The MRAP: Not a Silver Bullet, but a Bullet Nonetheless

A Monograph

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Secretary of Defense Robert Gates credits the MRAP for saving numerous lives. However, critics of the MRAP argue that the vehicle did not significantly reduce casualties and that it was ultimately a waste of money. The MRAP was designed to defeat explosive devices and, thereby, mitigate the number of troop casualties, but how well did it actually perform? Utilizing historical reports and military journals to investigate the US military's countermine techniques from the Vietnam War through Operation Restore Hope, and the First Gulf War up to the current conflicts in Iraq and Afghanistan this study sought to determine whether Secretary Gates or his critics were correct. The Vietnam War provided extensive after action reports on how the military dealt with mines and booby-traps. The following conflicts demonstrated how lessons were learned, passed on and developed in relation to the ever changing threat. Foreign government's mitigation techniques were explored to add to the breadth to the discussion and to highlight other ways of mitigation that were not as readily known in the United States. These findings helped to clarify the debate surrounding the MRAP by establishing what level of protection had been possible prior to the introduction of the MRAP into the US military's arsenal. Several studies from think-tanks and the Congressional Research Service better informed the examination of the effectiveness of the MRAP. The comparison of the observable numbers from the past and those collected in multiple studies of Iraq and Afghanistan revealed that the MRAP was no better at mitigating mines than previously used techniques. In addition, the quality of the current data, especially data on casualties vice fatalities, was sufficiently untrustworthy that no definitive determination concerning the MRAPs effectiveness could be made. The data on fatalities attributed to IEDs did indicate that there were proportionately fewer deaths among soldiers in MRAPS. However, general casualty figures indicate that the proportion of casualties from IEDs differed little from the proportion of casualties from mines and booby-traps in previous wars. Therefore, the MRAP worked, but was no better than other, previously known, counter mine techniques. Hence it was a bullet, but it was not the "silver bullet" some portrayed it to be.

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Abstract

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Secretary of Defense Robert Gates credits the MRAP for saving numerous lives. However, critics of the MRAP argue that the vehicle did not significantly reduce casualties and that it was ultimately a waste of money. The MRAP was designed to defeat explosive devices and, thereby, mitigate the number of troop casualties, but how well did it actually perform? Utilizing historical reports and military journals to investigate the US military's countermine techniques from the Vietnam War through Operation Restore Hope, and the First Gulf War up to the current conflicts in Iraq and Afghanistan this study sought to determine whether Secretary Gates or his critics were correct. The Vietnam War provided extensive after action reports on how the military dealt with mines and booby-traps. The following conflicts demonstrated how lessons were learned, passed on and developed in relation to the ever changing threat. Foreign government's mitigation techniques were explored to add to the breadth to the discussion and to highlight other ways of mitigation that were not as readily known in the United States. These findings helped to clarify the debate surrounding the MRAP by establishing what level of protection had been possible prior to the introduction of the MRAP into the US military's arsenal. Several studies from think-tanks and the Congressional Research Service better informed the examination of the effectiveness of the MRAP. The comparison of the observable numbers from the past and those collected in multiple studies of Iraq and Afghanistan revealed that the MRAP was no better at mitigating mines than previously used techniques. In addition, the quality of the current data, especially data on casualties vice fatalities, was sufficiently untrustworthy that no definitive determination concerning the MRAPs effectiveness could be made. The data on fatalities attributed to IEDs did indicate that there were proportionately fewer deaths among soldiers in MRAPS. However, general casualty figures indicate that the proportion of casualties from IEDs differed little from the proportion of casualties from mines and booby-traps in previous wars. Therefore, the MRAP worked, but was no better than other, previously known, counter mine techniques. Hence it was a bullet, but it was not the "silver bullet" some portrayed it to be.

Contents

Acronyms

APC	Armored Personnel Carrier
ARVN	Army of the Republic of Vietnam
C-IED	Counter - Improvised Explosive Device
COIN	Counterinsurgency
EFP	Explosively Formed Penetrators
EOD	Explosive Ordinance Disposal
GVN	Government of Vietnam
HMMWV	High Mobility Multi-Wheeled Vehicle
IED	Improvised Explosive Device
ISR	Intelligence, Surveillance, and Reconnaissance
IVMMD	Interim Vehicle Mounted Mine Detector
JIEDDO	Joint IED Defeat Organization
JPO	Joint Program Office
KHA	Killed by Hostile Action
LOO	Lines of Operation
M/BT	Mine and Booby trap
MPCV	Mine Protected Clearance Vehicle
MRAP	Mine Resistant Ambush Protected
MSR	Main Supply Route
NVA	North Vietnamese Army
RVN	Republic of Vietnam
SVN	South Vietnam
TTPs	Tactics, Techniques, and Procedures
TWV	Tactical Wheeled Vehicles
USARV	United States Army Republic of Vietnam
UXO	Unexploded Ordinance
VC	Viet Cong
WHA	Wounded by Hostile Action

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Introduction

> To those who contend then and still do that MRAPs were unnecessary and a costly one-dimensional, one-time-use vehicle that detracted from more important long-term priorities, I offer only this response: talk to the countless troops who survived IED blasts because they were riding in an MRAP.
>
> —Robert Gates, US Secretary of Defense

In his memoir, Duty, Secretary of Defense Gates hoped to silence critics who claimed the Mine Resistant Ambush Protected (MRAP) vehicles were an expensive boondoggle. He felt the MRAP was an unparalleled success, to its detractors the MRAP was the costly one-dimensional, one-time-use vehicle that was all the things Secretary Gates claimed it not to be. According to Mr. Gates, the value of the MRAP can be determined simply by the number of soldiers who survived explosions while riding in that vehicle. The purpose of the MRAP was to defeat the IED threat to the US military in Iraq and Afghanistan. At the beginning of those conflicts, the IED threat was so great that the US Department of Defense established a new organization dedicated to defeating these types of devices. The Joint IED Defeat Organization (JIEDDO) was established to counter IEDs through a three-pronged approach: Attack the Network (the terrorists), Defeat the Device (the IED), and Train the Force (the US military personnel). Probably more important than the three-pronged approach was JIEDDO's determination that the "new" IED threat was not a new threat at all. Explosive devices, mines and booby traps, have been used for hundreds of years to gain outcomes greater than the damage inflicted by the bombs themselves. The United States had seen such devices over and over again. In 2012, Lieutenant General Michael Barbero of the Joint IED Defeat Organization stated, "In the 20th century, artillery was the greatest producer of troop casualties. The IED is the artillery of the 21st century."[1] Thus, the MRAP was designed to defeat explosive devices and, thereby, mitigate the number of troop casualties. Breaking Defense reporter David Axe, who himself had survived an IED explosion inside an MRAP, stated, "that

[1] Joint Improvised Explosive Device Defeat Organization, *Counter Improvised Explosive Device Strategic Plan 2012-2016* (Washington, DC: JIEDDO, 2012), 1.

truck (MRAP) saved our lives."[2] If anecdotal evidence like Mr. Axe's were all that was taken into account then the MRAP was a success, but was it? If IEDs were not new, then the US military must have encountered them before. If the military did encounter them before how did those experiences inform the current efforts to counter IEDs?

The importance of the MRAP can only be determined by comparing the countermine efforts in previous US military conflicts and the relative casualty rates in those conflicts with similar data from Iraq and Afghanistan. By comparing what had been done previously and the results obtained by those countermine efforts with military actions in Iraq and Afghanistan, it was possible to observe and explain the similarities and differences between those conflicts. The data collected was from declassified US Army Vietnam era reports. The Headquarters US Army Vietnam and the Fleet Marine Force in Vietnam prepared mine and countermine reports that were compiled during and after the Vietnam War that have been subsequently declassified. Also, the Human Resources Research Office at George Washington University conducted extensive after-action interviews with soldiers from different Army divisions throughout the entire Vietnam theater. These reports are important since they dealt with mines and booby-traps over an extended area and time period which allowed for robust lessons learned.

Professional military journals, for instance the *Engineer*, the Professional Bulletin of Army Engineers, were examined to see not only how previous lessons learned were implemented, but how they were applied in subsequent conflicts involving mines. Also, an examination of the Journal *Engineer* revealed what advances had been made in the field of demining and route clearance. A number of RAND studies also addressed innovations that had occurred in the field of mine countermeasures and IEDs internationally. Other military journals were consulted for their perspective on the MRAP. The Center for Strategic and International Studies examined the

[2] David Axe, "The Great MRAP Debate: Are Blast-Resistant Vehicles Worth It?", Breaking Defense, accessed October13, 2017, https://breakingdefense.com/2012/10/the-great-mrap-debate-are-blast-resistant-vehicles-worth-it/.

casualty issues in Iraq and Afghanistan and produced relative numbers used here. In addition, other relevant websites and news service articles were inspected because those sites reflect contemporary viewpoints and battlefield conditions. The research report was limited to unclassified, open source, and non-special handling category materials and, therefore, some relevant information might be missing. Additionally, it was necessary to explore the definition of mines and booby traps to define clearly what data was comparable to what is now called an improvised explosive device. Despite obvious differences in the number, type, construction, and employment of explosive devices it was determined that all mining operations were comparable. The comparison revealed that the MRAP was initially needed to provide troop protection as a substitute for route clearance and demining procedures used in previous conflicts. However, casualty reduction was not obtained purely by employing the MRAP. Tactical route clearance helped reduce explosive events. Finally, when overall casualty rates was examined the rate in Iraq and Afghanistan did not differ significantly from previous conflicts. The MRAP protected some lives but was no better than other, previously known, countermine techniques.

Vietnam IEDs

The US military was involved in the war in Vietnam until the fall of Saigon in 1975. The US's involvement went from an advisory role to active combat operations. It was during active operations that the military first encountered mines and booby traps in Vietnam. The Army found that the enemy benefited directly by causing combat casualties and vehicle losses, but his real benefit was psychological. Therefore, the goal of emplacing an IED was not only the physical effect, but the greater effect on the psyche of the soldier or Marine in Vietnam. [3] To better understand this threat, the US Army collected reports on the mines and booby traps that soldiers encountered. To improve the precision of the reports, Headquarters US Army Republic of

[3] US Department of the Army, Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, by Major Walter C. Bell, Major George R. Kleb, Major William J. Skinner, MSG Charles S. Coverdale, SSG Richard C. Green, Aug 1969, 1.

