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Infantry Small Arms of the Future: Practical and Tactical Considerations

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ABSTRACT

Title: Infantry Small Arms of the Future: Practical and Tactical Considerations

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Thesis: Future infantry small arms and light weapons of the future will maximize effects, minimize logistics and training, and allow for more efficient and effective future infantry forces.

Discussion: As technological advances have been made more available to ground combat units over the last few decades, the combat load of the individual soldier has continued to increase. Currently, the top five weight-contributing items that the infantryman carries are his individual protective equipment, personal water, communications equipment, small arms or light weapons, and ammunition. The priority of the equipment (and proportion of the overall weight) varies according to the mission and role of the individual, but these "top five" remain fairly consistent as the major load considerations for the infantryman. Consequently, the Joint services of the United States and many services in other countries are embarking on related programs to examine and exploit technological advances in order to benefit the individual soldier of the future. One of the key components common amongst these many programs is the quest to find a new family of lightweight small arms and light weapons. These infantry small arms and light weapons of the future will maximize effects, minimize logistics and training, and allow for more efficient and effective future infantry forces.

Recommendation: With developments in caseless ammunition and precision bursting munitions, improved future weapons will be lighter, have lighter-weight ammunition, and deliver tailorable effects. Future infantry forces will be able to capitalize on the greater measures of effectiveness and efficiency that the synergy of these systems will deliver in the tactical realm. The effective combination of these future small arms and light weapons capabilities should allow the infantry battalion to reduce the number of personnel required to man the current heavier crew-served weapon systems, such as mortars and heavy machine guns, and allow for more infantrymen able to execute the mission to locate, close with and destroy the enemy by fire and maneuver. With more lethal systems able to be carried in the hands and on the backs of the individual infantryman, combined with the current improvements in communications, fire support and sensors, and the maturation of concepts such as Distributed Operations, future infantry units will be able to operate in nearly any future tactical environment and be successful. Additionally, these tactical enhancements will also cause measurable changes in the operational realm, whether through the increased tactical range for future infantry units or by realizing the reductions in collateral damage. However, with technological advances comes responsibility. With the current prolific increase in the availability of lightweight personal small arms, the instances of child soldiers has dramatically increased as well. Future small arms and light weapons development should take these third and fourth order factors into account when designing future systems to ensure that only legal combatants are able to employ these systems.

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INTRODUCTION

As the world draws close to the end of the first decade of the 21st century, the Joint services of the United States and many services in other countries are embarking on related programs to examine and exploit technological advances in order to benefit the individual soldier of the future.[1] One of the key components common amongst these many programs is the quest to find a new family of lightweight small arms and light weapons. **These infantry small arms and light weapons of the future will maximize effects, minimize logistics and training, and allow for more efficient and effective future infantry forces.** Specifically, the future infantryman can carry more ammunition (efficient) and enjoy a weapon system that is more accurate, durable, and easier to maintain (effective) resulting from the evolution of caseless ammunition. Further, with the developing tailorability of precision bursting munitions, future infantry forces will have the organic ability to quickly engage enemy forces in defilade or behind cover (effective) without having to coordinate supporting arms, such as mortars, artillery or close air support (efficient).

THE SOLDIER'S LOAD

The key reason for placing such emphasis on lightweight weaponry for a future combat force is simple; as technological advances have been made more available to ground combat units over the last few decades, the combat load of the individual soldier has continued to increase.[2] Currently, the top five weight-contributing items that the infantryman carries are his individual protective equipment, personal water, communications equipment, small arms or light weapons, and ammunition. The priority of the equipment (and proportion of the overall weight) varies according to the mission and role of the individual, but these "top five" remain fairly consistent as the major load considerations for the infantryman.[3] The following discourse outlines the current state of the art in the "top five", and is intended to provide the reader with a better understanding of the need and relationship between the major items of necessary infantry combat equipment.

As the lethal effects of small arms and light weapons have increased, especially since World War I, the need for better individual protective equipment has also increased. A flak jacket with Small Arms Protective Inserts (SAPI) plates and Kevlar helmet can weigh twenty pounds or more depending on the size of the individual.[4] These items, in addition to protecting the individual from fragmentation and small arms fire, retain heat and necessitate carrying increased personal water supply. With water weighing 8.34 pounds per gallon, this adds substantial weight to the individual combat load, especially in tropical or arid environments. Improved lethality also means that infantry forces have to fight in more dispersed formations due to the increased effectiveness of modern small arms and light weapons. This has amplified the requirement for infantrymen to carry specialized communications gear in order to enable effective command and control, as well as coordinating with other supporting elements such as indirect fire and aviation assets. The last two items, the infantryman's weapon and requisite ammunition to support it, are both the source of the individual's combat power and the major contributor to his combat load.

