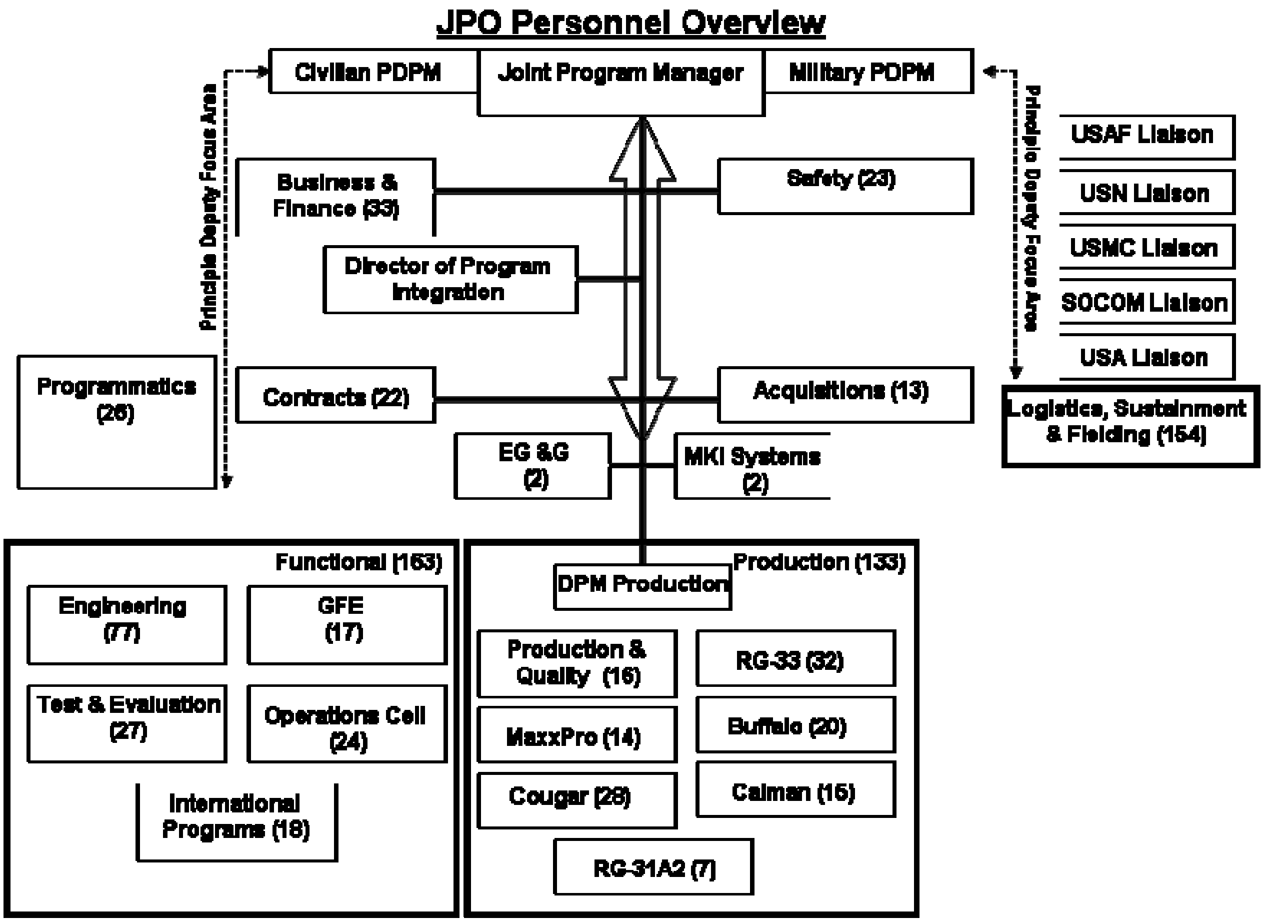


Figure 22. MRAP JPO Personnel Overview
(After MRAP JPO, 2008, September 15)

Unlike the other Services, Marine Corps personnel involved with the program are all directly assigned to the JPO. As of this writing, that number is 40 personnel, with augmentation by ten Navy and three Air Force personnel, as well as over 200 support contractors within the Quantico area. This brings the total number of personnel within the JPO to just fewer than 580, approximately 200 of whom are task-organized for MRAP support, but not assigned to the JPO. This number also includes individuals that are assigned part-time to the program from various agencies. Although the separation by distance between the various organizations under the JPO implies a difficult organization to manage, this separation has not affected the timeliness of the program. In retrospect, this program has managed to get more accomplished with fewer personnel and in a shorter amount of time than other joint programs. For most of the program existence, the JPO functioned with less than 60 government employees and yet still managed to meet mission goals (Hansen, 2008, June 10). Figure 23 depicts the structure of the MRAP JPO, current as of this writing.

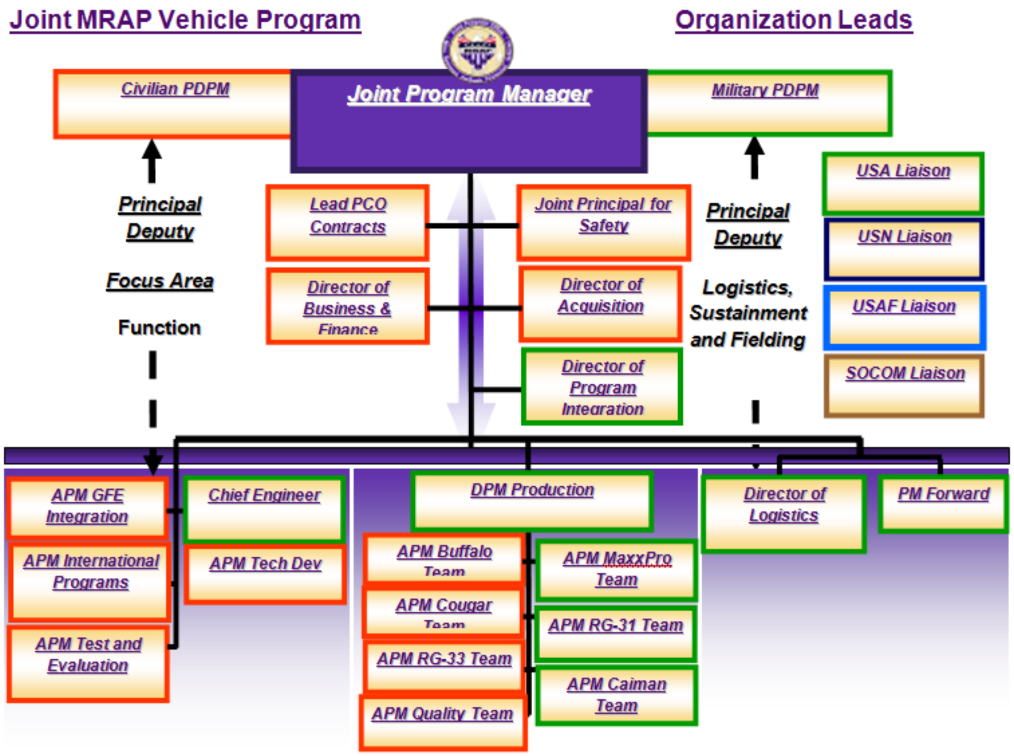


Figure 23. MRAP JPO Organizational Structure
(MRAP JPO, 2008c)

Besides accomplishing MRAP contracting, testing, production, and fielding very rapidly, the compactness of the initial JPO produced advantages in that by starting small, the program grew towards right-sizing its personnel as opposed to spread-loading requirements. With the expansion in personnel, individuals who initially worked in excess of 100 hours per week were able to transition to a more reasonable work schedule of 60 hours per week or less. Additionally, by growing the personnel numbers, the JPO allowed individuals who were specialized in certain fields to focus on their areas of expertise. Prior to the expansion of personnel, individuals had to execute all ten elements of logistics singlehandedly with the assistance of a few support personnel. As of this writing, the individuals associated with the program are specialized in their particular fields and are capable of doing their jobs effectively because they only have to focus on their own work (Hansen, 2008, June 10).

In summary, the expansion of the JPO reduced the need for over-tasking personnel. This expansion also allowed specialization rather than the multi-tasking prevalent at the program inception. Even considering these strides, the program continues to face a less-than-ideal organizational structure in that it is an *ad hoc* organization and is not a program of record within the DoD.

B. Technical Data

Contractually, MRAP vehicles were treated as commercial items and were, therefore, procured under fixed-price contracts from the start. Given this commercial-item designation and the relatively small 1,185 vehicle requirement at the program start, the MRAP JPO did not initially purchase technical data from any of the vehicle manufacturers. All vehicles were originally intended to be maintained by the manufacturers, with reliance on contractor logistics support (CLS). Therefore, purchase of technical data was deemed unnecessary during the initial procurement period. However, when the required number of MRAP vehicles increased, the JPO changed the sustainment plan to transition from CLS to hybrid/organic maintenance. This required some technical data for the provisioning of parts, specifically the engineering data for provisioning (EDFP) (Hansen, 2008, June 10). EDFPs are the drawings for parts and components that will be provisioned to support repair parts requirements.

With the EDFP from each manufacturer, the JPO was able to use the Defense Logistics Agency (DLA) system to compare identical, or similar, components that were already listed by National Stock Numbers (NSN). This enabled the JPO to determine if identical parts or suitable substitutes existed within the defense supply system; parts that didn't exist in the DoD supply system required new NSNs and addition to the supply system. In many cases, the EDFP was proprietary to prevent reverse engineering of components by competing manufacturers, but was used by the Government to find suitable substitutes (Hansen, 2008, June 10). An example of this is the Caterpillar C7 engine, which is used in two of the MRAP vehicle variants, as well as the Marine Corps LAV and the Army Stryker vehicles. Most of the parts on this engine already existed in the supply system, making provisioning simple. IMG, on the other hand, used its own proprietary engines that were not previously used within the DoD. Provisioning in this case required significantly more time and effort, as new NSNs were assigned and cataloged within the supply system.

As stated by Deputy PM, Dave Hansen, "99% of all technical data is used for provisioning and making sure that we can support the parts in the system for a long period of time" (2008, June 10). Therefore, even if a component is proprietary with no match in the supply system, the JPO can still load the component into the system, identifying it as being solely distributed by a particular manufacturer. In addition, EDFP serves as a form of insurance that allows the Government to procure a needed part even if the original manufacturer goes out of business or stops producing that part. Finally, EDFP assists the DLA in accepting or rejecting a product, thereby helping to ensure that the end-users get suitable parts.