Vietnam attempted to define clearly the difference between a mine and a booby trap. Arriving at precise definitions proved problematic. “For example, a 174-mm shell rigged with a trip wire device can destroy an Armored Personnel Carrier (APC), so is it a booby trap? If a trip-wired M18A1 (Claymore) is an anti-personnel mine, isn’t also the trip wired grenade in a VC defensive position?”[4] Therefore, in its reports the Army did not always distinguish between an incident caused by a mine and one caused by a booby trap. The terms were interchangeable and could fit the current term Improvised Explosive Device (IED). The way the enemy used these explosive devices was also different. In Vietnam, the US Army found, “[t]he [Viet Cong] VC lack artillery and in essence use mines as a replacement for artillery. The enemy does not lay minefields per se and cover them by fire in the classical manner. Rather he interdicts the road net in all areas, and he replies to off-the-road operations by quick and indiscriminate mining.”[5] The enemy did not use mines in the classical way. The United States was not dealing with classical minefields. The military encountered mines as artillery. This distinction was important as previously cited Lieutenant General Michael Barbero of the JIEDDO stated how artillery was the greatest producer of troop casualties in the 20th century.[6] So, in Vietnam the opposition used mines and booby traps as a producer of troop casualties. The enemy in Vietnam accomplished this by utilizing mines and booby traps to interdict the movement of troops throughout the country. First, roads were mined, road mining. In road mining the mines were used to disrupt movement of men and materials along main routes. Second was off-road anti-vehicle mining. Off-road vehicle mining placed mines on little used trails and tracks, in open fields, in jungle terrain, or any terrain that could be used by vehicles.[7] Finally the enemy used anti-personnel mines. Anti-personnel

[4] Ibid., 7.

[5] Ibid., 2.

[6] JIEDDO, *Counter Improvised Explosive Device Strategic Plan 2012-2016*, 1.

[7] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 2.

mines were often called booby traps because the mines were placed where inattentive soldier might move without caution. The Army felt that that term is not strictly applicable since booby traps usually refer to devices intended to prevent tampering with or disarming active mines.[8]

The enemy mines used to interdict movement and attack personnel posed a serious threat to the US soldier or marine on the ground in Vietnam. Depending on the report consulted vehicle losses from mine incidents were as high as seventy percent and personnel lost from mines amounted to one third of all personnel losses in the theater.[9] This threat did not discriminate and regardless of the type of unit the mine threat produced one third of the casualties.

1. Engineers suffer about a third of their casualties from mines and booby traps, with most of these being from mines.
2. Armored cavalry units suffer about a third of their casualties from mines and booby traps, with almost all of these being from mines.
3. Mechanized infantry suffer about a third of their casualties from mines and booby traps, with most of these being from mines.
4. Infantry units suffer a variable proportion of their casualties from mines and booby traps, depending on the relative incidence of direct contact with enemy troops; this proportion was found to range from about one-sixth to nearly all. However, regardless of the relative proportion of overall casualties reported, there was substantial unanimity in reporting that almost all casualties from mines and booby traps are caused by booby traps.
5. Divisions as a whole suffer about a third of their casualties from mines and booby traps, with most of these being from mines.[10]

The report showed that no matter what ground branch of the Army a soldier belonged to on average the proportion of casualties caused by mines was around a third.

However, the US Army was not the only US force dealing with mines. The US Marine Corps also faced the threat posed by mines and booby traps. “Marines landed in force in South Vietnam (SVN) in March 1965 and during the first months of fighting approximately 65-75 percent of all Marine casualties were caused by mines and booby traps.” . . . During 1968, 37.7

[8] Ibid., 2.

[9] Ibid., 3.

[10] George J. Magner, *Detection and Avoidance of Mines and Booby-traps in South Vietnam* (Alexandria, VA: Human Resources Research Organization, Jun 1968), 22.

percent of all Marine casualties were caused by the accidental detonation of a mine or booby trap. At the beginning of their time in Vietnam the threat of mines and booby traps caused the Marines approximately two thirds of their casualties. After applying countermeasures, casualties from mines and booby traps was very close to the rate experienced by the Army, one third. This showed that no matter which service the military member belonged to the threat from mines and booby traps was with proper training mitigatable.

The mine and booby trap threat to the US military while mitigatable to a point was never eliminated. That was because the threat was not static. The enemy had access to mines from a variety of countries including the US, USSR and PRC. In Quang Tri province the soldiers on the ground found themselves facing mostly metal or plastic bodied mines of Soviet manufacture with triggering fuses made in East Germany.[11] However, the supply of fully manufactured foreign mines used by the VC (Viet Cong) and NVA (North Vietnamese Army) was limited. Thus, the enemy had to create mines of his own design, using whatever explosive materials were available.[12] For instance the 3rd Marine engineers reported confronting recast blocks of TNT held together with string or vines. They further found that until a metallic trigger was attached these improvised mines were undetectable by the current mine detectors.[13] The major impact of this scarcity driven innovation meant that the US military entered into the conflict facing a mine threat they had not expected and had not trained to defeat. Additionally, mines themselves were booby trapped to inflict maximum damage upon the teams attempting to clear them. Mines were placed upon mines to explode when the top mine was removed, or anti-personnel mines were daisy chained to emplaced anti-vehicle mines to rake the whole clearance team with shrapnel as

[11] US Department of the Army, Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 7.

[12] Ibid., 2.

[13] Ibid., 8.

they destroyed an emplaced mine.[14] Therefore, these self-manufactured mines contributed directly to the higher casualties among soldiers in in country and the beginning of their tour Vietnam. By changing their mining approach to take maximum advantage of local conditions, the enemy actively countered the newly learned US military's TTPs. Therefore, even though the US military was working to eliminate the threat posed to personnel by mines, all that US forces were able to achieve was a sustainable level of threat mitigation.

Counter Actions in Vietnam

All US forces encountered high rates of casualties from mines and booby traps when they first entered the Vietnam War, and yet these same forces also experienced what were arguably dramatic reductions in the number of casualties in relatively short periods of time. All US forces in Vietnam reduced casualties from mines by applying mine/IED countermeasures and mitigation techniques. There were two categories of countermeasures, improved personal tactics and physical or equipment based measures. In Vietnam, the military found the eyes of the soldier or Marine on the ground were the most effective anti-mine/booby trap asset. Visual detection was the most important detection method. The US Army found that the best indication of a mine was a clearly defined trace.[15] A defined trace was the recognizable indication in the environment (disturbed dirt, wires, etc.…) that signaled that a mine or booby trap was present. The Marines also found visual detection to be the primary detection means. Throughout the Republic of Vietnam (RVN) even though the 3rd Marines were equipped with the P/1 5J electronic mine detector, the 3rd Marines engineers reported 90 percent of mines were located by visual means. The Marines adeptness at visual detection also allowed them to detect PY 60 type mines

[14] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 8.

[15] Ibid., 1.

(undetectable to the P/1 5J detectors).[16] This illustrated the important role in mine detection played by the man on the ground who was familiar with his surroundings.

However, visual detection was not restricted to just finding emplaced mines. "To further protect transportation routes, "[t]he [1st Infantry] division …constructed observation towers along routes Ql-13 and LTL-24 and these towers were manned around the clock."[17] The towers were built in known mining hotspots and the visual observations from these towers were important because they allowed the US military to recognize and interdict mining operations as they took place. In addition, with the increased risk of discovery, the observers in the towers discouraged sapper operations. However, visual detection was not possible without the physical occupation of the ground.

Vietnam showed that proper mine/IED clearance operations were manpower intensive. The Marine Corps dedicated two whole engineer battalions to clearing just two roads. The 11th Marine Battalion had responsibility for the route QL-9 from Dong Ha to Cam Lo and from Dong Ha to Go Linh on the route QL-1. The 3d Marine Battalion was responsible for the remaining 49,200 meters of these two roads. To accomplish this task the 3d Marine engineer battalion organized special elements along the route. Each element was tasked with clearing a specific portion of the route. In addition to these engineer elements, mechanized and infantry units provided security for the mine sweeping teams as they conducted their operations.[18] Thus, mine clearance was not solely an engineer task, in many ways it was a combined arms maneuver. Similarly, the Army used armored cavalry units to conduct a reconnaissance in force ten to fifteen minutes behind minesweep teams to deter VC from laying mines after the sweep team has gone

[16] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 7-8.

[17] Ibid., 30

[18] Ibid., 7-8.

through.[19] Hence, the US military found that not only was mine clearance team needed but also a security element personnel poised to engage the enemy elements that attempted to re-mine an area after it had been cleared.

Although trained personnel were important to mine detection in Vietnam, their important work was enabled by physical and equipment-based countermeasure. The Army found road paving to be the most effective means to counter enemy mines.[20] Another technique used to facilitate mine detection on unpaved roads was to apply oil daily over an area previously cleared of mines.[21] These counter measures changed the environment, road paving and oiling. Additionally, defoliating the areas around roads made mine identification easier. However, physical counter measures also included equipment. In Vietnam, there was a recognized need to conduct proofing operations to ensure that clearance operations had worked, and roads were passable for movement. The Army used a variety of equipment but found that backing a sand filled five-ton dump trucks backwards down a road was an extremely effective proofing device. Truck losses to undiscovered mines was inevitable and when dump trucks losses became too great, soldiers improvised a roller from scrapped dump truck axles with added weights for use in proofing operations.[22] This soldier innovation led directly to the military creating the ENSURE 202 Tank Mounted Expendable Mine Roller, which like the modified truck axle exerted high ground pressure without crushing roads and bridges. Like the many rollers used in Vietnam and earlier, the problem was to survive the mine detonation. "[23]

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[19] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 30.

[20] Department of the Army, *Vietnam Studies: Tactical and Material Innovation*, John H. Hays Jr., CMH Pub 90-21-1, 1974, 132.

[21] Ibid.

[22] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 2.

[23] Department of the Army, *Vietnam Studies: Tactical and Material Innovation*, John H. Hays Jr., CMH Pub 90-21-1 (1974), 134.

Equipment innovation was not limited to ways to explode mines, progress was made in Vietnam on protecting the troop from the mine as well. Kits were developed for armored personnel carriers to provide supplemental armor for the hull bottom and to relocate and strengthen the fuel line. [24] Therefore, upgrades to standard Army equipment were made to limit the threat posed by mines. "One armored personnel carrier (APC) on which the new armor kit was installed hit a twenty-pound mine with no casualties among the men on board."[25] So, again the US military had derived another countermeasure to mitigate the threat posed by mines and booby traps. The military collected these countermeasures in reports and published their lessons learned.

IED Lessons Learned in Vietnam

The reports from Vietnam drew many conclusions from the experiences of the soldiers, sailors, and marines who dealt with mines/IEDs. The most important lesson learned from the US military's experience with mines and booby traps was the importance of visual detection. The reports highlight again and again how mines were found visually. In one case up to 90 percent of all mines found were found visually.[26] Visual detection was even more important than using mine detection or defeating equipment.[27] The problem with detection equipment was three-fold: the need for better training on the equipment, more robust equipment better suited to real world conditions and the ability to detect mines that were undetectable to the available detectors. Personnel who arrived in Vietnam with basic anti-mine training were judged as ineffective by soldiers already in country.

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[24] Ibid., 133.

[25] Ibid.

[26] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 7-8.

[27] George J. Magner, *Detection and Avoidance of Mines and Booby-traps in South Vietnam* (Alexandria, VA: Human Resources Research Organization, June 1968), 74.