The requirement for increased effectiveness regarding the individual's lethality has also given rise to new add-ons to the infantryman's small and light arms. Today's weapons commonly have improved optics (both for day and night sighting), laser pointers, and even handles to help steady the aim and control the recoil of the weapon system. All of these items are provided with the ultimate goal of improving the infantryman's ability to obtain a first-round hit, but they also contribute to the individual's combat load.

Since World War I and the advent of the machine gun, there has been increasing emphasis on providing offensive firepower to support maneuver at lower levels of the tactical infantry organization. As a result, more light automatic weapons have been introduced to the infantry rifle platoon, squad, and even down to the fire team level. As current day automatic weapons need to sustain high rates of fire in order to have the requisite effect on the enemy, especially during offensive maneuvers, they are by design heavier than the individual rifle that most infantrymen carry. Also key to sustaining the effects of the automatic weapon is the need for increased ammunition. As the individual rifleman may carry a combat load of 180 to 240 rounds, the average automatic weapon at the squad level needs to carry anywhere from 600 to 1,000 rounds of ammunition in order to make it an effective contributor to the offensive maneuver capability of the infantry fire team, squad, or platoon. This increasing need for the firepower that automatic weapons have for engaging and suppressing an enemy, and the requisite ammunition to support them, were the driving factors behind the advancement of caseless ammunition technology.

With all of the deadliness of these small arms and automatic weapons, they have a common defect. They have fairly straight and flat trajectories, and leave "dead space" available for an enemy to avoid the effects of the direct-fire small arms systems. Therefore, infantry units worldwide have integrated light (defined as man-packed) indirect fire weapons to be able to cover this dead space. These systems include low and high velocity rifled grenades (usually 30 to 40mm), and light and medium caliber mortars. As these weapon systems are not precision guided, they require both specialized training as well as large amounts of ammunition for calibrating and adjusting fire, even by the most proficient individuals and crews. This ammunition is usually heavy and bulky, and rounds (especially for mortar systems) are spread-loaded throughout the infantry platoon, again adding to the individual infantryman's combat load. With the advent of micro and nano electronics along with improved explosives design, developing precision bursting munitions have the capability to provide the future infantryman the explosive punch required for small units themselves to effectively engage an enemy in defilade, or even behind cover, without the need for increasingly cumbersome light indirect weapons systems.

THE FUTURE THREAT – THE NEXT 15 YEARS

Worldwide, future small arms and light weapons developments during the next 15 years should be characterized by evolutionary product improvements to achieve lighter weight, longer range, and greater accuracy. Increased numbers of these weapons will be equipped with magnifying optics, night vision devices, or laser aiming devices.[5] Potential rival threat forces in this projected future environment, in addition to the aforementioned modernization of existing conventional weapons systems to help increase their effectiveness, will use adaptation and asymmetrical responses to counter U.S. conventional military advantages. It is also predicted that they will continue the trend of seeking sanctuary in complex and urban terrain while attempting to deny access to U.S. forces, and will exploit every opportunity of collateral damage in these urban areas to tarnish the image of U.S. forces. The combination of improved threat small arms and light weapons with adaptive and asymmetrical tactics could pose a truly significant threat to future U.S. forces.[6] To counter these threats, U.S. infantry forces (especially the United States Marine Corps) are refining concepts calling for smaller but highly capable units to operate in a distributed manner. The U.S. Marine Corps outlines this capability as follows:

> "In the tactical application of the distributed operations concept, it is envisioned that maneuver units will operate in disaggregated fashion, with companies, platoons, and even squads dispersed beyond the normal range of mutually supporting organic direct fires, but linked through a command and control network. All units will be organized, trained, and equipped to facilitate distributed operations, with capabilities beyond those historically resident at the small unit level. They will employ the advantage of extensive dispersion to reduce their vulnerability to enemy observation and fire, but will possess significant combat power, enabling them to locate, close with, and destroy the enemy."[7]

These units would have the advantage of operating separated in order to avoid detection, but coordinated throughout the battle space in order to maximize the effects of supporting arms and/or concentrate for massed ground effects when required. In the near term these concepts will require the infantryman to carry more ammunition, and therefore more weight, as distributed units will have to operate independently and undetected. This is due to the fact that resupply will not only be extremely challenging due to the increased numbers of smaller units dispersed throughout the battle space, but by the desire of the distributed units need to remain as low-profile as possible. Helicopter resupply and/or aerial deliveries to replenish ammunition to these distributed units risks exposing them to detection. This is where the capabilities presented by caseless ammunition weapons systems and precision bursting munitions show much promise.