Within the MRAP program, the manufacturers were required to participate in a production verification audit. This audit held all manufacturers accountable for the technical data they provided and assisted the JPO in understanding vehicle configuration provided by each of the manufacturers. The JPO insisted that manufacturers correct discrepancies when found, and with the assistance of DCMA quality-assurance personnel, verified the product met the specifications of the technical data. Correction of discrepancies in the technical data helps the Government to maintain an accurate EDFP database with which to support sustainment operations (D. Hansen, personal communication, 2008, October 15).

The technical data for the MRAP program concerning maintenance is currently collected at the unit or organizational level. Data indicating reliability, maintainability, and operational availability would normally be available as the result of testing and, therefore, would influence acquisition programs, but the MRAP program rapid testing with emphasis on survivability prevented this data from being collected prior to vehicle procurement. Data such as mean time between failure (MTBF), mean time to failure (MTTF), mean down time (MDT), and mean time to repair (MTTR) were instead gathered after procurement. This represents risk acceptance by the JPO in support of the program objectives, as well as a potential trade-off of reliability, maintainability, and availability in exchange for speed in fielding. The absence of reliability and failure data from vehicle testing increased sustainment risk; that is, reliability and failure information contributes to accurate quantity estimation needed for repair parts provisioning.

C. Design Interfaces

Considering the multiple manufacturers and vehicle variants involved in the MRAP program, integration of equipment was a major challenge. As previously discussed, each Service had unique GFE requirements, and some Services had requirements unique to specific units or applications.

The original solicitation provided the minimum essential interface controls identified at the program start for Mission Equipment Packages (MEP), considering that multiple manufacturers would be used. These interfaces were identified based on the space, power, heat load, cabling, cableways, and all through-hull connections required. Figure 24 is an example of a list of Mission Equipment Package items identified by the JPO for integration into the CAT II Infantry Tactical Maneuver Vehicle. Additional MEP packages were specified for the CAT II Ambulance vehicle, the CAT II Convoy vehicle, and the CAT I Reconnaissance vehicle. By tasking the manufacturers to provide key interfaces necessary for the SPAWAR integration effort under a “plug and play” concept, the JPO achieved success in providing full functionality of the MRAP variants before they ever reached using units. This relieved the crew or organization-level mechanics from the burden of configuring MRAPS for in-theater operations. Continuous crew feedback has also led to modifications to improve the fit and functionality of the MEPs.

MISSION EQUIPMENT PACKAGE	
Infantry Tactical Maneuver Vehicle (CAT II)	
Weapons System	
M2 50 Caliber Machine Gun	MK 19 40 mm Grenade Machine Gun
M240 B 7.62mm Machine Gun	TOW Improved Target Acquisition System
Gunner Protection Kits	Common Remotely Operated Weapons Station (CROWS)
Command, Control, Communication & Computers (C4)	
Dual Radio ASIP SINCGARS	FBCB2 - Blue Force Tracker
Vehicle Intercom System (VIS)	Enhanced Position Location Reporting System (EPLRS)
Sensors and Countermeasures	
Driver Viewer Enhancer	White and IR Spotlight
Loudspeaker public address system	Counter Remote Electronic Warfare System (CREW)

Figure 24. MEP Items Identified for Integration by the JPO
(After MRAP JPO, 2006).

By identifying key integration requirements early in the program, the JPO enabled the manufacturers to modify designs without compromising personnel safety or structural integrity of the vehicles. Again, however, a trade-off was made in that less than 100% of the required interfaces were identified at the program start. This trade for time at the program start led to a more labor-intensive and time-consuming installation effort at the SPAWAR integration site.

D. Computer Resources

Two computer applications played a critical role in the MRAP program. They are Wide Area Work Flow (WAWF) and Windchill (WC). Both of these Internet-based applications facilitated the simultaneous flow of information among multiple points, which was essential to the MRAP program success given its widely dispersed operations. These applications allowed all parties involved to see a common operating picture with the most up-to-date information, despite their geographical separation. Both of these Internet-sharing applications allowed JPO and other personnel to conduct concurrent activities based on real-time information. Every functional area within the MRAP JPO had a station set up for WAWF and/or WC access, providing all personnel with the latest information (D. Hansen, personal communication, 2008, October 15).

WAWF is a paperless, DoD-wide contract administration system designed to eliminate paper from the receipt and acceptance process of the DoD contracting lifecycle. The goal is to give authorized defense contractors and DoD personnel the ability to create invoices, receive reports, and access contract-related documents. Traditional DoD business methods call for three documents to make a payment: the contract, the receiving report, and the invoice. However, this is only true if the paper method is being used. These three documents are processed separately, and information is then manually keyed into the payment system (Defense Finance and Accounting Service, n.d.). The WAWF application eliminates the paper trail and redundant processes, and instantly shares all documents electronically. It also increases the accuracy of the data while reducing the risk of losing documents. WAWF was primarily used by the DCMA representatives who supported this program, the MRAP JPO staff, and the MRAP manufacturers.

WAWF provides many benefits such as improved efficiency, data accuracy, and speed of payment. For the MRAP program, however, the main benefit was in providing contractors and the DoD immediate accessibility to requisite documents from anywhere in the world. This mitigated the risk of conditional vehicle acceptance because it facilitated the deficiency-tracking and -resolution process. As previously discussed, this conditional vehicle acceptance is an example of the concurrency of effort that contributed to the program's success.

The second important application, Windchill, is business collaboration software that is designed to enable development efficiencies while reducing errors and rework. This software assists in managing distributed product development, product content, business processes, and complex information assets (Parametric

Technology Corporation, n.d.). It is fast, secure, scalable and interoperable, which enabled the JPO to post and share documents, despite having manufacturers and departments dispersed across the US. This Internet-based method proved an efficient way for the JPO to share information when individuals were not operating at their local workstations. It not only worked within the continental US (CONUS), but also for sharing information between the CONUS-based JPO and individuals deployed in the CENTCOM AO (D. Hansen, personal communication, 2008, October 15).

WC benefited the JPO because it reduced rework and, therefore, saved time. WC also enhanced the cross-enterprise understanding of program activity because it allowed everyone to see a common operating picture. Finally, WC gave its users within the JPO the freedom of mobility. Since information could be accessed almost anywhere, individuals were not restricted to working from their cubicles, but could execute their functions even from manufacturer facilities. Information flow within WC is depicted in Figure 25.

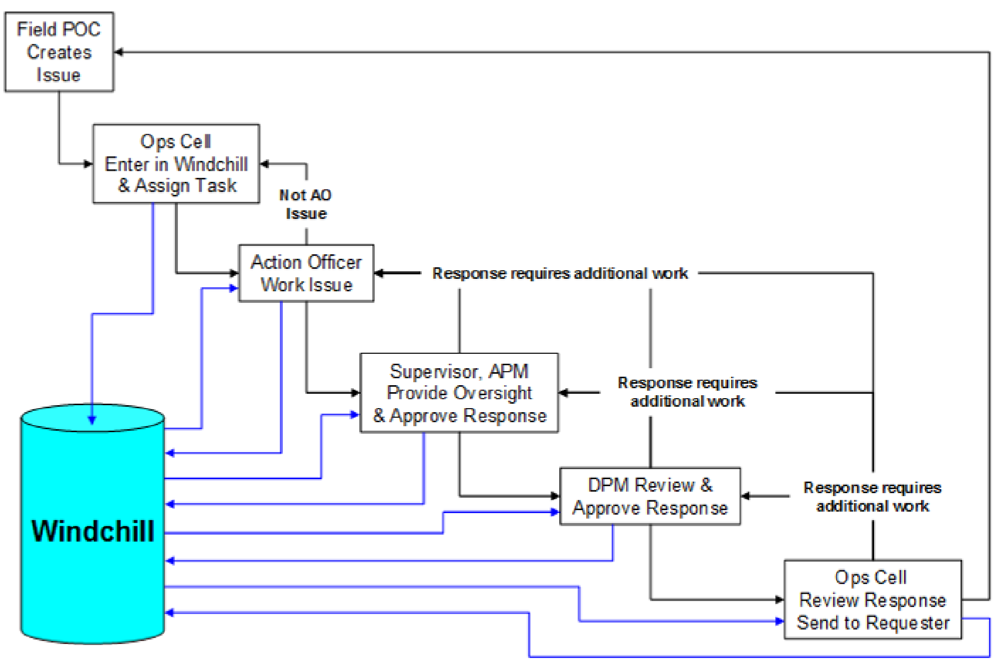


Figure 25. Windchill Field Issues and Response
(Conway, 2008, slide 26)

E. Maintenance Planning

A major factor in the high readiness rate of MRAP vehicles has been the use of contractor logistics support (CLS) during initial fielding. In the summer of 2007, as MRAP vehicle requirements expanded dramatically, the JPO shifted to a hybrid/organic approach, with eventual plans for fully organic sustainment. CLS, however, remained critical. Prior to the transition to organic support at the unit level, the ratio of FSRs to vehicles was one to ten. The JPO attained this ratio by pooling the efforts of original equipment manufacturers (OEMs) and organizing cross-training among the FSRs from each manufacturer. As an example of the commitment of one manufacturer to the program, FPII went from 105 FSRs to 300 in just a matter of months (Walsh, 2008a, August 6).

The short ramp-up to MRAP fielding did not afford the program time to fully test the vehicles for maintainability, nor did the JPO initially develop a maintenance plan beyond CLS. Given the commercial item designation, the JPO originally determined that manufacturers would maintain their own products; this created the need for FSRs.

As of this writing, unit organic maintenance personnel perform 10-level (crew-level) and some 20-level (organization-level) MRAP vehicle maintenance, while FSRs perform 20- and higher-level maintenance. In most cases, FSRs supervise the 10-level maintenance and ensure it is being performed properly. Additionally, to keep up with the latest technology, organic maintenance personnel do perform minor modification work orders within their capabilities. This prevents the necessity of running combat patrols to the regional support activities (RSAs) for purely maintenance purposes. For example, modifications such as 360-degree light kits and integration of other GFE have been completed by unit maintenance personnel in theater (Hansen, 2008, June 10).

For the maintenance policy at the unit level—including preventive maintenance procedures—FSRs and unit maintenance officers of each unit are responsible for updating and making recommended changes. This is attributable to the limited endurance and reliability testing prior to vehicle procurement, which did not allow determination of MTBF, MTTR, or other data necessary in developing maintenance procedures. The strategy was simple: ensure that repair parts are on hand, and then drive the MRAP until it breaks. Although these vehicles were commercially acquired, the standard unit mechanic's toolset contained most of the tools needed to work on the MRAP. The only missing item, a fixture required for removal and installation of the MaxxPro belly-plate, has since been provided by IMG (D. Hansen, personal communication, 2008, November 14).