The presence of the VC improvised locally manufactured mines invalidated some of the training the troops received prior to arriving in theater. Therefore, the US Army in Vietnam found that local training in the most locally effective practices prepared new personnel better than relying on new personnel showing up with relevant Stateside training.[28] The mine detection equipment (P-153) worked well but was considered too delicate.[29]Plastic mines posed a problem because detectors capable of locating them were scarce (one battalion had only one detector) and troops were unfamiliar with it.[30] One shortfall of mine defeating equipment; e.g., rollers, was its failure rate if it encountered a mine. For example, the improvised roller rarely survived an encounter with a mine.[31] US units newly arrived in Vietnam suffered up to approximately 80 percent casualties from mines and booby traps. However by applying locally learned lessons to counter mine training one soldier reported, "I learned more over here in one day than all the way through training."[32] This training tailored specifically to the threat in Vietnam allowed US forces to reduce mine induced casualties from 80 percent at the beginning of the war to the 30 percent seen throughout the military in the later years.

Another lesson learned was the importance of the aggregating data. This allowed the forces to discern trends in the enemy's mining behavior and to tailor better their counter mine responses to areas where the threat was most likely to be found. For instance, the 25th Infantry division utilized their adjutant general's computer to compile their mine incident reports and by doing so they found that, "over 50 percent of road mining activity . . . was concentrated in four

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[28] George J. Magner, *Detection and Avoidance of Mines and Booby-traps in South Vietnam: Training and Tactical Procedures of the 4th Infantry Division* (Alexandria, VA: Human Resources Research Organization, March 1968), 26.

[29] George J. Magner, *Training and Tactical Procedures of the 9th Infantry Division* (Alexandria, VA: Human Resources Research Organization, June 1968), 44.

[30] Ibid.

[31] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 31.

[32] George J. Magner, *Detection and Avoidance of Mines and Booby-traps in South Vietnam: Training and Tactical Procedures of the 4th Infantry Division*, 26.

sectors of road having a length of about four and a half kilometers."[33] One in three casualties caused by mines seems excessive until casualty numbers are examined. Table one represents three months of mine casualties experienced by the 9th Infantry Division in Vietnam from October 1968 to January 1969.

Table 1. 9th Division Casualty Data

9th Division	KHA	WHA	Approximate size of Unit	Percent of Unit Casualties Caused by Mines vs Total Unit Strength	Monthly Mine KHA as a Percentage of the Total KHA per Year
Oct-68	7	79	15000	0.57	0.04
Nov-68	10	139	15000	0.99	0.06
Dec-68	17	210	15000	1.51	0.1
Jan-69	26	344	15000	2.47	0.22

*Source***:** Table compiled from information found in multiple sources. https://www.archives.gov/research/military/vietnam-war/casualty-statistics accessed October 18, 2017, Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam,* 36**.**

The percentage of Killed by Hostile Action (KHA) and Wounded by Hostile Action (WHA) never exceeds two and a half percent of the total available troop strength. If attention is shifted to just deaths as a percentage of troop strength, the actual number of soldiers killed never reaches more than a quarter of a percent of the troop strength. A casual observer would be alarmed at the 30 percent casualty figure vice the actual 2.5 percent figure. Moreover, when all of the USARV casualties (see Table 2) were looked at the number of mine and booby trap (M/BT) induced casualties never exceeded 20 percent of total KHA per month and 25 percent of WHA per month. The yearly percentage drops below 10 percent for KHA for 1968 and 1969 and WHA never exceeds 12 percent for the year. So, even though unit casualties due to mines and booby traps constituted 30 percent of casualties, the actual percentage of M/BT caused casualties never

[33] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 31.

reached this percentage of total casualties. In addition, the report said the lessons of Vietnam would be applicable to future US conflicts. The report noted the mine threat would be enduring as the enemy changed its mines and mining techniques. Therefore, the military would need to keep up with new detection and destruction methods.[34]

[34] Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, 4.

Table 2. USARV Casualties

USARV CASUALTY DATA
January 1967 To March 1969

Month	TOTAL KHA	M/BT KHA	% M/BT to TOTAL	TOTAL WHA	M/BT WHA	% M/BT to TOTAL
JANUARY 1967	331	36	10.9	2044	418	20.5
FEBRUARY 1967	411	34	8.3	2568	379	14.8
MARCH 1967	563	28	5.0	3682	370	10.1
APRIL 1967	369	58	15.7	2935	317	10.8
MAY 1967	528	46	8.7	3706	395	10.6
JUNE 1967	485	30	6.2	2901	409	15.1
JULY 1967	355	18	5.1	2627	493	18.1
AUGUST 1967	266	15	5.6	2173	215	9.9
SEPTEMBER 1967	270	20	7.4	2293	235	10.3
OCTOBER 1967	476	19	4.0	2647	220	8.3
NOVEMBER 1967	669	19	2.8	3644	130	3.6
DECEMBER 1967	509	52	10.0	3505	297	8.5
JANUARY 1968	668	48	7.2	4339	377	8.7
FEBRUARY 1968	1295	45	3.5	7363	383	5.2
MARCH 1968	1155	42	3.6	7155	343	4.8
APRIL 1968	866	65	7.5	6467	470	7.3
MAY 1968	1336	65	4.9	8496	401	4.7
JUNE 1968	698	64	9.2	4431	387	8.7
JULY 1968	437	61	14.0	3264	307	9.4
AUGUST 1968	710	70	9.9	4366	331	7.6
SEPTEMBER 1968	641	64	10.0	4301	357	8.3
OCTOBER 1968	414	72	17.4	2972	413	13.9
NOVEMBER 1968	468	69	14.7	3268	585	17.9
DECEMBER 1968	473	93	19.6	3436	741	21.6
JANUARY 1969	538	98	18.2	3867	914	23.6
FEBRUARY 1969	580	75	12.9	3915	585	14.9
MARCH 1969	891	74	8.3	7232	342	4.7
TOTALS 1967	5232	375	7.2	34,625	3878	11.2
TOTALS 1968	9161	758	8.3	69,858	5095	8.1
TOTALS - 3 MOS 1969	2009	247	12.3	15,014	1841	12.3
GRAND TOTALS	16,402	1380	8.4	109,497	10,814	9.9

Source: Headquarters United States Army Vietnam, The Mine Warfare Center, Engineer Section, *Mine Warfare in Vietnam*, incl. 20.

IED Threat in the Intervening Year

Mines were encountered and countered in Vietnam, and lessons were learned. The threat from mine and IEDs did not stop with the end of the Vietnam War. The United States and other countries found themselves facing the threat from IED's during the intervening years (the timeframe between the Vietnam War and the Wars in Iraq and Afghanistan). Table three shows the mine /IED threat experienced by the United States and foreign countries, not reflected in the table is the US's experience with mines during the Operation Desert Storm, Operation Restore Hope and Operation Joint Endeavor. During the Operation Desert Storm, the US experienced 20 percent of the causalities were due to mines.[35] It was during Operation Restore Hope, "[i]n Somalia . . . within the confined streets of Mogadishu, US light infantry, Marine and Ranger units were mauled because of their lack of protection, and. . . . The result was that one quarter of the US casualties taken in Somalia were to mines."[36] Somalia again showed how mines were a threat to the troop on the ground because 26 percent of all casualties were from mines.[37] Land mines were also seen as a major threat during Operation Joint Endeavor in Croatia and Bosnia?[38] The main threat during Joint Endeavor was from anti-tank mines and anti-personnel mines as well as from unexploded ordinance. Even though time had passed since Vietnam, the US still suffered losses from mines.

Table 3. Mine Casualties per Conflict

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[35] John K. Leighow, "Route-Clearance Operations," *Engineer* 25, no. 3 (August 1995): 54-61.

[36] Nigel Vinson, "The demise of the anti-personnel mine: A military perspective," *RUSI Journal* 143, no.1 (Feb 1998): 18-23.

[37] John K. Leighow, "Route-Clearance Operations," *Engineer* 25, no. 3 (August 1995): 54-61.

[38] William C. Schneck Jr. and Brian M. Green, "Techniques and procedures for route clearance." *Engineer* 26, no. 1 (Mar 1996): 3.

		Casualties (Percent)	
Conflict	Combatant	Personnel	Vehicles
World War II (Italian Campaign)	United States	4.4	33
Korea	United States	10	56
Vietnam	United States	33	70
Thailand	Thai Government Forces	30	N/A
El Salvador	Salvadoran Government Forces	90	N/A

Source: Compiled from information in William C., Schneck and Malcolm H. Visser, "Advances in mine warfare: An overview." *Engineer* 23, no. 2 (April 1993): 5.

During the conflicts covered by table 3, there is an upward trend in casualties caused by mines. The reason for these numbers according to the journal *Engineer* was that over this time period, "mine technology had surged, [whereas] countermine capability remained 30 to 50 years old."[39] For example mines costs were as little as three dollars a mine. The number of types of mines increased to over 350 different kinds of mine. Types such as a mine that was designed to eject from its emplacement and explode in the air ensuring the largest possible scatter pattern and subsequently greatest number of casualties. In addition, more and more mines were designed with anti-defeat devices complicating the job of the demining team while increasing the risk.[40] Mine were made with low content of metal to evade detectors and some mines had seismic-magnetic type fuses which also acted as anti-handling measures.[41] However, it was not just the advance of technology that intensified the threat posed by mines and IEDs. The collective forgetting of the lessons learned in Vietnam also contributed to the number of causalities. According to another

[39] John K. Leighow, "Route-Clearance Operations," *Engineer* 25, no. 3 (August 1995): 54-61.

[40] "Landmines: A Global Scourge," Federation of American Scientists, accessed April 11, 2018, https://fas.org/asmp/campaigns/landmines/lmhistory.htm.

[41] William Schneck, "Desert Storm," *Engineer* 22, no. 3 (July 1992): 2.

Engineer article, in 1995, most units failed to recognize that route clearance was a combined arms operation; believing it to be the exclusive domain of engineering units. Also, forgotten was the need to collect data on mine incidents to allow for better planning of demining operations. Instead, units were dispatched to wherever the most current attack had taken place. [42] *Engineer* highlighted the lack of learning from the past when it reported that units conducted demining operations by roaming the roads at speeds in excess of 15 miles an hour and only discovered mines when they ran over them and they exploded. [43] In the military there is the saying you are always fighting your last war, but with mine clearance this does not seem to be the case. According to William Schneck and Brian Green, "the United States learned many lessons about route clearance in the Vietnam War and in Mogadishu, Somalia but had to relearn them a few years ago."[44] Thus, even though the Army recognized that it had learned many lessons in Vietnam those lessons were not systematically passed on. It was that failure that caused the threat of mines to remain so great.

Post Vietnam Mine Counter Measures

Mines remained a threat in the years following Vietnam. Globally, military forces used counter actions to mitigate the level of threat posed by mines and IEDs. Before examining US mine counter actions after 1975, the counter mine actions of South Africa and Rhodesia during their respective conflicts need to be investigated. The reasons for these African conflicts while vastly important are not relevant to this discussion of South African and Rhodesian military operations. What is relevant is that the South African and Rhodesian governments produced a category of equipment to combat the threat of anti-vehicle mines experienced by both countries. Out of these conflicts came, what could be argued the most significant innovation in the effort to

[42] John K. Leighow, "Route-Clearance Operations," *Engineer* 25, no. 3 (August 1995): 54-61.