NEAR AND MID-TERM (8-15 YEARS) POSSIBLITIES

The Case for Caseless Ammunition

One of the most promising near-to-mid-term solutions for reducing the soldier’s load was actually started in the 1960’s with a study instituted by the West German government, with a desire to improve the accuracy of automatic small arms fire. This call for better accuracy was developed to improve the capability of the individual soldier to effectively engage a target at longer ranges with accurate burst and automatic small arms fire, specifically from 300 to 600 yards. With that type of accuracy and output (similar to heavier automatic rifles and light machine guns), the infantry soldier using bounding and covered rushes at the team and squad level could effectively pin down an enemy at greater distances, allowing him and his comrades to maneuver on an enemy while facing much less effective counter fire. The 1960’s study also determined that then-current methods of automatic and burst fire management were not capable of meeting the accuracy demands established by the West German government.

Mechanically, past and current automatic weapon designs under burst and full automatic fire mode generate individual recoil impulses, which not only cause the weapon to rise (as the weapon pivots on the firer's shoulder), but when these impulses are transferred to the shooter's body they cause the shooter's torso to rotate as well. As a result, subsequent shots will be high and wide compared to the first.[8] Therefore, unless the first round is aimed low and to the side opposite of the shooter’s firing shoulder, all subsequent rounds will also miss the target.

The 1960’s study concluded that there were two solutions to this problem. The first option was a “shotgun” approach, where a large number of projectiles would be launched at the same time in order to “saturate” a target. This alternative was rejected because the size of the shell needed to launch the requisite number of projectiles for optimal effect would not only increase the individual’s combat load, but the high recoil impulse generated with each shot would increase fatigue on the individual, effecting subsequent accuracy. This greater recoil would also multiply the time it took for an individual to reacquire and engage subsequent targets, due to having to absorb and recover from the increased recoil effects of the “shotgun” round. These increased time and stress factors on the individual meant that even thought there was a higher first-round hit probability, there was no beneficial increase in combat effectiveness. The second option incorporated a rapid and successive discharge of bullets, or salvo, fired at as high a speed as possible thereby reducing the effects of recoil on bullet accuracy and condensing the individual recoil impulses into one manageable force. This required a weapon that had a cyclic rate of fire approaching 2,000 rounds per minute. To achieve such a high rate of fire meant either using multiple barrels, which was unacceptable due to the potential for increased weight and complexity of such a system, or by figuring out a way to speed up the cycle of operation.[9]

It was ultimately concluded that through developing a new type of “caseless” ammunition, in which the traditional brass cartridge case that holds the bullet, propellant, and primer together is eliminated, the extraction and ejection steps from the current seven to eight-step firing cycle can be skipped, and consequently the cyclic rate of fire can be increased. Secondly, eliminating the cartridge case not only reduces the overall weight and bulk of the ammunition, but also allows for more efficient weapons design due to the lack of a need for such items as an extraction and ejection system. Since there is no cartridge case, there is no longer a need for a hefty bolt assembly to force rounds in and out of a chamber, ultimately saving on weight and increasing the overall durability of the system. Thirdly, since there are no residual cartridge casings for the weapon to eject, there is no need for an ejection port, only a small unloading port for removing an unfired or failed round. This also helps to improve the weapon's durability by protecting its internal action from external contamination and fouling. Finally, by utilizing a more compact chambering system without the need for a bolt traveling back and forth to insert and extract rounds, more internal weapon space can be devoted to an improved recoil system. This then improves the accuracy of the weapon, especially when firing automatic bursts of fire.[10]

Heckler & Koch G-11 Caseless Ammunition Assault Weapon

Heckler & Koch (H&K) was the manufacturer ultimately selected to build a prototype weapon to meet the West German requirement for an improved combat rifle. The major challenge for H&K to overcome was to perfect the design of the caseless ammunition in order to be able to realize the rest of the weapon system, so they partnered with the Dynamit Nobel company to develop this new caseless ammunition technology. Several early tests identified the need for a less sensitive projectile propellant that would reduce the risk of "cook offs", and led to the development of High Ignition Temperature Propellant (HITP). H&K molded this HITP propellant into a rectangular block around a 4.7mm diameter projectile and cartridge primer. The rectangular shape allowed the rounds to feed more efficiently from the magazine, as there was no room in the magazine for the bullets to shift and potentially mis-feed. In addition to improving feeding, the molded propellant also significantly reduced the weight of each individual cartridge. With the caseless ammunition problem mastered, H&K developed the

4.7mm G11 prototype weapon system.[11] (See Figure 1A & 1B)