As of this writing, the JPO has achieved its goal of 90% operational readiness (OR) rate (MRAP JPO, 2008, October 21). This success is directly attributable to the decision to use CLS early in the program. This enabled the JPO to rapidly field the vehicles and maintain a high OR rate, while buying time for building the organic capability to sustain the MRAP fleet. This provides yet another example of how concurrency of effort contributed to success in the MRAP program.

F. Training

FSR and uniformed mechanic training courses are conducted at the Red River Army Depot (RRAD) in Texarkana, Texas. Participants in this training come from across the Services and MRAP manufacturers. This consolidated training was implemented by the JPO and was named MRAP University (Hansen, 2008, June 10).

1. MRAP University

MRAP University offers cross-platform training geared towards familiarizing all attendees with the five most common MRAP vehicles, as shown in Figure 26. MRAP University was created to provide a common place to familiarize personnel on operations and maintenance of the multiple variants of MRAP vehicles. It is run by TACOM and has been active since November 2007. Until September 19, 2008, MRAP University offered two courses, the Field Level Maintenance Training Course and the Operator Training Course, both 40 hours in length. These courses provided basic familiarization and operator training, as well as an overview of maintenance, diagnostics and troubleshooting, and recovery procedures.

The Operator Training Course was directed at unit level operators and covered basic familiarization, preventive maintenance checks and services (PMCS), training for day and night driving, emergency and recovery procedures, and operator-level troubleshooting and maintenance (MRAP University, n.d.).

The Field Level Maintenance Training Course was focused on FSRs, instructors, TACOM LARs, and key military personnel such as Battalion Maintenance Officers (BMOs) and Battalion Maintenance Technicians (BMTs). For each of the five vehicles, this course covered basic vehicle characteristics, safety, warnings and cautions, operation, maintenance procedures, diagnostics and troubleshooting procedures, and finally, an overview of the recovery procedures (MRAP University, n.d.).

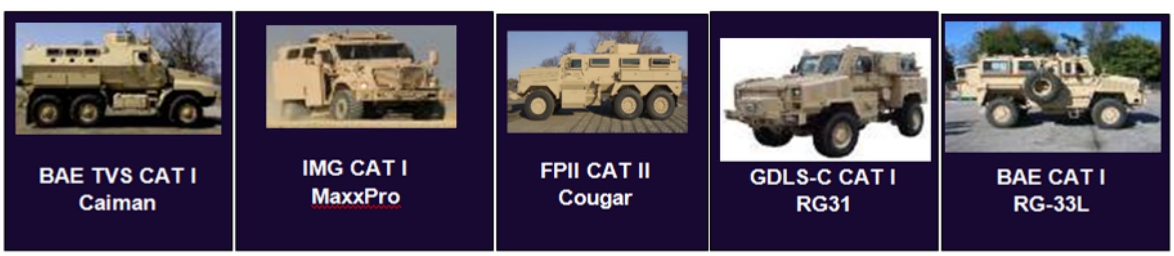


Figure 26. The Vehicles of MRAP University
(Hansen, 2008, June 4, slide 10).

The success of MRAP University resulted in a shift in focus after September 19, 2008, from basic operator and maintenance training to more in-depth familiarization. The maintenance familiarization course is now 5 weeks long and covers vehicle characteristics; safety; warnings and cautions; operation of MRAP vehicles; heating, ventilation, and air conditioning (HVAC) systems; maintenance procedures; diagnostics and troubleshooting procedures; and recovery procedures, with heavy emphasis on troubleshooting procedures and maintenance of air conditioning units. The operator familiarization course is now 2 weeks long and is designed for unit master drivers as opposed to operators. This course covers the same topics as the original Operator Training Course but with a focus on training unit trainers instead of actual operators (MRAP University, n.d.).

In addition to the training provided by MRAP University, the Infantry Center at Fort Benning, GA, published a “Smartbook” covering basic vehicle characteristics and employment for all MRAP variants (United States Army Infantry Center, 2008). Together, MRAP University and the Smartbook provide operators and maintainers the minimum information needed to successfully employ the vehicles. More importantly, they demonstrate that training and doctrine development programs can quickly adapt to major rapid acquisitions.

2. Manufacturer-provided Training

Some manufacturers have taken the basic training, described above, to a higher level by establishing their own facilities and offering training to Service members as well as FSRs from other manufacturers. Participation of FSRs who work for competitors does potentially expose proprietary data and technology to view by other manufacturers; however, as FPII Executive Vice President Damon Walsh stated, “this is support for the troops, so we do it for their (other manufacturers’) guys, too.” FPII provides a training program and facilities and offers 40 to 50 hours of FSR training per week. Additionally, FPII requires that trainers have 90 days of job experience and training before they are slotted as trainers (2008, August 6).

Once FSRs have achieved their individual skill levels, they rotate with counterparts in theater, and the returning FSRs share their knowledge with engineers and management stateside. This contributes to recommended changes in MRAP vehicles based on lessons learned from the returning FSRs. Unlike the other manufacturers, IMG does not provide its own FSRs, but instead subcontracts that requirement to DynCorp. Although this relieves IMG from the requirement to train and provide FSRs, it also may constrain a potential feedback loop when compared to other manufacturers. When IMG wants or needs information about its vehicles, it must request that through DynCorp (Major, 2008, August 22).

FSR cross-training has proven vital to the operational availability of the MRAP vehicle fleet. As a combat multiplier, FSRs have enabled the DoD to field MRAPs without trained maintenance personnel at the organizational level. This risk acceptance was based upon the urgent need and on the fact that MRAP maintenance could leverage FSR knowledge and relevant skills of organizational-level mechanics. In this respect, organizational-level maintenance personnel already possessed some of the basic automotive maintenance skills needed to work on MRAPs. This represents another example of the JPO accepting risk by fielding vehicles before development of a training program for operators and maintainers. This risk acceptance was not without cost, however. As reported by the Associated Press, at least 66 MRAP-related accidents occurred between November 2007 and June 2008—with at least 40 of those rollovers caused by bad roads, weak bridges, or driver error. These accidents resulted in five soldier deaths (Associated Press, 2008). Such incidents arguably might have happened in any vehicle, but this vividly demonstrates the trade-offs made in fielding MRAPs so rapidly.

G. Logistics Support

The initial JPO logistics support strategy was to employ a pure CLS approach with manufacturer FSRs and 90-day spares packages supplied at vehicle fielding. The 90-day spares packages were determined by the OEMs based on expected short-term parts needs. The initial plan also called for centralized fielding, centralized support, a ratio of one FSR for every ten vehicles, and the use of non-standard COTS manuals. However, as the program grew from 1,185 to more than 15,000 vehicles, the JPO had to adjust the strategy. Based on the need to get this significantly larger number of MRAP vehicles into the hands of warfighters as quickly as possible, the JPO had to conduct decentralized simultaneous fieldings as well as perform de-centralized support operations. In addition, the larger number of vehicles in use throughout Iraq made pure CLS infeasible. The JPO, therefore, changed to a hybrid/organic support concept, with manufacturer FSRs assisting organic maintenance personnel.

Like the initial pure CLS approach, the hybrid/organic approach relied heavily on manufacturer FSRs. The difference with the hybrid approach was the need for multi-variant FSRs trained at MRAP University, as previously discussed. In addition, this approach relied on multi-variant new equipment trainers and government depot mechanics. Instead of 90-day spares packages, the JPO supplied units with prescribed load listings (PLL) for expected routine repair needs. Additionally, the JPO supplied service support areas (SSAs) with authorized stockage lists (ASL) of parts based on analysis of Stryker and other similar vehicles—sized for an estimated 12 months of supply, with each ASL supporting a density of 25 vehicles. This approach also relied on provisioning parts through the defense supply system and on Government validation of manuals for all field-level tasks (Conway, 2008, slide 5). Changing the strategy in these ways allowed the JPO to meet the program objectives of fielding as many survivable vehicles as quickly as possible, while still being able to support them.

To support ongoing operations and prepare for future, purely organic support, the JPO planned to execute the provisioning of parts in two phases. Phase I involved assigning Type II NSNs for the items listed in the parts manual, with OEMs as the source of supply. Phase II encompasses the formal provisioning of parts to include assigning new Type I NSNs and identifying Type I NSNs already in the system, thereby removing OEMs from the supply chain.[30] Upon successful completion of parts provisioning, scheduled through March 2009, the logistics supply support will shift from parts deliveries based on OEM part number data to parts

---

[30] Type I NSNs are assigned to parts provisioned and verified by EDFP. Type II NSNs are provisional NSNs assigned as an expedient method of entering OEM parts in the defense supply system. Once fully provisioned through the use of EDFP, these Type II NSNs are replaced with the permanent Type I NSNs, or existing parts with previously assigned Type I NSNs are identified that are identical or are suitable substitutes. This process prevents permanent addition of redundant identical items to the system.

deliveries based on provisioning of technical data. Figure 27 shows the JPO parts provisioning and supply support timeline (2008, slide 23).

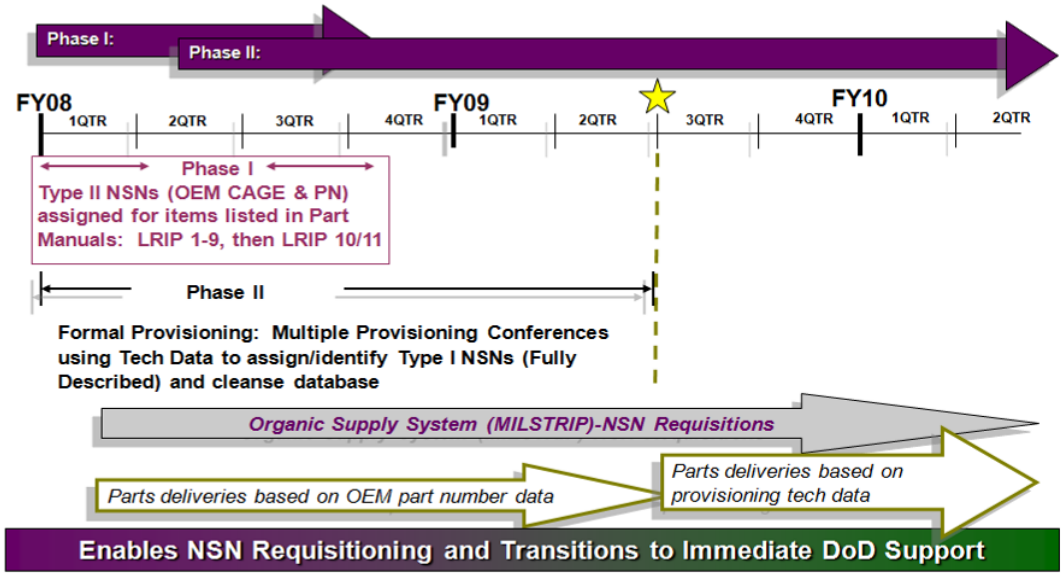


Figure 27. Path Forward: Provisioning and Supply Support
(Conway, 2008, slide 23)

Parts obtained under the hybrid/organic concept are requisitioned through the DLA supply system using Type II NSNs. These requisitions are sent to the OEMs that then procure the parts from the parts manufacturers. Parts are then consolidated at RRAD and shipped into theater based on priority. ManTech International Corporation and AECOM manage parts consolidation and shipping under contract from the JPO. These companies bring years of logistics distribution experience to the program, and their contribution allows the JPO to focus on future sustainment planning while providing oversight on the current sustainment execution. To maintain the operational readiness rate at or above 90%, the JPO also undertakes individual emergency buys through a parts-allocation board. This involves risk acceptance by the JPO because unforecasted orders may place manufacturers in a position of needing parts for both an emergency buy and for vehicles in production. In fact, this has occurred with FPII; the company has reallocated parts assigned for production to meet spares demands in theater (Walsh, 2008a, August 6).