[43] Ibid.

[44] William C. Schneck and Brian M. Green, "Techniques and procedures for route clearance." *Engineer* 26, no. 1 (Mar 1996): 3.

neutralize the effects of mines and IEDs. In the early 1970's, the South Africans used the Swedish Terrängbil m/42D as the basis for the design of what would be the world's first MRAP.[45] Concurrently during the conflict in Rhodesia, modern day Zimbabwe, unable to procure large numbers of South African MRAPs, the Zimbabweans produced MRAP variants from locally available materials. The application of lessons learned from these local conflicts, led to indigenous MRAP production.

The Rhodesia's first MRAP variant triggered 502 anti-vehicle mines while carrying 4,389passengers, but MRAP passengers were only 1 percent fatalities and 24 percent injuries. (see the Bedford table 4)[46] Like other countries before them, prior to the development of these new types of vehicles, the Rhodesian mine proofing efforts had been attempts to armor plate existing vehicles as was done to US APCs in Vietnam.[47] The casualties and fatality numbers were reduced with subsequent variants of MRAPs as the developers and users innovated to counter the developing threat, see table 4. According to the RAND report on the Rhodesian conflict, at the beginning of the conflict most injuries in MRAPs were attributed to improper employment of the vehicles, speeding and not wearing safety harnesses.[48] However, as the numbers show, these MRAPs worked well to reduce, but not eliminate fatalities (except for the Cougar, see table 4 below). The proportion of injuries averaged 29.7 percent and fatalities averaged 2.57 percent. Therefore, the MRAP showed the same efficiency at reducing causalities as US road clearance

[45] This refers to a 1943 design for an armored personnel carrier with mine resistant characteristics. Bruce Hoffman, Jennifer M. Taw, and David Arnold, *Lessons from Contemporary Counterinsurgencies* (Santa Monica: RAND, 1991), 65.

[46] Bruce Hoffman, Jennifer M. Taw, and David Arnold, *Lessons from Contemporary Counterinsurgencies*, (Santa Monica: RAND, 1991), 65.

[47] "Leopard-Land Mine Resisting Vehicle," accessed January 10, 2018, http://www.baragwanath.co.za/leopard/.

[48] Bruce Hoffman, Jennifer M. Taw, and David Arnold, *Lessons from Contemporary Counterinsurgencies*, 65.

procedures during the Vietnam War. Also, no variant eliminated all injuries suffered by passengers when a mine was encountered.[49]

Table 4. Rhodesian MRAP Numbers

Rhodesia Mine Resistant Ambush Protected Vehicle				
Vehicle Type	Number of mines hit	Total number of passengers carried	Percentage of Fatalities	Percentage of Injuries
Rhino	162	573	8	47
Bedford	502	4389	1	24
Leopard	67	264	2	15
Cougar	8	33	0	42
Puma / Crocodie	327	3230	<0.5	17
Kudus	59	267	6	43
SA Hyena	140	578	<0.5	20

Source: Table compiled from data in Bruce Hoffman, Jennifer M. Taw, and David Arnold, *Lessons from Contemporary Counterinsurgencies* (Santa Monica: RAND, 1991), 62-71.

Unlike the African forces, who pursued equipment innovation to combat the threat posed by mines and IEDs, US forces responded to the IED threat by relearning route clearance procedures. In Bosnia, the US used route clearance procedures to counter the IED threat. Engineers were implored to maintain situational awareness and flexibility to recognize and adapt to the nature of the mine threat to which they were exposed.[50] Therefore, route clearance was seen as a set of procedures: detection, reporting, neutralization, proofing, and protection. However, these procedures were descriptive not prescriptive and must be tailored to threat faced.[51]

[49] Bruce Hoffman, Jennifer M. Taw, and David Arnold, *Lessons from Contemporary Counterinsurgencies* (Santa Monica: RAND, 1991), 62-71

[50] William C. Schneck and Brian M. Green, "Techniques and procedures for route clearance," *Engineer* 26, no. 1 (Mar 1996):4.

[51] William C. Schneck and Brian M. Green, "Techniques and procedures for route clearance," 4.

- Detection was seen as an important but time intensive process. Engineers were admonished to emphasize to those outside the branch of this requirement, effective did not mean fast. The process outlined included many visual detection techniques and ways to enhance the possibility of visual detection. The techniques for the use of detection equipment followed a similar tact.
- Reporting was stressed as important to allow for the proper response to the threat encountered.
- Neutralization of emplaced mines allowed for, "rapid reopening of the lines of communications."
- Proofing of countermine operations was necessary because operations were rarely 100 percent effective.
- Protection while necessary for the sweep teams emphasized how counter mines operations were a combined arms maneuver.[52]

The procedures being taught drew heavily from the lessons learned in Vietnam and relearned in Somalia. This showed that the US military had learned from its previous experiences.

The *Engineer* stated that even though procedures were relearned, countermine related equipment solutions did not respond to the lessons learned in Vietnam and Somalia. For example, the improvised rollers mentioned in the proofing step of route clearance procedures had not been improved. First seen as an improvisation by military personnel in Vietnam, the roller reappeared as an improvisation by Army soldiers in Operation Desert Storm.[53] So even though rollers had been shown to work there had been no official procurement program for countermine vehicles. Therefore, US equipment solutions to the mine IED problem did not substantially change with subsequent conflicts. However, even without new equipment the US mine-sweeper could succeed through proper application of the lessons outlined in the route clearance procedures and through the awareness of and the flexibility to adapt to the actual conditions on the ground.

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[52] William C. Schneck and Brian M. Green. "Techniques and procedures for route clearance," 3–10.

[53] William C. Schneck, "Desert Storm," *Engineer* 22, no. 3 (Jul 1992): 2 – 8.

Lessons Learned in the Intervening Years

The US military also found that mines were still a threat to men and material. In Bosnia, the US military found that mine detection and route clearance were lessons that it had learned in Vietnam and had then subsequently forgotten. South Africa and Zimbabwe in response to the mine and IED threat had developed a new category of anti-mine equipment, the MRAP. The MRAP had the ability to minimize the threat posed by mines and IEDs to the vehicle's occupants. In 1993, the *Engineer* stated the following,

> the last 20 years have witnessed significant advances in technology associated with mine warfare. This technology is advancing at an almost geometric rate. Advanced electronic sensors and processors have been coupled with shaped charges and explosively formed penetrators. The resultant devices can defeat all known hard targets, such as tanks and armored personnel carriers—even those equipped with countermeasures.[54]

Yet people like Capt. Sinclair in his 1996 article wrote:

> The landmine problem will continue to haunt us . . . Mines are a cost-effective way for an unsophisticated enemy to produce casualties without becoming decisively engaged with superior forces . . . In stark contrast to the South Africans and a growing number of other armed forces, the United states has no standardized mine-resistant vehicles . . . An affordable answer to the landmine was developed over 20 years ago. It is time Marines at the sharp end shared in the wealth of discovery.[55]

So here are two opposing opinions, both recognized that the United States would face IEDs and their derivatives in the future and that something needed to be done about the threat.

Between the end of the Vietnam War and prior to the Wars in Iraq and Afghanistan, old lessons were rediscovered, and new ideas on both sides of the IED threat were identified. The rediscovered lessons were manifest in the similarities between equipment and tactics. These new ideas produced advocates for the MRAP and for better ways to countering the ever modernizing

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[54] William C. Schneck, and Malcolm H. Visser, "Advances in mine warfare: An overview." *Engineer* 23, no.2 (April 1993): 3.

[55] Franz J. Gayl, *Mine Resistant Ambush Protected* (Washington, DC: Headquarters US Marine Corps, 2008): 5.

IED threat. The dissemination of these ideas was done in the professional literature and not in classified reports. Somalia and Operation Desert Storm had been studied. Those studies informed the continuity of ideas about the task, techniques and procedures developed that were used in Bosnia. Like the Vietnam War previously, those experiences and discoveries seemed to have been subsequently forgotten.

IED Threat in Iraq and Afghanistan

"May 26, 2003 Pfc. Jeremiah Smith was killed after there was an explosion under his vehicle and the military was at a loss at what to call what had killed him."[56] Pfc. Jeremiah Smith was the first soldier killed by what would come to be known as an Improvised Explosive Device. The United States was involved in a war in Iraq, and the US was combating an insurgency that followed in the wake of the fall of Saddam Hussein. The insurgents were using weapon material found throughout Iraq and combining this material with other parts like pressure plates, radio control, or cell phones to create IEDs. [57] No matter how complex the improvisation, these devices were basically mines with either an offset trigger or command detonated device. Even though these types of threats had been seen before what was new was the speed of innovation. This innovation came be represented by the appearance of the Explosively Formed Penetrators (EFP) type of IED. The EFP was basically a metal tube packed with explosives and a piece of copper that gets formed by the explosion into a molten slug that penetrates the target. JIEDDO as part of their "defeat the device" branch of operations had developed electronic jammers capable of blocking the insurgent's use of the radio frequency spectrum as a trigger for their devices. Upon discovering this the insurgents recognized that they needed a new way of detonating their devices. The new way was a heat detector that would detect the heat of the vehicle passing overhead and trigger the explosion. Members of the US military quickly identified this new type

[56] Gregg Zorova, "How the IED changed the US military," *USA Today*, 19 Dec 2013.

[57] Joint Improvised Explosive Device Defeat Organization, *Counter Improvised Explosive Device Strategic Plan 2012-2016*, 3.

of trigger. Military members utilized a bit of ingenuity and procured a toaster which they subsequently wired and placed on pole extended in front of their vehicles. This innovation had the desired effect of activating the EFP while the vehicle was still a safe distance away from the explosion. The military recognized this innovation had value and replaced the toaster with a diesel engine glow plug. Subsequently the military had these new devices mounted on the vehicles in theater. The enemy countered this American innovation by changing the angle of the explosion to negate the heat source on a ten-foot pole. The US countered that change by making the pole length adjustable. The enemy then countered by dropping heat activation altogether and instead utilizing the frequencies that JIEDDO's electronic detonator jammer emitted as the triggering element.[58]

The world wide web facilitated rapid changes in IED concept and designs, and the dissemination of lessons learned. Insurgents exploited the web to share information and intelligence. [59] By June 2003, General John Abizaid, Commander US Central Command, declared IEDs his number one threat.[60] These concepts converged in Iraq's Anbar province where Al Qaeda (originally a foreign based terrorist organization) chose to use the IED as its weapon of choice. [61] The IED was used throughout Iraq. The US military undertook the Surge and with the subsequent decrease in unrest US forces returned in greater numbers to Afghanistan. US forces returning to Afghanistan brought IEDs with them. Future defense Secretary Ash Carter stated the threat in Afghanistan the best, "[w]hen we went to Afghanistan, we realized that the insurgents there were going to use IEDs just like the Iraqi insurgency had done, but in an even more

[58] Adam Higginbotham, "U.S. Military Learns to Fight Deadliest Weapons," *Wired*, July 28, 2010, accessed April 10, 2018, https://www.wired.com/2010/07/ff_roadside_bombs/all/1/.