The 4.7mm H&K G11 rifle is relatively simple and straightforward, utilizing a rotating breech/chamber cylinder instead of the locking bolt/chamber arrangement as in conventional rifles. In place of a locking bolt and chamber, the rifle has a rotating cylinder that serves as both breech and firing chamber.[12] (See Figure 2) The H&K G11 fires from a closed-bolt position, with the breech/chamber cylinder being operated via a gas-piston design. The caseless rounds are fed vertically through the top of the receiver into the breech/chamber cylinder, which is then rotated 90 degrees to align the breech/chamber with the barrel. When fired, the gas piston rotates the cylinder back 90 degrees and another caseless round is loaded.[13] To achieve the desired degree of accuracy in burst mode, the H&K G11 relies on an extremely high rate of fire (approximately 2,000 rpm). At this speed, the 3 projectiles fired in burst mode have already cleared the barrel before the recoil forces have a chance to affect the shooter's aim. On full auto, the H&K G11 reduces the cyclic rate of fire to 460 rounds per minute in order to minimize cumulative recoil effects and ammunition expenditure.[14] By maximizing the design benefits that caseless ammunition offers, the H&K G11 rifle with 510 rounds of 4.7mm caseless ammunition weighs as much as the old NATO G3 rifle with 100 rounds of 7.62mm cartridge style ammunition.[15]

In spite of all of these advantages, the West German Army never adopted the 4.7mm H&K G11 to replace the 7.62mm NATO G3. Although no specific reason was given, timing may have played a significant role in the failure of the project to be fielded. During the time the H&K G11 system was being perfected and tested, the Soviet Union and the Warsaw Pact collapsed, and the subsequent reunification of East and West Germany occurred. As a side note, the 7.62mm NATO G3 rifle was eventually replaced in 1999 by the 5.56mm H&K G36 rifle.[16]

Current Caseless Ammunition Programs

Since 2003, there has been a renewed interest in caseless ammunition technology, especially in the United States. Specifically, the Joint Services Small Arms Program (JSSAP) has begun to revive the Advanced Combat Rifle (ACR) program in light of lessons learned for Operations Enduring and Iraqi Freedom.[17] During the late 1980's and early 1990's, H&K and its refinement of caseless ammunition technology played a central part in the ACR effort with the H&K-ACR. The HK-ACR was identical to the 4.7mm H&K G11 with the addition of an optical sight designed to engage targets ranging from 25 to 600 meters. The H&K-ACR system was tested in 1990 at Fort Benning, Georgia, with the rifle receiving high marks, as there were no major parts failures on any of the test weapons used (fifteen H&K G11s in total).[18] A current day examination of this technology is again being seriously pursued under the auspices of the Joint Services Small Arms Program Office. In the most recent version of the Joint Service Small Arms Master Plan (JSSAMP), approved 18 November 2003, the following comments are outlined in the introduction:

> "Although the current small arms weaponry is the finest and most effective yet produced, rapid technology advances have caused a large gap to exist between the performance of the current family of weapons and the potential weapon capability."[19]

In delineating future technologies of greatest interest for advancement and realizing resulting capabilities, the JSSAMP makes the following statement regarding caseless ammunition:

> "New weapon mechanisms providing increased cartridge case support, obturation[20], and positive feeding and ejection will allow the use of lightweight ammunition concepts that are not possible in current weapon configurations. Low recoil and recoil mitigating mechanisms can also reduce weight. These technologies offer significantly lighter ammunition and simple lightweight mechanisms designed specifically for the ammunition concept. Ammunition is a significant weight burden to the dismounted combatant. These system concepts offer the potential to significantly reduce the dismounted combatant's combat load, thus affording increased mobility, survivability, and sustainability."[21]

In recognition of these benefits that caseless ammunition can offer, the U.S. Army's Armament

Research, Development and Engineering Center (ARDEC) has built and tested a Lightweight Machine Gun (LMG) demonstrator using newly engineered caseless 5.56mm ammunition.[22] (See Figure 3) This 5.56mm LMG system is meant to demonstrate the benefits of caseless ammunition technology through a direct comparison with the current 5.56mm FN M249 Squad Automatic Weapon system. The M249 system with 600 rounds of 5.56mm cartridge ammunition weighs 38.3 pounds, and the LMG demonstrator system with 600 rounds of 5.56mm caseless ammunition weighs 18.6 pounds, an aggregate weight savings of 52%.[22] This caseless LMG system is currently undergoing more development and testing, but already the potential that modern caseless ammunition has demonstrated in improving existing weapons design shows immense promise in regards to reducing the individual infantryman's combat load, as well as providing weapons systems that are more durable and effective (in regards to increasing the probability of a first round hit).