As the program matures, the JPO plans to transition to a fully organic logistics support concept and award long-term contracts to sole-source suppliers or add items to existing long-term contracts. Essentially, this means that all parts will be fully provisioned through the DLA supply system and that these parts will come directly from the supplier instead of going through the OEM, as is now the case.

1. The Role of the FSR

As the number of military personnel trained on the MRAP increases, the role played by FSRs in day-to-day unit operations varies based on unit and location. In some cases, FSRs perform all maintenance; in others, FSRs provide assistance to unit-level mechanics while performing 30-level maintenance. The level of involvement depends on the unit mission and requirements of specific missions. If the supported unit is conducting a mission that is personnel intensive, FSRs have reportedly conducted operator-level maintenance, which freed the Service members to participate in that mission. As of this writing, the Army has transitioned to a more organic maintenance posture, while the Marine Corps continues to rely heavily on FSRs at the unit level (Hansen, 2008, June 10).

CLS has arguably added significant cost to the MRAP program. However, when considering the urgent need, the JPO did not have time to establish a conventional support system. By employing CLS, the JPO allowed MRAPs to be placed in use while concurrently establishing the means to support the product in the present and future. Additionally, the JPO awarded contracts to ManTech International Corporation and AECOM Technology Corporation to manage the MRAP repair parts consolidation task based on their track records of logistical support to the DoD. CLS was the preferred method for this program because it not only reduced the timeline of the fielding process, but also enabled the DoD logistics system to make an orderly transition to support the new requirement. As of this writing, all requisitioned parts are consolidated at RRAD by ManTech and AECOM and are flown to their destinations based on priority (D. Hansen, personal communication, 2008, November 14). CLS has, therefore, allowed the JPO to focus on fielding a quality product to the warfighter, rather than on sustaining it.

2. Commonality

Although typically a major concern when procuring a new family of vehicles (FOV), parts commonality was never a significant consideration given the program objectives and acquisition strategy of using multiple manufacturers. The vehicles procured for testing contained proprietary technology that distinguished one manufacturer from another. These prototype vehicles, and the initial production vehicles, were designed with limited consideration of GFE and, therefore, had limited requirement for common design interfaces (Hansen, 2008, June 10). Consequently, design interfaces became an issue when the Services requested specific equipment in each of the vehicles.

The selected MRAP vehicles do not provide 100% commonality across the MRAP family of vehicles (FOV), or even offer complete commonality within the existing DOD vehicle fleet. They do, however, provide commonality with vehicles widely available worldwide in the commercial marketplace. For example, the FPII Cougar model includes a Caterpillar C7 engine, and the IMG MaxxPro is built on the widely used Navistar severe service chassis. Caterpillar and International have worldwide distribution and support systems, as do most other suppliers of major components to the MRAP manufacturers (Hansen, 2008, June 10). Using five manufacturers suggests added complexity for program logistics, but analysis of components from the JPO shows that significant commonality exists among the MRAP variants and that many parts are currently in use within the existing DoD vehicle fleet. These components include engines, transmissions, transfer cases, axles, oil filters, air filters, fan belts, fuel filters, starters, alternators/generators, batteries, and tires. Figure 28 depicts these commonalities among existing vehicles and the MRAP FOV. This chart indicates that a large number of MRAP parts already existed in the supply system. As such, many military organizations already carried these parts on their PLL or ASL (2008, June 10). Although the lack of commonality across the MRAP FOV added complexity to sustainment, the use of widely available components made the trade-off more manageable and acceptable.

MRAP Component Matrix

Vehicle Applications	BAE (RG-33)	GDLS-C (RG-31)	IMG (Maxx Pro)	FPII (Cougar)	BAE-TVS (Caimen)
Engine	Cummins ISL-400e	Cummins QSB 6.7(275 HP)	INTL DT530 ST	Caterpillar C7	Caterpillar C7
Military	MRAP Only	HEMIT	MRAP Only	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RVs	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Eng Oil Filter	Cummins, Fleetguard, Luberfiner, Donaldson, Baldwin	Cummins, Fleetguard, Luberfiner, Donaldson, Baldwin	Fleetguard, Luberfiner	Baldwin, Donaldson	Baldwin, Donaldson, AMSOIL
Military	MRAP Only	MRAP, HEMIT	MRAP Only	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RVs	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Air Filter	Donaldson, Baldwin, Fram	Donaldson, Baldwin, Fram	Insufficient Technical Data to Determine Source of Original Parts Vendor	Donaldson, Hastings	Donaldson, Hastings
Military	MRAP Only	MRAP, HEMIT	MRAP Only	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RV's	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Fan Belts	Dayco, Ford, Bosch, Hamilton	Gates, Bosch, Goodyear, Carlise, Veyance	Goodyear, Bosch	Gates, Nacco, Goodyear, Bosch	MS, Nacco, Goodyear, Veyance, Carlise
Military	MRAP Only	MRAP, HEMIT	MRAP Only	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RV's	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Starter	Bendix, Delco-Remy, Rockwell	Bendix, Delco-Remy, Rockwell	Bendix, Delco-Remy, Rockwell	Bendix, Delco-Remy, Rockwell	Bendix, Delco-Remy, Rockwell
Military	MRAP Only	MRAP, HEMIT	MRAP Only	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RV's	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Alternator	Niehoff - 400 Amp (N1601-1)	Niehoff - 450 Amp	Niehoff - 400 Amp (N1602-1)	Niehoff - 400 Amp (N1601)	Niehoff - 400 Amp (N1602-2 & N1602-3)
Military	HMMWV	Insufficient Technical Data to Determine Military Application	Insufficient Technical Data to Determine Military Application	HMMWV	Insufficient Technical Data to Determine Military Application
Commerical	Marine, Medium and Heavy Duty Trucks	Marine, Medium and Heavy Duty Trucks	Marine, Medium and Heavy Duty Trucks	Marine, Medium and Heavy Duty Trucks	Marine, Medium and Heavy Duty Trucks
Fuel Filter(s)	Fleetguard	Fleetguard. Mowag	International, CAT, Fleetguard	Supacat, Baldwin, Cat, Parker	Supacat, Baldwin, Cat, Parker, Mowag
Military	MRAP Only	MRAP, HEMIT	MRAP	FMTV, Stryker, USMC LAV	FMTV, Stryker, USMC LAV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RV's	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Battery	Interstate, Delco-Remy, Hawker	EXIDE, Interstate, Hawker	EXIDE, Interstate, Hawker	EXIDE, Interstate, Hawker	EXIDE, Interstate, Hawker
Military	Across the Fleet	Across the Fleet	Across the Fleet	Across the Fleet	Across the Fleet
Commerical	Commerical Wide	Commerical Wide	Commerical Wide	Commerical Wide	Commerical Wide
Tire	Michelin, Goodyear	Michelin, Goodyear	Michelin, Goodyear	Michelin, Goodyear	Michelin, Goodyear
Military	395/85R20 XZL	365/80R20	395/85R20 XZL	395/85R20XZL	395/85R20 XML
Commerical	Across the Fleet	Across the Fleet	Across the Fleet	Across the Fleet	Across the Fleet
Transmission	Allison	Allison S-2500SP	Allison 3000SP	Allison 3500SP	Allison
Military	MRAP	MRAP	MRAP	MRAP	Caimen, FMTV
Commerical	Motor Homes, Farm Equipment, Medium Duty Trucks, Buses	Farm Equipment, Medium Duty Trucks, Construction Equipment	Medium Duty Trucks, RV's	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks
Transfer Case	Cushman 315M-2	Insufficient Technical Data to Determine Source of Original Parts Vendor	Insufficient Technical Data to Determine Source of Original Parts Vendor	Cushman 315N	Insufficient Technical Data to Determine Source of Original Parts Vendor
Military	Insufficient Technical Data to Determine Military Application	Insufficient Technical Data to Determine Military Application	Insufficient Technical Data to Determine Military Application	Insufficient Technical Data to Determine Military Application	Insufficient Technical Data to Determine Military Application
Commerical	Farm Equipment, Medium Duty Trucks,	R0079495	Medium Duty Trucks, RVs	Medium Duty Trucks, RVs, Buses, Fire Trucks	Medium Duty Trucks, RVs, Buses, Fire Trucks

Figure 28. Parts Commonality Matrix
(MRAP JPO, 2008, June 2)

As Figure 28 demonstrates, the MRAP FOV includes four engine models by three manufacturers: Cummins, Inc., International Truck and Engine Corporation, and Caterpillar. The Cummins QSB engine used on the RG-31, for example, is also used in the Heavy Expanded Mobility Tactical Truck (HEMTT), and the Caterpillar C7 engine is used on the Stryker, Family of Medium Tactical Vehicles (FMTV), and the Marine Corps' Light Armored Vehicle (LAV). Since these engines are already in the supply system, repair parts are readily available. Additionally, these companies are globally established—providing the DoD an alternate method of procurement should a problem arise with the normal supply distribution program.