[59] Amin Tarzi, "Analysis: Could Afghan and Iraqi Insurgencies Muster Operational Ties?" *Global Security*, May 2006, accessed March 23, 2018, https://www.globalsecurity.org/military/library/news/2006/05/mil-060512-rferl02.htm.

[60] Christopher J. Lam, Matthew J. Schmidt, and Berit G. Fitzsimmons, "*MRAPs, Irregular Warfare and Pentagon* Reform," *Joint Force Quarterly* 55 (Fourth Quarter 2009): 77.

[61]Todd M. Jacobus, 2010 "Strategizing the Counter-IED Fight in Anbar Province," *Engineer* 40, no. 3, (September - December 2010):13.

insidious way, because terrain is much more rugged, there are fewer roads- and so fewer alternatives to driving on roads, where they know you're going to come." [62] This statement acknowledged that the insurgents operating against the US had through the internet or through contact with Iraqi insurgents obtained IED information. US military forces found themselves fighting an enemy that, ". . . avoided force on force combat by employing improvised explosives devices (IEDs) plus hit and run tactics against convoys and units to inflict casualties."[63] The use of hit and run tactics minimized force on force engagements which in turn shifted the source of casualties away from direct enemy action to IEDs.

The shift to IEDs was evident in the US reported fatalities during summer 2005 and spring 2008. IEDs constituted 50 to 80 percent of the casualties (See tables 7 and 8). As previously shown with the EFP example, as US forces started to counter the IED threat; the insurgents responded. Therefore, the IED threat evolved from primitive charges at the beginning of the conflict in Iraq to larger and more sophisticated charges in both theaters as the fighting went on. The US countered by up armoring tactical vehicles and the enemy responded by making the IEDs even larger. Eventually as shown, the IED threat utilized explosively formed penetrators (EFP) to defeat US counter measures. [64] These "new" IEDs were proof that "[t]he users of IEDs will adapt the most recent and successful TTP [Tactics, Techniques, and Procedures] gained from experience in Iraq, Afghanistan and elsewhere, and use them for political, ideological, or criminal purposes worldwide." [65] Thus, the insurgents, like those in conflict past, used the latest TTPs to emplace and employ IEDs against their foes.

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[62] Thomas Shanker, "The Man behind the MRAP moves on" *At War*, *New York Times*, November 26, 2013, accessed January 10, 2018, https://atwar.blogs.nytimes.com/2013/11/26/the-man-behind-the-mrap-moves-on/.

[63] Mr. Dorian D'Aria and Mrs. Tahnee L. Moore, "Adapting the Army: Institutionalizing Counter-IED Training Efforts," *Engineer* 40, no. 1 (January - April 2010): 10.

[64] Christopher J. Lam, Matthew J. Schmidt, and Berit G. Fitzsimmons, "*MRAPs, Irregular Warfare and Pentagon Reform*," 77.

[65] Joint Improvised Explosive Device Defeat Organization, *Counter Improvised Explosive Device Strategic Plan 2012-2016*, 2.

Counter Actions in Iraq and Afghanistan

Counter IED actions in Iraq and Afghanistan are complicated. What made countering IEDs so difficult was the issue of the nature of threat. The nature of the threat was seen by those concerned with IEDs in one of two ways. The first way to view IEDs was that IEDs are nothing more than a modern-day form of the mines and booby trap. The second way to view the IED threat was that they were a new unique threat and the response to them would have to be the same. GEN John Abizaid, Commander of US Central Command at the time, asked the Department of Defense (DOD) to initiate a "Manhattan like-Project" to glean the expertise of all Services involved directly with countering IEDs.[66] The Army responded and "[a]fter a holistic analysis of the Counter -IED (C-IED) threat, the Army . . . identified three primary lines of operations (LOOs)-Defeat the Device, Attack the IED Network, and Adapt the Force-that are pivotal to defeating the enemy IEDs."[67] The Department of Defense responded to the threat by establishing the Joint IED Defeat Organization in 2006 to coordinate efforts to accomplish the previous mentioned three main lines of operations.[68] These efforts included bringing in Air Force and Navy electronic warfare officers to work on counter IED measures.[69] The Defeat the Device efforts broke down into two main lines of effort, technological efforts to prevent the IED from exploding and physical measures, to include traditional route clearance, to protect the soldiers on the ground from the explosion. During the period of 2004-2007 these lines of effort received 11 billion dollars of funding. The significant portion of the funding went towards the technology line

[66] Brad Martin, Thomas Manacapilli, James C. Crowley, Joseph Adams, Michael G. Shanley, Paul Steinberg, Dave Stebbins, *Assessment of Joint Improvised Explosive Device Defeat Organization (JIEDDO) Training Activity*, (Santa Monica: RAND, 2013).

[67] Mr. Dorian D'Aria and Mrs. Tahnee L. Moore, "Adapting the Army: Institutionalizing Counter-IED Training Efforts," 12.

[68] Clay Wilson, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*, CRS Report No. RS22330 (Washington, DC: Congressional Research Service, 2007), 1, accessed April 10, 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/a475029.pdf.

[69] Clay Wilson, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*, 4.

of Defeat the Device operations, especially jamming technology and devices. [70] In 2006 alone, JIEDDO funded over 14,000 jammers for the soldiers and marines in theater. However, vehicle based and man portable jamming technologies were found to be problematic in that jamming, jammed not only the IED frequencies but also the frequencies used by friendly forces for warfighting. Another technology procured by JIEDDO to assist in the IED fight were robots for use by Explosive Ordinance Disposal teams. Also, JIEDDO procured Cougar (a type of MRAP) vehicles for the Route Clearance Platoon[s] . . .[71] The Route Clearance Platoon was part of the physical line of Defeat the Device operations.

According to FMI 3-34.119/MCIP 3-17.01, "The mission of a route clearance platoon is to conduct route reconnaissance, minesweeping to include identifying and neutralizing mines, IEDs …and [Unexploded Ordinance] UXO on routes, enemy or unobserved minefield clearance operations, and deliberate route clearance. [72] However, like Vietnam route clearance, route clearing was manpower intensive because platoons were only able to clear and mark 85 kilometers of road per day in an uncontested environment. [73] In 1990, Iraq had over 22, 397 kilometers of road which would have required 264 road clearance platoons or 6600 to 7920 engineers (based on average platoon size).[74] Clearing all roads would have required 29 to 35 percent of all the boots on the ground in Iraq at the time. The number of personnel dedicated to mine clearing does not include the required security personnel to support the demining

[70] Sharon K. Weiner, "Organizational interests versus Battlefield Needs: The US Military and Mine-Resistant Ambush Protected Vehicles in Iraq," *Polity* 42, no. 4 (October 2010): 462.

[71] Clay Wilson, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*, 4.

[72] Department of the Army, US Marine Corps, *Improvised Explosive Device Defeat*, FMI 3-34.119/MCIP 3-17.01, (Washington, DC: Department of Defense, 2005), 5-3, accessed January 23, 2018, http://www.ssi.army.mil/ncoa/AGS_SLC_ALC_REGS/FMI%203-34.119.pdf.

[73] Ibid., 5-3.

[74] Helen Chapin Metz, *Iraq: a Country Study* (Washington DC: Government Printing Office, 1990), 163; Alexandria Robinson, "Route Clearing Training Crucial for Deploying Engineers," accessed April 11, 2018, https://www.army.mil/article/41405/route_clearing_training_crucial_for_deploying_engineers.

operations. In 2005 in Iraq's Anbar province, the 224th Engineer Battalion, Iowa Army National Guard, sought to defeat the device through the use of the Route Clearance Package or mobility operations. [75] During the initial operations route clearance assets were sent to areas that had suffered recent attack, but this was a reactionary measure. Applying the lessons learned from Vietnam War to present, the 224th started to collect and analyze data on IED attacks. This collection led to better clearance operations plans and to routes of movement that were better cleared. The 224th's engineers experienced the same frustration as clearance teams in Vietnam when they found that the modern insurgents also re-emplaced IEDs in the holes that had just been cleared during an operation. However, by following these proven procedures, the teams were able to reduce IED effectiveness from 70 percent effective against vehicles in October 2004 to only 30 percent effect in December 2005.[76] One piece of equipment used by the route clearance platoon was the Buffalo MPCV (Mine Protected Clearance Vehicle). Its primary mission was to use its mechanical arm to interact with IEDs. Another part of the package was the IVMMD (interim vehicle mounted mine detector) and another a mine resistant vehicle that used electronic means to identify and defeat the IED threat. [77] These vehicles allowed for the soldiers to conduct their route clearance missions in relative safety protected from exploding IEDs by the very design of the vehicle itself. US military personnel who were not part of the route clearance platoons traveled in HMMWVs. As the IED threat grew so did the up-armoring of the HMMWVs.[78] However, HMMWVs had a wide flat underbelly which made the vehicle particularly vulnerable to IED

[75]Gerald S Law, "Employing the Route Clearance Package in Afghanistan," *Engineer* 40, no. 2, (May – August 2010): 49.

[76] Todd M., Jacobus, *Strategizing the Counter-IED Fight in Anbar Province*, 14.

[77] Scott R. Gourley, "Mine Resistant Ambush Protection." *Army* 57, no.7 (July 2007): 34.

[78] Christopher J. Lam, Matthew J. Schmidt, and Berit G. Fitzsimmons, *MRAPs, Irregular Warfare and Pentagon Reform*, 77.

explosions and led to high levels of fatalities. Route clearance platoons equipped with mine resistant vehicles suffered proportionately fewer fatalities.[79]

The reduction in fatalities and relative safety provided by MRAP type vehicles did not go unnoticed by the soldier or marine on the ground in the theater. As early as 2004, the Marines were requesting the procurement of 1,169 MRAPs to bridge the gap in mine resistance until a replacement for the HMMWV could be fielded.[80] As LtCol. McGriff proposed in 16 July 2007 in a *USA Today* article for a phased transition to the MRAP. Continue to up armor Humvees to provide better protection now while as expeditiously as possible, purchase the MRAPs and as MRAPs arrive transition out the Humvees."[81]

Lesson Learned in Iraq and Afghanistan

First, the numbers did not support the idea that IEDs were the dire threat that they were portrayed as in the media. During the entire war in Iraq, June 2003 to November 2008, the total number of personnel killed by IEDS was less than nine and a half percent of the US troops in country (See table 5). The deaths attributed to IEDs were less than a fifteenth of a percent of the monthly average. During one month, June 2006, the percentage of personnel killed by IEDs reached 86 percent but the number of personnel who were killed numbered only fifty four deaths out of the total 23200 in the Iraqi theater. The number of casualties caused by IEDs in any one month in Iraq never reached three percent during the same timeframe.

[79] Christopher J. Lam, Matthew J. Schmidt, and Berit G. Fitzsimmons, *MRAPs, Irregular Warfare and Pentagon Reform*, 81-82.

[80] Gayl, Franz J. *Mine Resistant Ambush Protected*, 11.

[81] Ibid., 15.