Caseless Ammunition Implications for Future Tactics

Lighter and more effective future small arms systems (weapon, attachments, and ammunition combined) utilizing improved ammunition technologies outlined above will realize two major advantages for the future infantryman. First, through improved weapons design, he will be better able to control the fires of these future systems, and therefore increase the probability of a first-round hit on a target. This means it will not require as many rounds of ammunition to neutralize a target. It will also enable the individual infantryman to put out a higher volume of accurate fire that was once only possible with heavy automatic rifles and light machine guns. These combined factors will allow teams and squads to maneuver against an enemy without requiring additional heavy automatic weapons or light machine gun teams, as is the case in current tactics, thereby increasing his effectiveness. Secondly, the decrease in the weight of future weapons systems will mean the ability to carry more rounds, thereby increasing his ability to engage more targets before being resupplied, thereby increasing his efficiency. This will enable the future infantry force to sustain offensive actions longer, due to increased individual and unit lethality.

The design of caseless ammunition also offers other advantages in addition to those in the tactical realm, specifically in regards to safety of the individual. HITP, with its significantly higher cook-off temperature compared to standard nitrocellulose based propellant, has a better ability to resist accidental or sympathetic detonation. This means that caseless rounds will resist impacts better while being carried by individuals, while being stored in Ammunition Storage Points (ASP) subject to enemy fires, or while being transported to and from an area of conflict. Additionally, caseless ammunition design, with the projectile surrounded by propellant, also means almost no likelihood of a cooked-off projectile obtaining any velocity and injuring bystanders if it does ignite outside of a firearm.

Potential Concerns

As successes have been made in recent years to reduce the load of the individual soldier by developing and fielding lighter and more effective small arms and light weapon systems, there have been disturbing side effects. Recently, an increasing number of study groups and activist organizations have brought the issue of children soldiers into the spotlight of the public consciousness. Distinguished individuals, such as Peter W. Singer (Senior Fellow for Foreign Policy Studies at the Brookings Institute), highlight the problem that a "proliferation and technological advancement of personal weaponry" causes in regards to enabling the "transformation of children into fighters equally as lethal as any adult."[23] The author is cautiously optimistic that with advancements in small arms technology, commensurate steps will be taken in order to ensure that technologies are developed to ensure only proper, legal combatants are able to obtain and operate these developing advanced, lightweight systems.

Precision Bursting Munitions

As mentioned previously, one of the disadvantages for direct fire weapons systems (both current and the projected caseless versions) is in the "dead space" that the flat trajectory rounds leave uncovered. This dead space allows an enemy to use terrain to provide cover to his advantage, such as using gullies or small draws to maneuver close to our defensive positions while avoiding the deadly effects of our direct fire weapons. Additionally, our potential future adversaries will continue the trend of taking advantage of the asymmetrical advantages that urban terrain affords them, both in terms of cover and concealment as well as in exploiting the very real potential for increased collateral damage in these areas. Along these lines, a 1986 "Small Arms System 2000" (SAS-2000) study by the US Army Infantry School at Ft. Benning opined that despite future trends towards caseless and fleschette ammunition (researched and developed under the ACR program as mentioned above), conventional small arms had reached their technological peak. The study proposed that the only way to increase the probability of a first round hit with future small arms was to introduce a weapon that would fire explosive and fragmentation warheads, in combination with smart fusing and sighting/aiming technologies.[24]

The Joint Services Small Arms Master Plan (JSSAMP) outlines the desire for similar technologies in the 18 November 2003 version of the Master Plan, specifically mentioning the goals to "achieve improved effects on point, area and defilade targets", "reduce collateral damage", and to "improve target acquisition over longer ranges."[25] The 2003 Master Plan continues more specially along these lines by stating that the "Services envision that precision bursting munitions systems will provide the desired leap ahead in lethality and overmatch capability, with increased survivability."[26]

Current Precision Bursting Munitions Programs

To overcome these challenges, military Science and Technology (S&T) money has been used to direct efforts at developing Precision Bursting Munitions, or PBMs. These munitions utilize micro- and nano-scale components, as well as advancements in explosive formulations to produce lighter, more lethal programmable munitions. Over the last decade, major advancements have been made in the areas of miniaturization and hardening of electronics, as well as explosive charge designs. The Defense Advanced Research Projects Agency (DARPA) has invested heavily in several related PBM systems technologies in the last few years, providing seed money to kick-start advances in Microelectromechanical Systems, or MEMS, as well as advancements in other areas such as explosive formulation and sensing technologies in order to realize the potential that PBMs offer the future infantryman. The benefits projected from these advances showcase a smaller, more deadly programmable bursting munition that can be employed in a variety of ways.[27]