H. Facilities

All facilities used by the MRAP JPO are referred to as issue points or RSAs. To establish such sites, the JPO needed huge areas for use as parking lots, buildings for vehicle processing, areas for installation of last-minute items (such as IED jammers), and finally, areas for mechanics to work on the vehicles. Each site included an implied task of providing shop tools such as hydraulic lifts and air compressors necessary for conducting vehicle maintenance. Essentially, every site needed to replicate a maintenance bay with all infrastructure support. This section of the report provides an overview of the facilities in Charleston, SC; Kuwait; Iraq; and Afghanistan, and their effect on the value stream in MRAP fielding.

1. Charleston

As previously discussed, SPAWAR in Charleston, SC, was selected as the integration facility based on its capabilities and prior experience in up-armored HMMWV integration. In addition to its proximity to the aerial port of debarkation (APOD) and the sea port of debarkation (SPOD), the facility also provided expertise in engineering and testing of C4I systems. SPAWAR's Poseidon Park facility not only allowed the execution of three major types of C4I tests, but also allowed these tests to be completed in 30 days. As stated by SPAWAR's industrial engineer, Pete Ward, "If we did not have Poseidon Park, we could not have done that in 30 days"

(2008, August 5). To provide insurance against work stoppage due to hurricane or other natural disaster, SPAWAR positioned an identical site set-up about 10 miles from the primary site. This alternate site ensured continuous integration of vehicles and only required the movement of personnel and equipment for it to be operational.

2. Kuwait

The facilities in use in Kuwait are fully mature due to continuous US presence in that nation since the Persian Gulf War in 1991. The JPO had no issues securing sites to conduct vehicle disembarkation procedures, and the infrastructure within the country also supported the rapid movement the program required. Many facilities were available for rent and immediate occupation such as at Ali-Al-Salim Airbase, which has functioned as the Aerial Port of Debarkation (APOD) in Kuwait since the military terminal at Kuwait International Airport ceased operations in 2004. The required port facilities were no different as huge port areas were not being utilized; these facilities were constructed by the US during Operations Desert Shield and Storm. The JPO chose the facility best suited to its needs among the many available at the Kuwaiti port and converted it into a functional support activity by making minimal changes such as installing air conditioners, lighting, and hydraulic lifts. Thus, establishing the RSA in Kuwait was not a significant issue for the JPO, and the same applied for facilities in Iraq (D. Hansen, personal communication, 2008, October 15). Although not an issue, the well-positioned facilities aided the timely movement of the vehicles to warfighters.

3. Iraq

The JPO considers Iraq as a mature theater that is lacking some minor infrastructure support. The use of plywood shelters and tents at forward operating bases (FOBs) supports this classification. Therefore, to establish issue points (IPs) and RSAs in Iraq, the JPO took extra measures that included pouring concrete slabs for maintenance bays and erecting sprung shelters. Nine different sites were established in Iraq, each with requirements unique to its location. These sites included Mosul, Tikrit, Al-Taqaddum, Kalsu, Talul, Baghdad, Taji, Balad, and Kirkuk.

Of the nine sites, four were established as RSAs and, therefore, had the capacity to perform battle-damage repairs. These RSAs are depicted in Figure 29. Their strategically dispersed locations provide support to Service members, and the locations are easily accessible through established main supply routes (D. Hansen, personal communication, 2008, October 15).

Besides the basic infrastructure required at the IPs and RSAs, the JPO also built living facilities at some locations to house FSRs supporting the program. These living facilities included containerized housing units, latrines, and showers, all of which were the responsibility of the JPO. The presence of the fielding and support teams at these locations, coupled with the new equipment and facilities, contributed to the rapid fielding of MRAP vehicles.

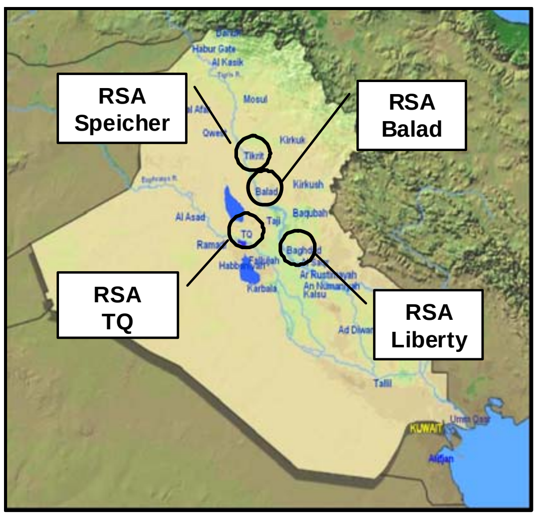


Figure 29. RSA Locations within Iraq
(Conway, 2008, slide 27)

4. Afghanistan

Unlike the facilities in Kuwait and Iraq, those in Afghanistan were very immature and lacked the infrastructure needed to support the MRAP program. Due to constraints on suitable locations and space within forward operating bases, limited options existed for the JPO to conduct operations. As of this writing, these options are limited to flying into Kandahar and Baghram, with additional issue points at

Jalalabad and FOB Salerno. The base JPO plan for Afghanistan involved establishing four RSAs with a budget of just under $500 million. Included in this cost estimation is fencing for expansion of forward operating bases and the cost of procuring additional land needed for work areas (D. Hansen, personal communication, 2008, October 15). Figure 30 below shows the fielding locations within Afghanistan.

Figure 30. Current Fielding Locations within Afghanistan
(MRAP JPO, 2008, October 18)

The multiple IPs and RSAs located within the respective theaters are another example of how the JPO fielded MRAP vehicles and how it is supporting those vehicles in a rapid manner. Centrally locating RSAs led to low turnaround times for battle-damaged MRAP vehicles, thereby improving operational availability. As of this writing, the RSAs have returned all but 50 MRAP vehicles to fully mission-capable status (MRAP JPO, 2008, October 28). The vehicles have been repaired and returned to duty largely due to FSRs on-site, OEM parts on-hand, and the available equipment at these facilities to rebuild the vehicles.

I. Transportation

The initial transportation plan called for completed MRAPs to be shipped and flown directly from Charleston, SC, to Iraq or Kuwait. These vehicles would then be de-processed at the destination before being issued to the receiving units. Until October 2007, all MRAPs were flown into the Iraqi theater because of the urgent need, with the flow reaching 380 vehicles per month. Vehicles were flown into Ali Al-Salim Airbase in Kuwait, as well as Balad Airbase located on Camp Anaconda in Iraq (Hansen, 2008, June 10). The JPO, Transportation Command (TRANSCOM), individual Services, combatant commands, and DCMA shared the responsibility of placing the vehicles into warfighter hands.

As of this writing, the average time required to ship and field MRAP vehicles is 30 days from the time the vehicle leaves the US. The process of moving the vehicles into theater is depicted in Figure 31 and shows the 10-step process. First, the completed MRAPs are inspected and accepted by DCMA representatives at the manufacturer locations. The MRAP contracts specify Freight on Board Origin (FOB), and the co-location of DCMA assets with manufacturers assists in conditional acceptance of vehicles prior to transport. Next, vehicles are transported from the various manufacturing sites by trailer to SPAWAR in Charleston, SC, where the third step, GFE integration, takes place. Responsibility during this step lies with the MRAP JPO. Following GFE integration, the vehicles are tested and driven to Charleston Air Force Base for airlift or to Charleston Naval Weapon Station for sealift. Vehicles identified for use within the US are transported to their destinations by trailer. Once the vehicles are delivered to the APOD and SPOD, TRANSCOM assumes responsibility for the air- and sealift.

The vehicles arriving in Kuwait undergo de-processing and await intra-theater transport, which is the responsibility of the combatant commands. These vehicles are sent to respective IPs in Iraq by trailer where the JPO re-assumes responsibility. Receiving units then draw the vehicles, conduct familiarization training as per Service-specific standards, and then move to their respective forward operating bases.

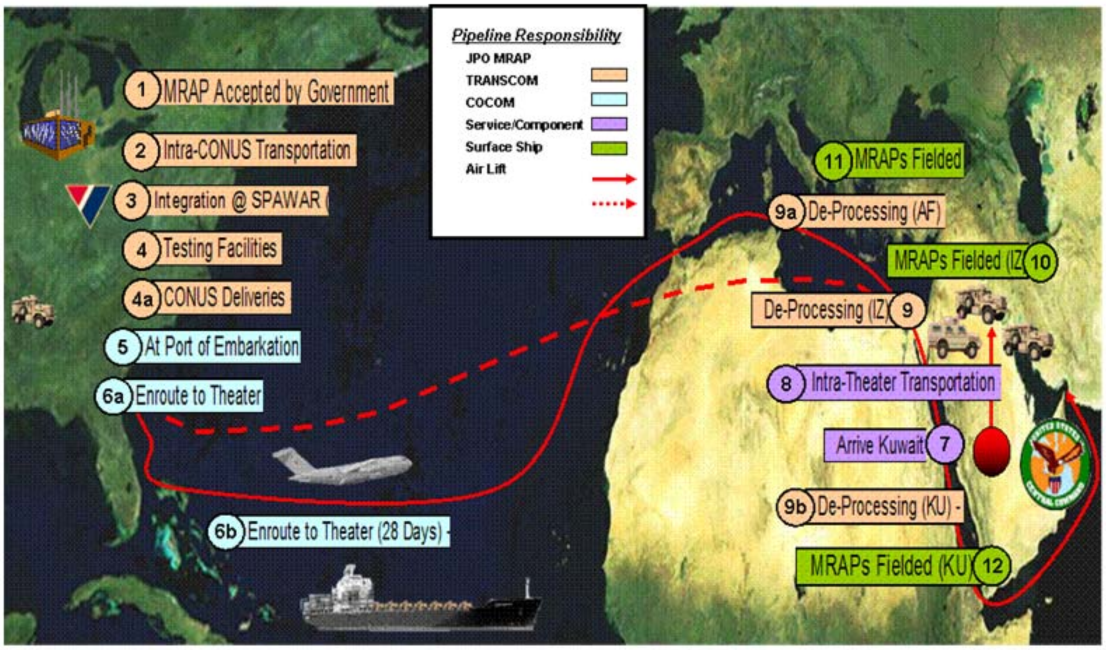


Figure 31. Transportation Pipeline and Responsibility
(After MRAP JPO, 2008, October 21)

When the MRAP production rate surpassed the TRANSCOM airlift limit of 380 vehicles per-month, the JPO moved to surface-shipping as the primary means of transportation to Iraq. With the ability to transport up to 500 vehicles per-ship, and production rates exceeding 1000 per-month by early 2008, vehicle flow eventually exceeded both the 250 vehicle per-week de-processing capability in Kuwait, as well as the ability of units to receive vehicles given ongoing combat operations. As the queue filled at multiple sites in Kuwait and Iraq, the program shifted entirely to ship-borne transportation by May 2008. MRAPs bound for Afghanistan, however, must still be airlifted because of that country's landlocked and remote location (Hansen, 2008, June 10).