Table 5. Iraq KIA per Boots on Ground

Total KIA in Iraq from June 03-November 08	2135
Average Monthly Boot on the Ground Iraq	22793
Total KIA as a Percentage of Average Total Boots on Ground in Iraq	9.37
Average Monthly KIA in Iraq from June 03 - November 08	32.35
Monthly Average of KIA as a Percentage of Average Total Boots on Ground	0.14

Source: Compiled from the numbers in table 8.

In Afghanistan, from January 2004 to November 2008, the total number of personnel killed by IEDs was less than seven and a half percent of the total number of soldiers deployed. (See table 6) The monthly average proportion of deaths attributed to IEDs in Afghanistan never exceeded two hundredths of a percent.

Table 6.Afghan KIA per Boots on Ground.

Total KIA in Afghanistan from January 04 - November 08	1626
Average Monthly Boots on Ground Afghanistan	22178
Total KIA as a Percentage of Average Total Boots on Ground in Afghanistan	7.33
Average Monthly KIA in Afghanistan from January 04-November 08	5.34
Monthly Average of KIA as a Percentage of Average Total Boots on Ground	0.02

Source: Derived from numbers found in table 9.

In January 2006, 100 percent of US casualties were from IEDs, but only one individual was lost. Exact numbers beyond 2009 are unavailable for Iraq and Afghanistan. However, the IED Efficacy graph for Iraq showed that IEDs were successful in causing casualties between 22 to 35 percent of the time (See figure 1).

Figure 1. Iraq IED Numbers.

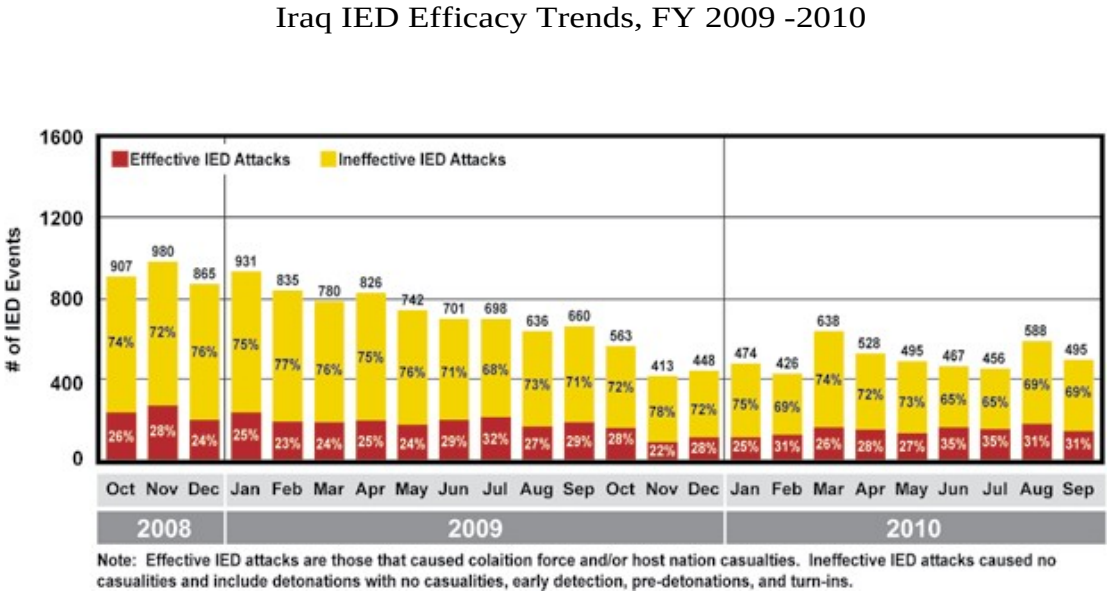
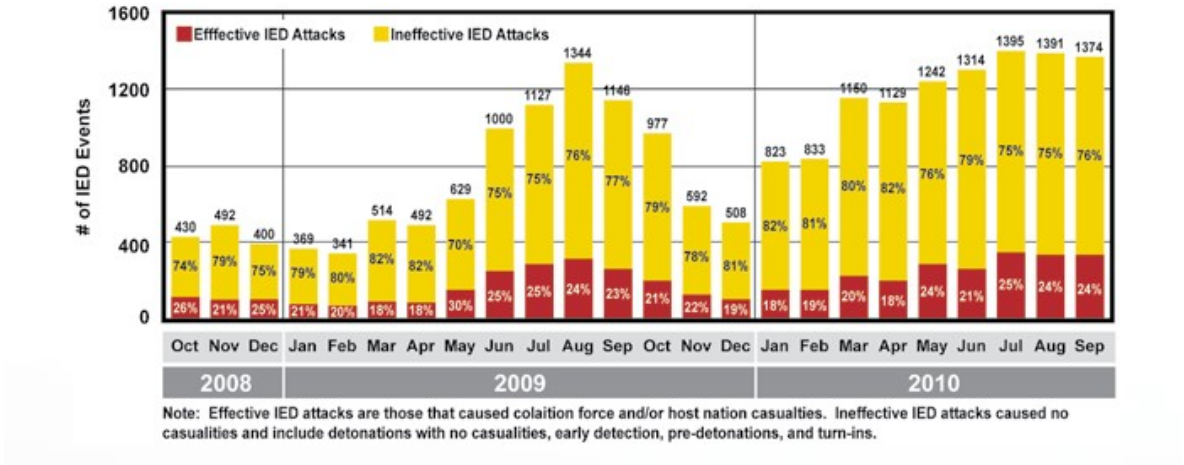


Figure 1. Iraq IED Numbers. *Joint Improvised Explosive Device Defeat Organization, Annual* Report 2010 (Washington DC: Department of Defense, 2010), 6.

In Afghanistan IEDs were effective at causing casualties between 18 to 30 percent of the time. (See figure 2).



Afghanistan IED Efficacy Trends FY 2009-2010

Figure 2. Afghanistan IED Numbers. *Joint Improvised Explosive Device Defeat Organization, Annual Report 2010* (Washington DC: Department of Defense, 2010), 7.

This data shows that not only were the number of casualties not as great as previous wars, but also that the threat could be reduced but not eliminated. The United States spent billions and billions of dollars in an attempt to defeat a relatively inexpensive threat. The return on these expenditures was a failure because, "[a] countermine "silver bullet" is nowhere in sight. Even if the [Countermine Modernization] plan is fully funded . . . technology can only provide part of the answer."[82] The technologies from detectors to jammers to robots were also not the answer. Moreover, "… no one technology stood out to the point it would have been seen as a solution to the problem that the MRAP could mitigate.[83] Yet, the MRAP was not the solution either.

The MRAP the Imperfect Solution

The MRAP arrived in Iraq in 2003 with the road clearance platoons and Explosive Ordinance Disposal (EOD) teams. As previously cited, personnel on the ground recognized the survivability of personnel in these vehicles after they encountered IEDs. The Marines' request for the MRAP came in 2004. The reason for the delay according to Franz Gayl, the Marine Corps' main MRAP advocate, was the Marines Corps commitment to using traditional route clearance procedures. Gayl stated that I MEF (Fwd) was able to conduct mine clearance by utilizing the marines on the ground, supplemented with the constant observation of Main Supply Routes (MSRs) by Intelligence, Surveillance, and Reconnaissance (ISR) assets to effectively move about their area of responsibility. Gayl believed the MRAP only became necessary when the war transitioned to a Counterinsurgency (COIN) and the available ground and ISR forces shrank which made using traditional route clearance very difficult. Gayl stated that he felt the IED menace may not have become as great if proper COIN procedures had been employed from the

[82] William C. Schneck, and Malcolm H. Visser, "Advances in mine warfare: An overview," *Engineer* 23, no. 2 (April 1993):4.

[83]Weiner, Sharon K., "Organizational interests versus Battlefield Needs: The US Military and Mine-Resistant Ambush Protected Vehicles in Iraq," *Polity* 42, no. 4 (October 2010): 462.

beginning of the conflict.[84] According to Gayl, the MRAP was a last-ditch force protection measure.[85]

How effective was the MRAP as a force protection measure? The following table depicts the effectiveness of the different mine mitigation techniques in past conflicts.

Table 7. Mitigation Techniques Effectiveness.

Effectiveness of Different Mine Mitigation Techniques		
Timeframe	Mitigation Technique	Percentage of injury due to IEDs
Vietnam	Route Clearance	33
Gulf War 1	Route Clearance	22
Operation Restore Hope	Route Clearance	26
Iraq	Route Clearance	30
Iraq	MRAP	28*
Afghanistan	MRAP	23*

Source: Table created from statistics in tables1, 3 and figures 1, 2.

As table 9 showed, in Iraq traditional route clearance procedures achieved better results than Vietnam. However, the numbers for the MRAP in Iraq were only slightly better than the traditional route clearance procedures. Afghanistan fared better. It must be noted that these numbers were more descriptive than authoritative. The numbers used throughout the MRAP debate were problematic. In 2011, Secretary Gates had claimed that thousands and thousands of lives had been saved by the MRAP. Also, that year the Pentagon's Joint Program Office published a study that claimed 30,000 lives in Afghanistan and 10,000 lives in Iraq. The validity of these numbers was questioned by security experts.[86] The questions arose from the problem of quantifying the numbers. One recurring issue encountered was certain months that are more prone to violence due to seasonal factors. This made the numbers cyclical in nature subsequently

[84] Gayl, Franz J. *Mine Resistant Ambush Protected*, xii.

[85] Ibid., xii.

[86] David Zucchino, "From MRAP to Scrap: U.S. military chops up $1 million vehicles," *Los Angeles Times*, December 27, 2013, accessed October 13, 2017, http://articles.latimes.com/2013/dec/27/world/la-fg-afghanistan-armor-20131227.

skewing the data for any particular timeframe. Therefore, determining if any trends truly existed was seen as difficult if not impossible. [87] One area of difficulty relates to casualty reporting. Casualty is a term that includes both injuries and fatalities. Unfortunately, the MRAP discussion exhibited multiple examples of conflating the two. The Center for Strategic and International Studies stated that the use of fatalities as a measure was problematic for the reasons previously discussed. For example, in table 8, the coalition suffered 100 percent of their fatalities from IEDs in January of 2006. However, this loss was one individual, so the fatalities percentage claimed was misleading. However, if the number of actual fatalities were viewed as a percentage of boots on the ground the lost rate in Vietnam, Iraq and Afghanistan was similar. The average percentage of casualties in Vietnam from IEDs, shown in Table 1, was approximately 1.4 percent of the boots on the ground, which matches the percentage of casualties experienced in Iraq, shown in Table 5. In Afghanistan, Table 6, only 12 tenths of a percent of the casualties were from IEDs. Consequently, it can be argued that the level of the threat posed by IEDs in the wars in Vietnam and Iraq were similar, and that route clearance procedures and the MRAP seemed to provide an equivalent level of protection.

The effect of introducing the MRAP into Iraq was according to Christopher Lamb and others in their article *MRAPs, Irregular Warfare, and Pentagon Reform* was to dramatically reduce the number of casualties from IED explosions.