Developments of small arms systems that will utilize these PBMs to cover dead space and have effects on targets behind cover are already underway, with the JSSAP and ARDEC as the program manager. One current program is the Objective Individual Combat Weapon (OICW), which produced a prototype in 1999 for an Advanced Technology Demonstration (ATD) in 2002. The OICW is capable of firing kinetic energy projectiles (traditional bullets) and air-bursting fragmentation munitions. It enables the infantryman to effectively attack targets at greater ranges, and to attack targets in defilade or direct fire weapons dead space.[28] (See Figure 4A & 4B) During the demonstration phase, the OICW demonstrated an individual weapon capable of hitting obscured targets with a 300-500% increase in probability of hit and increased effective range of 1000 meters.[29] Another current program is the Objective Crew-Served Weapon (OCSW), which also saw a demonstrator system constructed for the 2002 ATD. (See Figure 5) This prototype effectively showcased some characteristics of the next generation of crew-served weapons, with improved combat effectiveness over the current generation of infantry dismounted crew-served medium and heavy machine guns. One of the most prominent characteristics was a dramatically reduced weight of 65-75% over the weapon systems it is meant to replace, such as selected M2 machine guns, MK19 grenade machine guns and M240 machine guns.[30]

Precision Bursting Munitions Implications for Future Tactics

The key capabilities that these systems promise for the future infantryman are the ability to engage targets in defilade or behind cover, and to do so with reduced weight and with improved accuracy and range. Additionally, these systems give the infantryman a much more responsive explosive punch than current indirect fire means. These factors also contribute to the infantry small-unit's efficiency and effectiveness, respectively. Tactically, these types of systems will enable quick, timely precision strikes against an enemy hiding behind cover or utilizing the dead space of direct fire weapons systems to try and maneuver against or away from our infantry. This capability will be extremely important in urban areas in the future, especially in regards to reducing the immense amount of collateral damage that current weapons produce in this environment.

From World War II to modern-day battles in Operation Iraqi Freedom, infantry attacking in urban areas often have to resort to the use of increasingly larger weapons systems to neutralize a determined foe fighting from within built-up areas. Presently, the U.S. Marine Corps has few weapons choices with which to engage an enemy established in urban structures with an eye to reducing collateral damage. Two current systems include the family of 40mm grenade launchers (low velocity: M-79 & M203; and high velocity MK-19) and the 83mm Shoulder-launched Multi-purpose Assault Weapon (SMAW). However, neither of these current systems have the ability to tailor the detonation range of their projectiles as the future Objective Individual and Crew Served systems do. If these current smaller systems do not work, the alternatives include the M1-A1 Abrams Tank with 120mm Main Gun round, or precision strike with attack aviation assets. Both of these larger systems cause extensive collateral damage, as one might expect. The use of indirect fire systems in urban environments is extremely troublesome, due to the vast amounts of overhead cover and the far greater potential for collateral damage due to the lack of precision capability in the current family of mortars and artillery (except for the 155mm Copperhead Round, which is extremely costly both in regards to the artillery battery's dedication to the mission and actual cost of the round). The new Objective family of rounds, with their increased capability due to improved microelectronics and tailorable fusing, will enable the future infantry a much greater ability to precisely and quickly engage targets in defilade or behind cover at greater distances. Coupled with current advances in sensor and unmanned optical tracking technologies, the future infantry force will be able to quickly and precisely eliminate increasingly troublesome enemy threats, no matter where they hide.

SUMMARY

With the combination of improved weight savings and future weapons design improvements from caseless ammunition and the tailorability of precision bursting munitions, future infantry forces will be able to capitalize on the greater measures of effectiveness and efficiency that these systems will deliver in the tactical realm. Through the use of caseless ammunition technology, the future infantryman be able to carry more ammunition, and will employ a weapon system that is more accurate, durable, and easier to maintain. Further, precision bursting munitions will enable future infantry forces to organically engage enemy forces in defilade or behind cover without having to coordinate supporting arms. These tactical enhancements will also cause measurable positive changes in the operational realm, whether through the increased tactical range for future infantry units or by realizing reductions in collateral damage. Additionally, the effective combination of these future small arms and light weapons capabilities should allow the infantry battalion to reduce the number of personnel required to man the current heavier crew-served weapon systems, such as mortars and heavy machine guns, and allow more infantrymen to be able to execute the mission to locate, close with and destroy the enemy by fire and maneuver.