1. Transportation Cost Oversight

Transportation was one of the most significant cost elements for the MRAP program; therefore, the mode of transportation was a significant concern for the JPO. At the height of fielding operations, airlift costs were $134,000 per vehicle versus $18,200 per vehicle for sealift. Hence, the transition to sealift for the Iraq theater resulted in a huge cost savings.

2. MEAP

Among many issues that arose from airlifting MRAP vehicles was the extra protection of the EFP kits that resulted from the MEAP program. Depending on the variant, these kits add anywhere from 4,300 to 11,000 pounds per vehicle, which in some cases puts the vehicles over their GVWR. Besides the weight, most of the aircraft used to transport these vehicles could not accommodate the width of the vehicle once the kit was installed. Airlifting vehicles with EFP kits installed was therefore not a feasible option, and the EFP kits were flown separately and mounted at destination. Not all MRAPs were retrofitted with EFP kits, and, as of this writing, only the vehicles destined for areas prone to EFPs receive the kits (Hansen, 2008, June 10).

The addition of EFP kits has also caused problems in ground transportation. The additional weight changes a vehicle's center of gravity, complicating trailer transport. This creates problems even in the US, where road conditions are better than in Iraq. However, once these kits are bolted on in Kuwait, movement by trailer is the only available means of moving them into Iraq for fielding. Installing these kits in Kuwait alleviated the transportation problem from the US into theater but added a problem of transportation from Kuwait into Iraq (2008, June 10).

Logistically, EFP kit additions in theater caused major concern for the JPO as it created requirements for, among other things, personnel to do the work, lease space for the actual work, and the health and welfare of the personnel. Despite these challenges, the JPO has successfully shipped the EFP kits and vehicles separately, married them in theater, and delivered them to warfighters (Hansen, 2008, June 10). This additional requirement and complexity in the value stream, meanwhile, has been transparent to receiving units.

J. Fielding Operations

As with sustainment, the MRAP program is unique in its initial lack of a fielding plan. No real plan existed because the JPO did not initially know the total requirements at the time fielding started. The program objectives, on the other hand, were very simple–field as many survivable vehicles as quickly as possible; everything else remained secondary. In the early stages of the program, this meant a fielding timeline of production plus 60 days (Hansen, 2008, June 10). The MRAP fielding process was no different than the regular process any unit would undergo in drawing vehicles. The difference existed in the expedited fielding, characterized by the "truncated," or shortened, training that operators and maintainers underwent prior to receiving the vehicles.

The fielding process varies between the Services and individual units based on Service-specific standing operating procedures (SOPs) and prior unit experience with MRAPs. Units with more familiarity conduct an expedited fielding process, while others spend up to five days in familiarization training before completing their equipment draw. As an example, Army units typically conduct five days of operator and maintenance training and account for all ASL and PLL parts in the presence of a mechanic before receiving the vehicle. Marine Corps units, on the other hand, typically conduct a much less rigid fielding process, preferring to place the vehicles directly into operation (Hansen, 2008, June 10).

This expedited fielding process represents yet another trade-off made by the JPO in support of the program strategy. Whereas a typical new equipment fielding would include an extensive training and familiarization period for operators and maintainers, the urgent need required MRAPs to be placed into immediate operation.

K. Key Factors and Trade-offs

This overview of MRAP logistics planning and execution highlights numerous factors that contributed to program success. As previous analysis has shown, many of the trade-offs that enabled rapid MRAP fielding involve risk acceptance in sustainment. Accordingly, the key factors from a logistics standpoint are those which mitigate this risk of fielding an unsupportable and unsustainable vehicle.

First, the JPO mitigated complexity in sustaining MRAP vehicles by using CLS to execute sustainment operations. A combination of manufacturer FSRs, OEM new equipment training (NET) trainers, and organic Service mechanics ensured that vehicle fielding occurred on a compressed timeline. Co-locating FSRs with units in theater ensured that vehicles remained mission-ready, evident in the operational readiness rate of the MRAP FOV. FSRs provided units with the expertise needed to maintain MRAPs and enabled unit mechanics to concentrate on other missions, such as maintaining other equipment or augmenting combat patrols. The trade-off, however, of having co-located FSRs was that the JPO was responsible for the health and well-being of those individuals.

In addition to maintenance support, CLS also enabled the sustainment of MRAP vehicles while parts were being provisioned in the defense supply system. OEM supply systems with initial spares packages ensured that parts were readily available and accessible to the warfighter during fielding. As the program transitioned to organic support, established supply chain management companies such as ManTech International and AECOM also ensured the continuous flow of parts to keep the vehicles operational.

A second major factor contributing to the MRAP program's success involved providing a common place for learning, also known as MRAP University. This ensured FSRs and select Service members were cross-trained on products from all manufacturers and that key maintainers and operators had the expertise needed to safely operate and maintain the vehicles. This cross-training allowed the JPO to conduct decentralized, simultaneous fielding and to fulfill decentralized support requirements.

In conclusion, the key logistics factors again follow the trends prevalent throughout the MRAP program. Use of a CLS approach allowed concurrency in normally sequential tasks by ensuring sustainment of MRAP vehicles while the DoD built an organic sustainment capability. MRAP University contributed to this concurrency in operations by providing a base of knowledge to key personnel while operators and maintainers adapted to the new vehicles. As before, however, the conditions that allowed concurrency also required risk acceptance. This came in the form of compressed new equipment training and the risk of fielding vehicles without full knowledge of their limitations or maintenance requirements. As before, however, these trade-offs were necessary factors for the program to successfully meet overall objectives.

THIS PAGE INTNETIONALLY LEFT BLANK

VII. Conclusions

As of October 21, 2008, more than 9,000 MRAP vehicles have been fielded to warfighters in Iraq and Afghanistan, with nearly 4,000 more progressing through the integration and transportation process (MRAP JPO, 2008, October 21). Considering MARCORSYSCOM released the original RFP in November 2006, this is an unprecedented DoD acquisition accomplishment that required flexibility and priority of effort within the DoD, industry, and Congress. Although detailed data indicating MRAP effectiveness in saving lives is held at the classified level, substantial anecdotal evidence, as well as significantly reduced casualties in Iraq through 2008, indicates that MRAP vehicles are indeed survivable. By these criteria, the MRAP program has been effective in meeting the program objectives of fielding as many survivable vehicles as quickly as possible.

The question of whether the program has met warfighter needs is more difficult to address, given the requirement was largely top- rather than user-driven. Again, however, substantial anecdotal evidence suggests that MRAP vehicles have largely met warfighter needs by providing survivability and the required mobility for most missions in Iraq. For Afghanistan and the much more restrictive terrain associated with that country, however, the question is more difficult to answer. Effectiveness in meeting warfighter needs is, therefore, best assessed in how the program addressed the range of needs. In this case, the final LRIP purchases of smaller vehicles and the latest evolution of the program, the MATLCV, demonstrates that the MRAP program is not forcing an ineffective solution, but is tailoring the solution for maximum effectiveness in the operational environment. From this perspective, the MRAP program has met warfighter needs.

The success of the MRAP program is attributable to many factors, all of which point back to the overall program objectives of fielding as many survivable vehicles as quickly as possible. This chapter summarizes the key factors, starting with a comparison to prior research and an overview of additional factors that contributed specifically to the MRAP program and concluding with the significant trade-offs involved.

Research indicates that four conditions must exist for a successful rapid acquisition program: existence of a materiel solution, user acceptance, leadership acceptance, and a dedicated source of funding. Analysis of the MRAP program generally conforms to these conditions, but with exceptions. Comparison with this prior research is as follows:

Prior research involving rapid acquisitions concludes that a materiel solution must exist that meets the user's requirements. Further, this solution must be technologically mature and ready for production. In the case of MRAP, this largely holds true. At the program outset, FPII produced multiple variants of MRAP vehicles that were already in operational use. FPII vehicles, as well as those built by BAE and GDLS, were based on technology and designs that date back 30 years. In that respect, a materiel solution did exist—although large production capacity did not. IMG vehicle design and status as the largest MRAP producer provides an exception to this condition, however, in that it did not have a materiel solution at the program start. Rather, that company had only a concept based on proven technology. This shows that a complete materiel solution is not a key factor in enabling a rapid acquisition; the key factor is the presence of a mature technology that meets the requirement. Had extensive research and development work been required, the MRAP program would not have progressed as it did. The IMG example, however, demonstrates that a world-class manufacturer can rapidly take a mature technology from concept to fielded product. This indicates that emphasis should be placed as much on the required technology as on an off-the-shelf product when researching materiel solutions for urgent needs. In cases in which the technology exists, the program strategy should include ways of incentivizing industry to apply that technology in a rapidly produced product.

User acceptance of any fielded product must be considered before assessing its overall success in meeting a requirement. For the MRAP program, user acceptance depends largely on the timeframe of the assessment. Prior to Secretary Gates making the MRAP the top DoD acquisition priority, no consensus existed within the user community—and particularly within the Army—over the best way of addressing the IED threat. Since the program start, however, MRAPs have gained widespread user acceptance—although with recognition of the limits based on size and maneuverability. This acceptance, therefore, conforms to prior research from the perspective of how warfighters have used the MRAP. It does not, however, indicate that user acceptance is critical at program start.

Perhaps more than any other factor, the MRAP program demonstrates the importance of leadership acceptance in the success of a rapid acquisition program. Even after the initial JUONS validation in December 2006, consensus did not exist in the user community or the senior DoD leadership that MRAP offered the best solution to the IED threat. Through the spring of 2007, MRAP was still largely a Marine Corps initiative. When Secretary Gates prioritized the program first among all DoD programs, however, he effectively established leadership acceptance and a broad mandate for the program. From that point on, the program commanded the priority of effort at every level within the DoD. This indicates that leadership acceptance enabled program success more than any other factor, and largely influenced the user acceptance that followed.

The final condition, a dedicated funding source, is critical for any acquisition program regardless of whether it is rapid or standard in nature. The urgent need and scale of the program with requirements exceeding $22 billion precluded funding through the standard PPBES process. Its priority and backing within the DoD and Congress enabled it to receive sufficient funding through reprogrammed funds, and emergency and supplemental appropriations. The MRAP program conforms to prior research in that it required money through non-standard sources. The tremendous political support ensured the program had relatively little resistance in obtaining those funds.