[87] Anthony H. Cordesman, *US Casualties: The Trends in Iraq and Afghanistan*, Burke Studies, The Center for Strategic & International Studies, slide 6, accessed 10 April, 2018, http://www.csis.org/files/media/csis/pubs/080808_war_casualties.pdf.

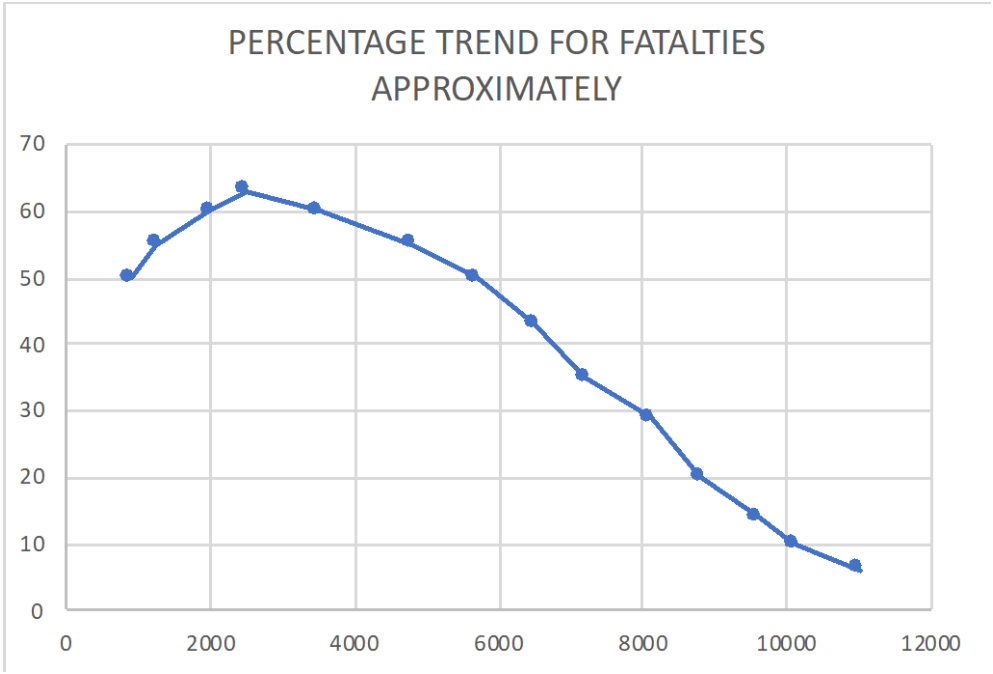


Figure 3. Fatalities versus MRAPs. Derived from numbers in Lamb, Schmidt, and Fitzsimmons, *MRAPs, Irregular Warfare, and Pentagon Reform*, 81.

The trend that was depicted showed as the number of MRAPs increased there was a subsequent reduction in the percentage of IED caused fatalities in theater. This is another example of confusing of terms and figures to show the value of the MRAP (casualties versus fatalities).[88] However, this data does prove that the Rhodesian military experience with the MRAP was valid. The MRAP in Iraq just like the MRAP in Africa was a proven way to reduce fatalities. In fact, even though there were questions about the validity of the numbers, experts felt the MRAP had reduced the overall number of deaths and injuries in areas where they were used.[89] The absence of separate information on casualties meant, according to the MRAPs critics, that most public figures were misinformed about the MRAPs performance. Rohlfs and Sullivan did an analysis and felt one reason for the inaccuracies were the numbers coming from the Joint Program Office (JPO). These critics believed the JPO got its numbers for lives saved by taking

[88] Christopher J. Lamb, Matthew J. Schmidt and Berit G. Fitzsimmons, "MRAPs, Irregular Warfare, and Pentagon Reform," 81.

[89] David Zucchino, "From MRAP to Scrap: U.S. military chops up $1 million vehicles,"

the number of attacks on the MRAP and counting up the number of military personnel in those MRAPs. The number of passengers was then reported as equal to the number of lives saved. Rohlfs and Sullivan said this unfairly bolsters the MRAP because it implies that if the personnel had been in Humvees they would have all died.[90] When it comes to the issue of casualties the data was less clear. As seen in the anecdotal evidence of the seven personnel riding in Mr. Axe's MRAP, five survived but all were casualties. In addition, when interviewing soldiers that had survived IED explosions in MRAPs, they were reported as displaying signs of mild Traumatic Brain Injuries. Which was a type of injury that has been called the signature wound of these current conflicts. [91]

Several proponents of the MRAP talked of its value and dismissed critics that questioned the MRAP's cost. The question of the MRAP's cost effectiveness was examined by University of Syracuse Professor Chris Rohlfs and US Naval Postgraduate School Professor Ryan Sullivan. In Rohlfs and Sullivan's analysis they looked at the cost effectiveness of the different up armoring campaigns during the wars and attempted to control for the physical environment. The study defined the MRAP's cost effectiveness in terms of money spent versus the dollar value of the lives saved by that expenditure. The study looked at the cost of the three different class of Tactical Wheeled Vehicles (TWV) fielded in Iraq and Afghanistan. The Type 1 TWV had a replacement cost of $50,000. The Type 1 vehicle is unidentified in the study but most likely was the unarmored Humvee. The Type 2 cost $170,000 to replace (unidentified as well, but most likely the up armored Humvee). The Type 3 cost $600,000 to replace (the MRAP). Utilizing for Official Use Only materials, while accounting for the different variables in the theater conditions,

[90] Chris Rohlfs and Ryan Sullivan, "The MRAP Boondoggle: Why the $600,000 Vehicles aren't Worth the Money," Snapshot, *Foreign Affairs*, 26 July, 2012, accessed 10 January, 2018, https://www.foreignaffairs.com/articles/2012-07-26/mrap-boondoggle.

[91] Gregg Zoroya, "How the IED changed the US Military," *USA Today* last modified December 19, 2013, accessed January 10, 2018, https://www.usatoday.com/story/news/nation/2013/12/18/ied-10-years-blast-wounds-amputations/3803017/.

the authors found that the shift from the Type 1 TWV to the Type 2 TWV was much more cost effective than the switch from the Type 2 TWV to the Type 3 TWV. They found the return on the dollar for the MRAP was insufficient to justify its cost.[92] This was one of the areas the study's detractors attacked as not taking into account the total cost of the enlisted person or officer lost. This was another area where the values assigned to lives varied by a wide margin, from as low as $500,000 in one study for an enlisted person[93] to a value of a statistical life of 7.5 million dollar in Rohlfs and Sullivan's.[94] Therefore, these numbers are descriptive. Rohlfs and Sullivan stated multiple times that if the Type 3 TWV had been fielded sooner in conflict the cost effectiveness of the Type 3 TWV would have been greater. However, they found the MRAP was deployed during a period of decreasing overall violence. Thus, there were fewer IED incidents from which to judge cost effectiveness. Importantly though, they recognized that the MRAP had lifesaving properties. Their conclusions were echoed in other critiques for instance, General Barry McCaffery, USA (Ret.) claimed that the MRAP was too late and the wrong vehicle to face a threat that was being managed.[95] Thus, to GEN McCaffery, the MRAP was an expensive and ill-timed mitigation strategy.

Even though some critics claimed the MRAP was the wrong vehicle for the task. Secretary Gates claimed that the MRAP was not a single use platform. This statement proved to be only partially true. The MRAP was hobbled when initially deployed because it deployed before an adequate supply chain was in place. Moreover, the platform was unsuitable for most

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[92] Chris Rohlfs and Ryan Sullivan, "The Cost-Effectiveness of Armored Tactical Wheeled Vehicles for Overseas U.S. Army Operations," Defense Resources Management Institute, Naval Post Graduate School, 18-19, accessed January 10, 2018, https://my.nps.edu/documents/103424423/106950799/DRMI+Working+Paper+2011-1.pdf?a1369347-.

[93] Christopher J. Lam, Matthew J. Schmidt, and Berit G. Fitzsimmons, "MRAPs, Irregular Warfare and Pentagon Reform," 84.

[94] Chris Rohlfs and Ryan Sullivan, "The Cost-Effectiveness of Armored Tactical Wheeled Vehicles for Overseas U.S. Army Operations," 15.

[95] Christopher J. Lamb, Matthew J. Schmidt and Berit G. Fitzsimmons, "MRAPs, Irregular Warfare, and Pentagon Reform," 76.

terrain it operated in. There were numerous stories of MRAPs crews needing to dismount to assist maneuver or clear the way, so their MRAP could traverse an area.[96] These issues only worsened when the MRAP deployed to Afghanistan. There the roads were poorer and the terrain was much more rugged than Iraq. Making the MRAP suitable for Afghanistan required building a whole new variant in addition to refitting the existing fleet for operations. Even after refitting, the Iraq and Afghanistan MRAPs have been deemed excess equipment due to their limited utility and cost to remove them from theater. This designation meant out of the 27,000 MRAPs bought only approximately 10,000 were kept for future needs with the subsequent number being given away or sold for scrap.[97]

Conclusion

The US has been involved with mine/IED mitigation in every war it has been in. Mines, booby traps and IEDs are different names for the same threat. No matter the conflict the US has faced enemies that use explosive devices in place of artillery to cause inflict casualties and impede military operations. These devices essentially consist of an explosive charge married to some type of detonating mechanism. The physical manifestations of these devices have changed greatly over the years, always with an eye towards preventing their defeat by demining teams. The historical record shows that the United States learned multiple countermine lessons in Vietnam. These lessons showed the importance of local training to meet the local threat. The lessons also revealed how manpower intensive mine mitigation procedures were. The manpower needs were not just numbers. Countermine operations were combined arms operations consisting of sweep teams needed to clear a sector and of security support personnel needed to protect mine clearance teams. The manpower needs were also time intensive. This time requirement was not

[96] Christopher J. Lamb, Matthew J. Schmidt and Berit G. Fitzsimmons, "MRAPs, Irregular Warfare, and Pentagon Reform," 82.

[97] Thomas Shanker, "The Man behind the MRAP moves on."

constrained to the time mine clearance takes, but also the time that is necessary to become familiar enough with your operating environment to notice when something is out of place. This directly contributed to what was the most important lesson from Vietnam, the importance of visual detection. The importance of the person on the ground using their familiarity with their surroundings, who then was able to detect mine that were undetectable to the technology of their time. Military personnel contributed more than just visual detection, their ingenuity was evident in the development of proofing rollers. Therefore, there were many lessons concerning mine/IED mitigation that were learned in Vietnam.