Finally, through creating more effective and efficient weapons systems for the future infantryman, caseless ammunition and precision bursting munitions technologies will help enable such concepts as Distributed Operations, as alluded to in this excerpt from the U. S. Marine Corps Concept for Distributed Operations:

> "**Fires**. Distributed operations by networked forces will potentially generate significant amounts of actionable intelligence. Small units will exploit this intelligence by using both *enhanced direct fire capabilities* and *supporting arms* to neutralize or destroy much larger hostile forces."(emphasis added)[31]

In conjunction with improvements in long-range indirect fires and counter-fires, the use of improved infantry weapons systems utilizing caseless ammunition and precision bursting munitions technologies will enable the future infantryman to project power deeper into the battle space before needing to be resupplied. This fact will also assist small units in remaining undetected for longer periods, and better able to achieve stealth in order to avoid detection until it is time to unleash their firepower on an unsuspecting enemy.

All of these positive potential effects (increased tactical and operational effectiveness, potential infantry force restructuring, and contributing to enabling future concepts such as Distributed Operations) show the great potential that continued investment and development of caseless ammunition and precision bursting munitions technologies herald for the future infantryman.

FIGURES

Figure 1A Heckler and Kock 4.7mm G11 automatic weapon system, exterior view

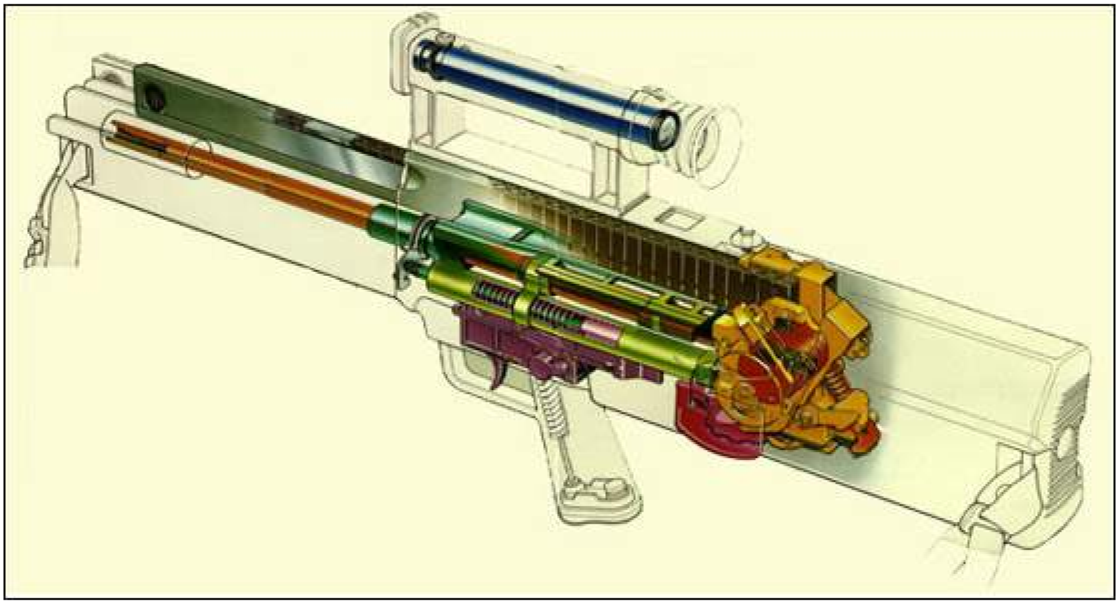

Figure 1B Heckler and Kock 4.7mm G11 automatic weapon system, internal view

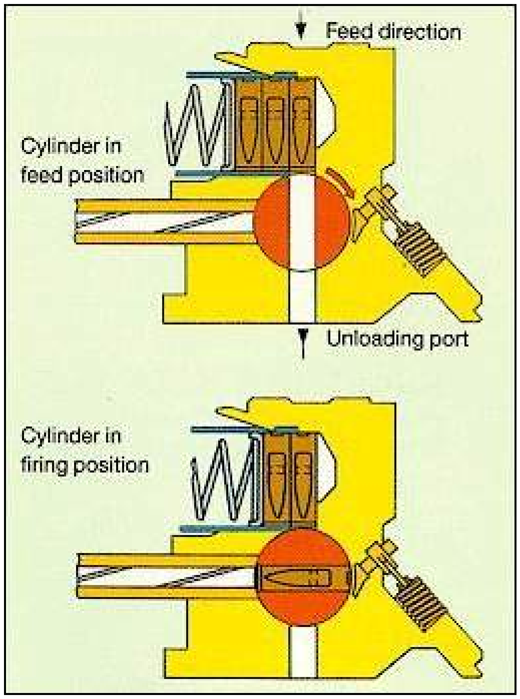

Figure 2 Schematic of 4.7mm H&K G11 bolt and feeding system.