In addition to the conditions identified in prior research, two key factors enabled the MRAP program to field more than 9,000 vehicles by late October 2008: concurrency and risk acceptance. Both are related in that concurrency is a direct example of risk acceptance; yet, they are distinct in the ways they enabled rapid execution of the program. Just as important is the tremendous political and DoD leadership support the program received from inception. The political support enabled the program to receive more than $22 billion in funding through non-standard sources, as well as the flexibility to obligate those funds as needed and with speed consistent with the program execution. DoD leadership support gave the program top priority within the DoD and industry, effectively focusing all resources on the effort. This support, specifically from Congress and the Secretary of Defense, set the conditions for the PM to apply the two key factors of concurrency and risk acceptance to the program.

Concurrency in execution is the first key factor that enabled rapid execution of the MRAP program. This applied throughout the program and is evident in the following examples:

- The program executed all phases of the acquisition management framework simultaneously, rather than in sequence. As of this writing, the JPO is involved in activities associated with concept refinement, technology development, systems development and demonstration, production and deployment, and operations and support, to include disposal.
- Manufacturers initiated vehicle production prior to and during developmental testing. In a normal acquisition, developmental testing would be complete before production of vehicles for fielding.
- DCMA conditionally accepted vehicles to allow concurrent integration, deficiency correction, and continuous flow to warfighters. DCMA normally requires correction of all deficiencies prior to acceptance.
- The program simultaneously fielded vehicles while building the organic capability to support them. Normally, a program builds sustainment capability prior to fielding.

Additional examples of concurrency exist throughout the program execution, representing the single biggest factor in how the program compressed what would normally be a much longer schedule.

Risk acceptance is the second key factor that enabled rapid acquisition of MRAP vehicles, and is largely connected to the concurrency in execution. Risk acceptance came in multiple forms and in all phases of the acquisition. Examples of risk acceptance critical to the rapid execution of the MRAP program include the following:

- Acceptance of a materiel solution not necessarily based on consensus in the user community and not ideally suited to the operational environment increased the risk of committing to a product that did not meet warfighter needs.
- Award of LRIP contracts prior to testing involved risk of procuring vehicles that could not ultimately be used.
- Award of LRIP contracts based heavily on survivability testing meant risk of procuring vehicles that were unreliable or difficult to maintain.
- Advanced purchase of materials and production capacity expansion by manufacturers before award of production contracts increased risk of manufacturer losses and liability to the Government.
- Conditional acceptance of vehicles with minor deficiencies increased tracking requirements and involved risk of passing deficiencies to warfighters.
- Procurement of multiple variants from multiple manufacturers increased risk of high lifecycle cost and complexity in sustainment.
- Fielding vehicles before parts were fully provisioned in the defense logistics system involved risk of fielding an unsustainable vehicle.

The program includes numerous other examples of risk acceptance, all of which contributed to the overall objective of fielding as many survivable vehicles as quickly as possible.

As with any decision, the risk acceptance and concurrency that enabled rapid execution of the MRAP program came with trade-offs. As one example, the use of a COTS technology and materiel solution resulted in procurement of thousands of vehicles that are largely one-dimensional. The size and weight of the MRAP vehicles limit mobility in restrictive terrain, thereby limiting the range of mission capability. Although very effective at increasing survivability, MRAP vehicles do so at the expense of mobility and, therefore, do not meet all warfighter needs. As another example, the use of multiple manufacturers, although critical in achieving the desired production rates, increased training requirements for operators and maintainers, added complexity in sustainment, and increased lifecycle costs as compared to a common vehicle. Multiple other trade-offs exist for every case of risk acceptance in the program.

In conclusion, the MRAP program represents an important example of how the defense acquisition system can rapidly react to meet warfighter needs. This report highlights the key factors that enabled program success in rapidly fielding thousands of vehicles: concurrency and risk acceptance enabled by unprecedented political and DoD leadership support. Political and DoD leadership support, obviously, is situation dependent and is largely out of a PM's control. In addition, concurrent execution of acquisition processes and heavy risk acceptance is not appropriate for every program. Therefore, this report does not provide a guide to rapid acquisitions that can apply to all programs. It does, however, provide an example of risk acceptance and concurrent execution that can be tailored to the urgency of many needs on a case-by-case basis. In addition, the modified acquisition process used to develop and field the MRAP demonstrates that the current acquisition management framework and JCIDS process are flexible enough to enable rapid execution of major weapons systems.

List of References

Aberdeen Test Center. (2008, August 11). *MRAP test overview.* Unpublished Powerpoint briefing.

Aberdeen Test Center. (2008, August 17). *ATC about us*. Retrieved August 17, 2008, from http://www.atc.army.milpages/aboutATC/aboutus.html

Associated Press. (2008, July 24). *Fatal military vehicle wrecks prompt warnings.* Retrieved November 3, 2008, from http://www.msnbc.msn.com/id/25836450/from/ET/

Biden, J. (2007, April 26). *Biden: Don't veto our troops' safety.* Press release. Retrieved March 1, 2008, from http://biden.senate.gov/press/press_releases/release/?id=b46f6f99-9542-4be2-b05d-fe94a76755c5

Carr, E., Collins, K., & Daniel, K. (2008, August 22). Managers, SFI fabrication. [Inteview with researchers].

Castellaw, J. L. (2007, July 19). Statement before the Seapower and Expeditionary Forces and Air and Land Forces Subcommittees of the House Armed Services Committee on the Mine Resistant Ambush Protected program. Washington, DC: US Government Printing Office.

Chairman of the Joint Chiefs of Staff (CJCS). (2005, July 15). *Rapid validation and resourcing of Joint Urgent Operational Needs (JUONS) in the year of execution* (CJCSI 3470.01). Washington, DC: Author.

Chairman of the Joint Chiefs of Staff (CJCS). (2007, May 1). *Joint capabilities integration and development system* (CJCSI 3170.01F). Washington, DC: Author.

Clements, A.F. (2002). *A study of the alpha contracting processes and its effects on integrated product and process development (IPPD) within selected army acquisition programs* (Master's Thesis). Monterey, CA: Naval Postgraduate School.

Conatser, J.L., & Grizio, V.E. (2005). *Force XXI battle command brigade and below-blue force tracking (FBCB2-BFT): A case study in the accelerated acquisition of a digital command and control system during Operations Enduring Freedom and Iraqi Freedom* (Master's Thesis). Monterey, CA: Naval Postgraduate School.

Conway, J.P. (2008, August 11). *Joint MRAP sustainment and logistics*. Unpublished Powerpoint briefing.

Council for Scientific and Industrial Research (CSIR). (2008, September 12). *About us*. Retrieved October 12, 2008, from http://www.csir.co.za/about_us.html

Cresswell-Atkinson, M. (2007, July 17). *Reprogramming action-prior approval* (DD Form 1415-1). Quantico, VA.

Cresswell-Atkinson, M. (2008a, July 29). *Business financial manager input for week ending 25 July.* Standard JPO weekly status report. Unpublished document.

Cresswell-Atkinson, M. (2008b, July 29). *Status report*. Unpublished Powerpoint presentation. Quantico, VA: MRAP Joint Program Office.

Cresswell-Atkinson, M. (2008c, July 29). *Financial management.* Unpublished Powerpoint presentation. Quantico, VA: MRAP Joint Program Office.

Defense Finance and Accounting Service. (n.d.). *Contract/vendor pay: Electronic commerce*. Retrieved October 14, 2008, from http://www.dfas.mil/contractorpay/electroniccommerce/wideareaworkflow.html

Defense Industry Daily. (2008, September 4). *More MRAPs: Navistar's MaxxPro maintains the pole position.* Retrieved October 20, 2008, from http://www.defenseindustrydaily.com/more-mraps-1200-maxxpro-mpvs-from-navistar-03344/

Department of Defense (DoD). (2008, September). *Federal acquisition regulation (FAR)*. Washington, DC: Author.

Department of the Army. (1997, April 30). *Materiel requirements* (AR 71-9 Para. 5-5). Washington, DC: Author.

Department of the Army. (2003, December 31). *Army acquisition policy* (AR 70-1). Washington, DC: Author.

Eisler, P., Moorison, B., & Vanden Brook, T. (2007, July 16). The Pentagon balked at pleas from officers in field for safer vehicles. *USA Today*. Retrieved March 1, 2008, from http://www.usatoday.com/printedition/news/20070716/1a_iedcoverxx.art.htm

Feickert, A. (2007). *Mine resistant ambush protected (MRAP) vehicles: Background and issues for Congress* (RS22707). Washington, DC: Congressional Research Service.

Feickert, A. (2008). *Joint light tactical vehicle (JLTV): Background and issues for Congress.* Washington, DC: Congressional Research Service.

Force Protection Industries. (2008, September 30). *Products*. Retrieved September 30, 2008, from http://www.forceprotection.net

Fuller, P.N. (2008, February). Rapid acquisition—Developing processes that deliver soldier material solutions now. *Army AL&T Online*. Retrieved September 23, 2008, from http://www.usaasc.info/alt_online/article.cfm?iID=0802&aid=15

General Services Administration, Department of Defense, National Aeronautics and Space Administration. (2005, March). *Federal acquisition regulation (FAR)*. Washington, DC: Author.

Gregory, K. (2008, August 5). Quality Assurance Specialist, DCMA. [Interview with researchers].

Hansen, D. (2008, May 30). MRAP Deputy Program Manager. [Interview with researchers].

Hansen, D. (2008, June 4). *Mine resistant ambush protected vehicles*. Unpublished Powerpoint presentation. Quantico, VA: MRAP Joint Program Office, Quantico, VA.

Hansen, D. (2008, June 10). MRAP Deputy Program Manager. [Interview with researchers].

Inspector General, US DoD. (2007, June 27). *Procurement policy for armored vehicles* (D-2007-107). Arlington, VA: Author.

Jones, L., & McCaffery, J. (2008) *Budgeting, financial management, and acquisition reform in the US Department of Defense*. Charlotte, NC: Information Age.

Jones, W. (1996). *Case analysis of the US Army warfighting rapid acquisition program: Bradley Stinger fighting vehicle-enhanced weapon system* (Master's Thesis). Monterey, CA: Naval Postgraduate School.

Major, J. (2008, August 22). MaxxPro Program Manager. [Interview with researchers].

Mann, P. (2007, November 15). *Joint program office, MRAP vehicle program policy letter MP08-0002.* Memorandum. Quantico, VA: MRAP JPO.

Mann, P. (2008, September 8). *Joint mine resistant ambush protected vehicle program lessons being learned*. Unpublished Powerpoint presentation. Monterey, CA: Naval Postgraduate School.