Advances in mine/IED mitigation continued after Vietnam. The greatest advances in mitigation were developed in the civil wars in South Africa and Rhodesia (now Zimbabwe). This advance was the MRAP. The MRAP was originally a 1943 Swedish design that inspired the South African Army to develop a similarly shaped vehicle that mitigated the explosions of anti-vehicle mines. The Rhodesians improved this design. . The Rhodesians were spurred on by necessity. They developed multiple models of MRAPs and thereby reduced the number of fatalities due to mines/IEDs. Importantly, the Rhodesia experience proved MRAPs cannot eliminate casualties. The US military did not develop a MRAP like vehicle in the period between the Vietnam War and the wars in Iraq and Afghanistan. Instead, the United States rediscovered the need for route clearance procedures and the importance of conducting them appropriately. This period was another time when the innovations by the warfighter on the ground directly contributed to beating the threat posed by mines/IEDS. The improvised proofing roller, first improvised in Vietnam, was improvised again in Operation Desert Storm. By utilizing proper techniques, the US proved the threat of mines/IEDs could be kept to an acceptable level. However, this level was not acceptable to all in the US military and some personnel familiar with the MRAP started advocating for its procurement.

The wars in Iraq and Afghanistan demonstrated in the beginning of the conflict that traditional route clearance procedures when properly applied still worked. This was demonstrated

by the similarity between the proportion of casualties attributed to mines and that in previous conflicts. It was only when the nature of fight changed to a counter insurgency, and the number of deployed troops did not allow for the proper conduct of route clearance that the MRAP was required. Force caps directly created the need for the "stop gap" force protection measure, the MRAP.

Casualty figures from Iraq and Afghanistan are difficult to sort out. However, the number of fatalities owing to an IED strike demonstrate the value of the MRAP in mitigating the threat of mines/IEDs. The MRAP design was a proven to reduce fatalities. However, there is no consistent separate data on casualties in distinction to fatalities with which to assess the value of the MRAP toward reducing casualties from IEDs. Reports in favor of and opposed to the MRAP, use these terms interchangeably... However, when data on IED casualties in previous conflicts are compared with similar data from Iraq and Afghanistan, the MRAP seems to be no more successful in reducing casualties that other countermine efforts.

Whether the MRAP was cost effective is open to debate. Calculating the cost effectiveness depends to a large extent on estimates of the value of a soldier's life. Additionally, the number of actual IED incidents declined and with that the value of the MRAP as a countermine measure also declined. One way the MRAP could be seen as a failure was the expansion from the original request for a vehicle to bridge the gap while a replacement for the Humvee was found. However, that request expanded to placing everyone in an MRAP and resulted in the procurement of many models in large numbers. Consequently, thousands of MRAPs have been sold or scrapped as excess property, 17,000 MRAPs in all. In the end, the MRAP was just another mine/IED mitigation technique among many. So as JIEDDO had stated there was no silver bullet that would answer the IED threat. In the future, the United States must ensure that it does not forget all the lessons that it has learned and must keep a ready eye to identify innovative mitigation techniques where ever they are developed.

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Appendix

Table 8. Iraq Casualties by Month.

Month of Count	CF KIA in Iraq	CF WIA in Iraq	US Boots on Ground Iraq	Percentage of Boots on Ground IED Casuaties in Iraq	Percent of Boots on Ground KIA by IEDs in Iraq	IEDs Percentage Of Total KIA in Iraq
Jun 03	0	35	12850	0.27	0.00	0.00
Jul 03	7	81	12400	0.71	0.06	14.29
Aug 03	8	142	12800	1.17	0.06	18.60
Sep 03	7	172	11900	1.50	0.06	21.21
Oct 03	15	240	13100	1.95	0.11	31.91
Nov 03	35	179	14900	1.44	0.23	31.82
Dec 03	24	241	22500	1.18	0.11	50.00
Jan 04	21	107	23000	0.56	0.09	40.38
Feb 04	11	154	22050	0.75	0.05	47.83
Mar 04	25	188	22350	0.95	0.11	48.08
Apr 04	34	292	22000	1.48	0.15	24.29
May 04	31	330	19500	1.85	0.16	36.90
Jun 04	17	216	20300	1.15	0.08	34.00
Jul 04	29	299	19300	1.70	0.15	50.00
Aug 04	29	323	18150	1.94	0.16	38.67
Sep 04	44	369	18850	2.19	0.23	50.57
Oct 04	35	362	17200	2.31	0.20	51.47
Nov 04	40	418	17550	2.61	0.23	28.37
Dec 04	16	257	19200	1.42	0.08	21.05
Jan 05	38	255	19800	1.48	0.19	29.92
Feb 05	29	242	20500	1.32	0.14	48.33
Mar 05	20	230	21193	1.18	0.09	51.28
Apr 05	30	367	19710	2.01	0.15	57.69
May 05	36	338	20132	1.86	0.18	40.91
Jun 05	38	322	19475	1.85	0.20	45.78
Jul 05	35	348	21305	1.80	0.16	60.34
Aug 05	44	382	19110	2.23	0.23	51.76
Sep 05	31	360	19515	2.00	0.16	59.62
Oct 05	52	405	20060	2.28	0.26	52.53
Nov 05	42	186	19775	1.15	0.21	48.84
Dec 05	40	259	20340	1.47	0.20	58.82
Jan 06	29	206	22090	1.06	0.13	45.31
Feb 06	36	207	24500	0.99	0.15	62.07
Mar 06	13	333	23230	1.49	0.06	38.24
Apr 06	57	283	23800	1.43	0.24	69.51
May 06	53	355	22850	1.79	0.23	67.09
Jun 06	54	410	23200	2.00	0.23	85.71
Jul 06	30	383	21700	1.90	0.14	65.22
Aug 06	47	384	20666	2.09	0.23	71.21
Sep 06	43	505	21466	2.55	0.20	55.84
Oct 06	72	486	20835	2.68	0.35	64.86
Nov 06	55	358	21530	1.92	0.26	70.51
Dec 06	69	401	22095	2.13	0.31	60.00
Jan 07	49	403	27325	1.65	0.18	56.98
Feb 07	45	375	24840	1.69	0.18	52.94
Mar 07	59	389	26520	1.69	0.22	71.95
Apr 07	76	416	23925	2.06	0.32	64.96
May 07	98	497	27710	2.15	0.35	74.81
Jun 07	83	572	24875	2.63	0.33	76.85
Jul 07	49	434	25130	1.92	0.19	55.06
Aug 07	37	419	25280	1.80	0.15	42.05
Sep 07	29	262	25650	1.13	0.11	41.43
Oct 07	20	188	25530	0.81	0.08	50.00
Nov 07	22	136	25800	0.61	0.09	55.00
Dec 07	8	136	25695	0.56	0.03	32.00
Jan 08	22	184	28620	0.72	0.08	55.00
Feb 08	12	110	27700	0.44	0.04	40.00
Mar 08	28	192	31100	0.71	0.09	70.00
Apr 08	30	160	33600	0.57	0.09	57.69
May 08	14	105	32400	0.37	0.04	66.67
Jun 08	16	121	31700	0.43	0.05	51.61
Jul 08	2	72	33610	0.22	0.01	15.38
Aug 08	7	52	31700	0.19	0.02	30.43
Sep 08	4	43	32300	0.15	0.01	16.00
Oct 08	2	47	32750	0.15	0.01	14.29
Nov 08	2	59	31800	0.19	0.01	11.76

Source: Table compiled from ICasualties Accessed October 18, 2017 http://www.icasualties.org/, CSIS studies and CRS documents.

Table 9. Afghanistan Casualties by Month.

Month of Count	CF KIA in Afghanistan	CF WIA in Afghanistan	US Boots on Ground Afghanistan	Percentage of Boots on Ground IED Casuaties in Afghanistan	Percent of Boots on Ground KIA by IEDs in Afghanistan	IEDs Percentage Of Total KIA in Afghanistan
Jan 04	0	2	13500	0.01	0.00	0.00
Feb 04	0	5	12300	0.04	0.00	0.00
Mar 04	0	3	14100	0.02	0.00	0.00
Apr 04	0	3	19500	0.02	0.00	0.00
May 04	4	2	17700	0.03	0.02	44.44
Jun 04	2	8	17800	0.06	0.01	40.00
Jul 04	0	6	17400	0.03	0.00	0.00
Aug 04	2	7	15700	0.06	0.01	50.00
Sep 04	0	7	16800	0.04	0.00	0.00
Oct 04	1	16	17500	0.10	0.01	12.50
Nov 04	2	2	17800	0.02	0.01	28.57
Dec 04	0	1	18300	0.01	0.00	0.00
Jan 05	1	3	18700	0.02	0.01	50.00
Feb 05	0	3	20300	0.01	0.00	0.00
Mar 05	1	8	20900	0.04	0.00	16.67
Apr 05	1	2	19500	0.02	0.01	5.26
May 05	1	9	20000	0.05	0.01	25.00
Jun 05	2	15	19200	0.09	0.01	6.90
Jul 05	0	16	21100	0.08	0.00	0.00
Aug 05	9	17	17400	0.15	0.05	27.27
Sep 05	1	16	18000	0.09	0.01	8.33
Oct 05	1	16	17800	0.10	0.01	10.00
Nov 05	3	10	17400	0.07	0.02	42.86
Dec 05	1	18	18500	0.10	0.01	25.00
Jan 06	1	7	20300	0.04	0.00	100.00
Feb 06	5	4	22700	0.04	0.02	29.41
Mar 06	4	11	20000	0.08	0.02	30.77
Apr 06	4	15	23300	0.08	0.02	80.00
May 06	2	22	21800	0.11	0.01	11.76
Jun 06	6	32	22300	0.17	0.03	27.27
Jul 06	1	21	20800	0.11	0.00	5.26
Aug 06	7	21	19700	0.14	0.04	24.14
Sep 06	11	74	20400	0.42	0.05	28.95
Oct 06	6	29	19800	0.18	0.03	35.29
Nov 06	4	18	20500	0.11	0.02	44.44
Dec 06	1	25	21800	0.12	0.00	25.00
Jan 07	0	13	26000	0.05	0.00	0.00
Feb 07	4	20	24800	0.10	0.02	22.22
Mar 07	0	16	24400	0.07	0.00	0.00
Apr 07	11	25	23900	0.15	0.05	55.00
May 07	3	65	26400	0.26	0.01	12.00
Jun 07	15	43	23800	0.24	0.06	62.50
Jul 07	12	55	24000	0.28	0.05	41.38
Aug 07	10	40	24000	0.21	0.04	29.41
Sep 07	9	44	24500	0.22	0.04	37.50
Oct 07	5	49	24400	0.22	0.02	33.33
Nov 07	4	33	24800	0.15	0.02	18.18
Dec 07	4	12	24600	0.07	0.02	44.44
Jan 08	6	37	27000	0.16	0.02	42.86
Feb 08	4	12	28000	0.06	0.01	57.14
Mar 08	12	62	28800	0.26	0.04	60.00
Apr 08	17	56	33100	0.22	0.05	Invalid
May 08	11	70	35600	0.23	0.03	47.83
Jun 08	25	90	34000	0.34	0.07	54.35
Jul 08	8	74	33700	0.24	0.02	26.67
Aug 08	26	114	34200	0.41	0.08	56.52
Sep 08	22	71	33500	0.28	0.07	59.46
Oct 08	13	72	Not Available			68.42
Nov 08	10	79	Not Available			83.33

Source: Table compiled from ICasualties Accessed October 18, 2017 http://www.icasualties.org/, CSIS studies and CRS documents.