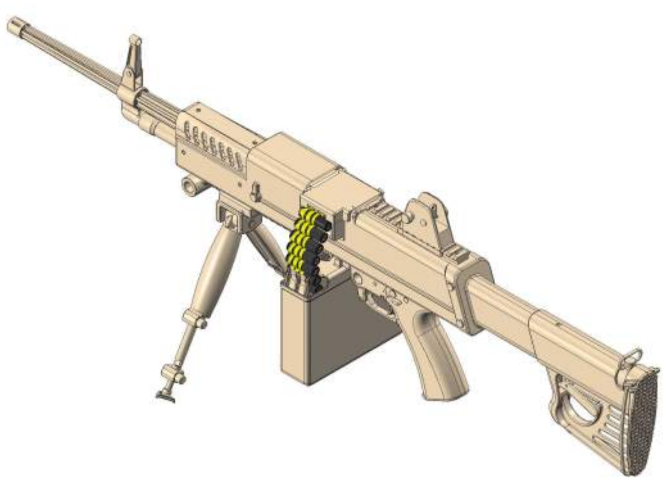

Figure 3 ARDEC 5.56mm Caseless Ammunition Lightweight Machine Gun

Figure 4A Objective Individual Combat Weapon (OICW) System Prototype

Figure 4B Objective Individual Combat Weapon (OICW) System Prototype

Figure 5 Objective Crew Served Weapon (OCSW) System Prototype

ENDNOTES

[1]USMC INFANTRY CAPABILITIES BRIEF for LtGen Amos, USMC, DC CD&I, 9 Nov 2006
[2]LIGHTWEIGHT SMALL ARMS TECHNOLOGIES program report, by Ms. Kori Spiegel (ARDEC) and Mr. Paul Shipley (AAI Corporation), dated 11 Nov 2006, pg. 1.
[3]Ibid.
[4]Phone Call to PM, Marine Expeditionary Rifle Squad, MarCorSysCom, 15 Nov 2006.
[5]JOINT SERVICE SMALL ARMS MASTER PLAN (JSSAMP), signed 18 Nov 2003, page 7.
[6]Ibid, pages 7-8.
[7]A Concept for Distributed Operations, signed by General M. W. Hagee, 25 April 2005, page II.
[8]THE GUN THAT NEVER WAS: Heckler & Kock G11 hosted by Military.Com Web Site (http://www.military.com/soldiertech/0,14632,Soldiertech_G11.html).
[9]Ibid.
[10]Ibid.
[11]Ibid.
[12]Ibid.
[13]Ibid.
[14]Ibid.
[15]Ibid.
[16]Ibid.
[17]Phone Call to Ms. Kori Speigel, US ARMY ARDEC, 15 Nov 2006.
[18]THE GUN THAT NEVER WAS: Heckler & Kock G11 hosted by Military.Com
[19]JSSAMP, signed 18 Nov 2003, page 5.
[20] *Obturation:* to close (a hole or cavity) so as to prevent a flow of gas through it, esp. the escape of explosive gas from a gun tube during firing
[21]JSSAMP, signed 18 Nov 2003, page 13.
[22]Lightweight Small Arms Technologies (LSAT) brief to NDIA, by Ms. Kori Spiegel (ARDEC) and Mr. Paul Shipley (AAI Corporation), dated May 2006
[23]Child Soldiers; The New Face of War, by Peter W. Singer, hosted by American Federation of Teachers Web Site (http://www.aft.org/pubs-reports/american_educator/issues/winter05-06/singer.htm)
[24]Small Arms and Light Weapons (SA/LW), hosted by GlobalSecurity.Org Web Site (http://www.globalsecurity.org/military/systems/ground/small-arms.htm)
[25]JSSAMP, signed 18 Nov 2003, page 4.
[26]Ibid., page 9.
[27]2006 DARPA FACT FILE: A Compendium of Programs. Defense Advanced Research Projects Agency (DARPA), dated June 2006.
[28]Objective Individual Combat Weapon (OICW), hosted by Federation of American Scientists Web Site, (http://www.fas.org/man/dod-101/sys/land/oicw.htm)
[28]Small Arms and Light Weapons (SA/LW), hosted by GlobalSecurity.Org Web Site (http://www.globalsecurity.org/military/systems/ground/small-arms.htm)
[29]Ibid.
[30]A Concept for Distributed Operations, signed by General M. W. Hagee, 25 April 2005, page VII.

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http://www.military.com/soldiertech/0,14632,Soldiertech_G11.html