Manna, J. (2008, August 5). CAPT, USN, Commander, DCMA Atlanta. [Interview with researchers].

Manna, J. (2008, September 8). *DCMA MRAP contract execution*. Unpublished Powerpoint Briefing. Monterey, CA.

Marine Corps Logistics Command. (2008). *USMC PQDR program standard procedures.* Albany, NY: Author.

Middleton, M.W. (2006). *Assessing the value of the joint rapid acquisition cell* (Master's Thesis). Monterey, CA: Naval Postgraduate School.

Miles, D. (2007, July 18). Gates asks Congress to transfer more funds to MRAP program. *American Forces Press Service*. Retrieved September 23, 2008, from http://www.defenselink.mil/news/newsarticle.aspx?id=46766

MRAP JPO. (2006, December 6). *Mine resistant ambush protected vehicle performance specification.* Quantico, VA: Author.

MRAP JPO. (2008, June 2). *MRAP component matrix*. Unpublished MRAP JPO internal document. Quantico, VA: Author.

MRAP JPO. (2008, September 15). *MRAP JPO personnel overview*. Unpublished MRAP JPO internal document. Quantico, VA: Author.

MRAP JPO. (2008, Oct 15). *MRAP JPO organizational structure*. Unpublished MRAP JPO internal document. Quantico, VA: Author.

MRAP JPO. (2008, October 21). *Pipeline charts*, *production, integration & delivery times*. Quantico, VA: Author.

MRAP JPO. (2008, October 28). *SECNAV- MRAP readiness slide.* Unpublished MRAP JPO internal document. Quantico, VA: Author.

MRAP JPO. (2008, October 18). *JMVP PMR LOG slide.* Unpublished MRAP JPO internal document. Quantico, VA: Author.

MRAP University. (n.d.). *MRAP U Training.* Retrieved September 15, 2008, from MRAP U, https://www.redriver.army.mil/mrap_u/mrap_u_training.htm

Munro, J. (2008, August 22). Plant Manager, IMG MaxxPro. [Interview with researchers].

Nalwasky, R.M. (2007, October). *Principles of systems acquisition and program management* (MN3331 Coursework). Unpublished Powerpoint presentation. Monterey, CA: Naval Postgraduate School.

Nussle, J. (2007, October 22). *White House letter asking Congress to consider amendments for FY 2008.* Retrieved May 1, 2008, from http://www.whitehouse.gov/omb/budget/amendments/amendment_10_22_07.pdf.

Office of the Secretary of Defense. (2008, October 8). *Military casualty information*. Retrieved October 10, 2008, from http://siadapp.dmdc.osd.mil/personnel/CASUALTY/castop.htm

Office of the Secretary of Defense. (n.d.). *OSD comparative testing office*. Retrieved September 30, 2008, from https://cto.acqcenter.com/osd/portal.nsf/Start?ReadForm

Owen, R. (2008, June 2). *MRAP vehicle program history and lessons learned*. Unpublished MRAP JPO internal document. Quantico, VA: Author.

Parametric Technology Corperation. (n.d.). *Windchill*. Retrieved October 18, 2008, from http://www.ptc.com/products/windchill

Rooney, J. (2008, August 7). COL, USA, Commander, Aberdeen Test Center. [Interview with researchers].

Rutherford, E. (2007, October 8). *Inouye pledges to fund Pentagon's mine resistant vehicle request.* Retrieved November 15, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=NAVY-20-40-9&f=defense_2002.ask

Sherman, J. (2007, April 26). *Pentagon shifts $498 million to "accelerate" MRAP purchases*. Retrieved November 15, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=PENTAGON-23-17-14&f=defense_2002.ask

Sherman, J. (2007, May 17). *Army eyes $10 billion in procurement cuts to fund larger MRAP fleet*. Retrieved November 15, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=PENTAGON-23-20-5&f=defense_2002.ask

Sherman, J. (2007, March 15). *Defense Department charting course for fast-growing MRAP program.* Retrieved November 15, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=PENTAGON-23-11-8&f=defense_2002.ask

Sherman, J. (2007, May 8). *JROC ratifies MRAP requirement, Krieg weighs new program designation*. Retrieved October 12, 2008, from http://www.insidedefense.com/libproxy.nps.edu/secure/defense_docnum.asp?f=defense_2002.ask&docnum=582007?may8a

Sherman, J. (2008, November 10). *DoD eyes MRAP-like acquisition of light trucks worth up to $3 billion.* Retrieved November 15, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=ARMY-20-45-15&f=defense_2002.ask

Sherman, J., & Castelli, C.J. (2007, May 24). *Marines rejected original request for MRAP in 2005*. Retrieved September 23, 2008, from http://www.insidedefense.com.libproxy.nps.edu/secure/defense_docnum.asp?f=defense_2002.ask&docnum=PENTAGON-23-21-4

Steinholtz, L. (2007, August 1). *PM MRAP $200M steel mitigation plan.* Unpublished Powerpoint presentation. Internal Program Office Report. Quantico, VA: MRAP JPO.

Towell, P., Dagget, S., & Belasco, A. (2008, January 23). *Defense: FY2008 authorizations and appropriations.* Washington, DC: Congressional Research Service.

Under Secretary of Defense (AT&L). (2003a, May 12). *The Defense Acquisition System* (DoD Directive 5000.1). Washington, DC: Author.

Under Secretary of Defense (AT&L). (2003b, May 12). *Operation of the Defense Acquisition System* (DoD Directive 5000.2). Washington, DC: Author.

United States Army Infantry Center. (2008). *MRAP family of vehicles smartbook.* Fort Benning, GA: Author.

US Congress. (2002, December 2). *Bob Stump National Defense Authorization Act for Fiscal Year 2003* (Section 806, Pub. L. No. 107-314). Washington, DC: US Government Printing Office.

US Congress. (2004, October 28). *Ronald Reagan National Defense Authorization Act for Fiscal Year 2005* (Section 811, Pub. L. No. 108-375).Washington, DC: US Government Printing Office.

Walsh, D. (2008a, August 6). Executive Vice President, FPII. [Interview with researchers].

Walsh, D. (2008b, August 6). *Internal company status report, FPII.* Unpublished Powerpoint presentation. Ladson, SC: Force Protection Industries.

Ward, P. (2008, August 5). Industrial Engineer, SPAWAR. [Interview with researchers].

Young, J. J. (2007, September 19). *Prototyping and competition*. Internal DoD Memorandum.Washington, DC.

Young, J. J., Greenwalt, B., & Hoover, C. (2007, November 8). *Statement before the Subcommittees on Seapower and Expeditionary Forces and Air and Land*

Forces of the House Armed Services Committee. Washington, DC: US Government Printing Office.

110th Congress. (2007, November 13). *Department of Defense Appropriations Act, 2008* (Public Law 110-116). Washington, DC: US Government Printing Office.

110th Congress. (2008, June 30). *Supplemental Appropriations Act, 2008* (Public Law 110-252). Washington, DC: US Government Printing Office.

THIS PAGE INTENTIONALLY LEFT BLANK

2003 - 2008 Sponsored Research Topics

Acquisition Management

- Acquiring Combat Capability via Public-Private Partnerships (PPPs)
- BCA: Contractor vs. Organic Growth
- Defense Industry Consolidation
- EU-US Defense Industrial Relationships
- Knowledge Value Added (KVA) + Real Options (RO) Applied to Shipyard Planning Processes
- Managing Services Supply Chain
- MOSA Contracting Implications
- Portfolio Optimization via KVA + RO
- Private Military Sector
- Software Requirements for OA
- Spiral Development
- Strategy for Defense Acquisition Research
- The Software, Hardware Asset Reuse Enterprise (SHARE) repository

Contract Management

- Commodity Sourcing Strategies
- Contracting Government Procurement Functions
- Contractors in 21st Century Combat Zone
- Joint Contingency Contracting
- Model for Optimizing Contingency Contracting Planning and Execution
- Navy Contract Writing Guide
- Past Performance in Source Selection
- Strategic Contingency Contracting
- Transforming DoD Contract Closeout
- USAF Energy Savings Performance Contracts
- USAF IT Commodity Council
- USMC Contingency Contracting

Financial Management

- Acquisitions via leasing: MPS case
- Budget Scoring
- Budgeting for Capabilities Based Planning
- Capital Budgeting for DoD
- Energy Saving Contracts/DoD Mobile Assets
- Financing DoD Budget via PPPs
- Lessons from Private Sector Capital Budgeting for DoD Acquisition Budgeting Reform
- PPPs and Government Financing
- ROI of Information Warfare Systems
- Special Termination Liability in MDAPs
- Strategic Sourcing
- Transaction Cost Economics (TCE) to Improve Cost Estimates

Human Resources

- Indefinite Reenlistment
- Individual Augmentation
- Learning Management Systems
- Moral Conduct Waivers and First-tem Attrition
- Retention
- The Navy's Selective Reenlistment Bonus (SRB) Management System
- Tuition Assistance

Logistics Management

- Analysis of LAV Depot Maintenance
- Army LOG MOD
- ASDS Product Support Analysis
- Cold-chain Logistics
- Contractors Supporting Military Operations
- Diffusion/Variability on Vendor Performance Evaluation
- Evolutionary Acquisition
- Lean Six Sigma to Reduce Costs and Improve Readiness

- Naval Aviation Maintenance and Process Improvement (2)
- Optimizing CIWS Lifecycle Support (LCS)
- Outsourcing the Pearl Harbor MK-48 Intermediate Maintenance Activity
- Pallet Management System
- PBL (4)
- Privatization-NOSL/NAWCI
- RFID (6)
- Risk Analysis for Performance-based Logistics
- R-TOC Aegis Microwave Power Tubes
- Sense-and-Respond Logistics Network
- Strategic Sourcing

Program Management

- Building Collaborative Capacity
- Business Process Reengineering (BPR) for LCS Mission Module Acquisition
- Collaborative IT Tools Leveraging Competence
- Contractor vs. Organic Support
- Knowledge, Responsibilities and Decision Rights in MDAPs
- KVA Applied to Aegis and SSDS
- Managing the Service Supply Chain
- Measuring Uncertainty in Eared Value
- Organizational Modeling and Simulation
- Public-Private Partnership
- Terminating Your Own Program
- Utilizing Collaborative and Three-dimensional Imaging Technology

A complete listing and electronic copies of published research are available on our website: www.acquisitionresearch.org

THIS PAGE INTENTIONALLY LEFT BLANK

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL
555 DYER ROAD, INGERSOLL HALL
MONTEREY, CALIFORNIA 93943

www.acquisitionresearch.org