

Automatic Rifle Concept: Part I—History and Empirical Testing

by CWO3 Jeffrey L. Eby

Those German units fortunate enough to have officers who understood the effect of modern firepower went into battle in dispersed skirmish lines, with as many as six meters between each man and with each man granted the freedom to make use of whatever cover was available during his forward movement.¹

—Bruce Gudmundsson
Stormtroop Tactics

The relationship between the lethality of weapons and the dispersion of the troops found on the same battlefield has been a consideration for commanders since man first engaged in combat. From the Spartan phalanx to German stormtroop operations, combat leaders have been forced to adjust their tactics to the technology of the day. The dispersion of the troops has always been a critical aspect of the tactics employed. As the lethality of weapons has increased so has the dispersion necessary to preserve combat power.

History

Throughout history, advances in technology have driven tactical changes. As smaller units of combatants have gained greater firepower, dispersion has become a critical function of survivability on the battlefield. Dispersion is not merely a function of physical distance between elements but also incorporates the elements of mobility, command, and control. One end of the spectrum of dispersion is a massed armed force in physical contact, slow to move, and under the direct observation and control of its senior leader. The opposite end of the spectrum is a force of individual skirmishers moving quickly and guided only by a general intent. Commanders have continually adjusted the deployment of their forces in order to most effectively bring fire to bear on the enemy while simultaneously attempting to minimize the effects of enemy fire on their own forces.

The combatants of World War I learned a number of lessons as they attempted to resolve how to increase dispersion in the face of increased firepower, while still maintaining some type of control over their squads and platoons. By increasing the training standards of the individual soldier they hoped to enable themselves to decentralize command and increase dispersion.² Better trained soldiers could operate more effectively without direct supervision.

Realizing that coordinated rushes drew fire, soldiers began advancing using stealth, microterrain, and individual rushes.³ The development of a light machinegun and trench mortar—fielded at the squad level—increased the unit's firepower without having to resort to linear formations of riflemen.⁴ Without the need to “build up the skirmish line,” squads could maneuver freely, furthering dispersion while maintaining offensive momentum.⁵

By the beginning of World War II almost all combatants possessed squad organizations built around light machineguns and automatic rifles (ARs). Armies fielded units capable of the dispersion necessary to survive and operate on this new, more expansive battlefield in both offensive and defensive operations.

As World War II progressed, American Army and Marine Corps squads focused on gaining further firepower that improved their survivability and allowed for further dispersion and movement. Army experiences in the bocage country of Normandy and the woods of the Huertgen forest led to two and even three Browning ARs (BARs) at the squad level. The American “light” machinegun—a water-cooled, .30 caliber model—could not be used in the assault due to its weight.⁶

The Marine Corps developed the fire team concept. As early as the Corps' Nicaragua experience, Marines recognized the need for a squad-level automatic weapon.⁷ Through World War I and into the Pacific campaigns of World War II, Marine Corps squad development continually evolved toward smaller maneuver elements, each armed with an AR. In keeping with the “triangle” concept, the Corps finished World War II with the 3 fire team, 13-man squad still utilized today.⁸

By Vietnam the Marine Corps rifle squad lost the BAR as an AR largely due to logistical, vice tactical, concerns.⁹ Attempts to replace the BAR with a modified M14, a never fielded M15, or the M60 medium machinegun proved to be failures.¹⁰

After the Vietnam War the Marine Corps led development of the M16A2 to replace the M16A1. However, with the loss of the M16A1's full automatic capability, even the fiction of an AR at the fire team and squad level disappeared.¹¹ As the M16A2 was fielded the Marine Corps searched for an available weapons system to fill in the AR void. While some testing apparently occurred, the vagaries of the contracting system and the urgency of fielding demands led to the selection of the FN Minimi light machinegun—the M249 squad automatic weapon (and the introduction of the term “SAW” to the Marine Corps lexicon).¹²

The Assessment

The relationship between lethality and dispersion has recently come under scrutiny in the context of a debate over the role of the M249 SAW within the Marine rifle squad and the need for a true automatic weapon in the infantry. Two articles will discuss the role of the M249 SAW, the need for a true automatic weapon in the infantry, and the constrained reorganization of the infantry company to best utilize the strengths of organic weapons systems. This article will address the relationship between lethality and dispersion, examine the historical background of the AR,

and provide the results of a 1st Marine Division (1st MarDiv) sponsored assessment of three ARs and the M249 SAW.

In May 2001 the 1st MarDiv commissioned a study tasking 2d Battalion, 7th Marines to execute a quantitative and qualitative assessment of several AR candidates alongside the M249 SAW. The objective of this assessment was twofold:

- Determine if the AR is more effective than the SAW in an operational environment during day, low-light, and night in selected offensive and defensive operations.
- Evaluate the SAW through organizational change by considering constrained reorganization that will experiment with a SAW consolidation within the infantry squad and platoon.

Once the quantitative results were obtained (detailed results are included in this article), the battalion attempted to answer the following two questions:

- Will the inclusion of the AR in the infantry squad and the consolidation of the SAW at the squad level enhance the effectiveness of the platoon?
- Will the inclusion of the AR in the infantry squad and the consolidation of the SAW at the platoon level enhance the effectiveness of the company?

In attempting to answer the two questions above, several other questions were generated that created more debate on the utility of the SAW and its role in the battalion and the role of the AR in the fire team. The debate centered on the following:

- Should the M249 be replaced outright or have its role tailored to meet its capabilities (light machinegun or AR)?
- Can the historical progression of increased lethality be forwarded and, if so, how?
- How or should the Marine Corps rifle squad and platoon be organized to maximize strengths and minimize weaknesses of the SAW, increase dispersion in the face of the new lethality that might be developed with more automatic weapons in the rifle squads, and take advantage of new technologies?

Before the assessment began the following generally held weapons definitions were adopted. A machinegun is a weapon possessing interchangeable barrels in order to allow continuous high-volume fires. The high volumes are achieved by using belt-fed ammunition. The machinegun will have an effective range beyond that of rifles as impacts of rounds can be directed onto targets by other members of the machinegun team.

An AR will be designed around the battle rifle of the infantry (currently the M16A2) but may come with a heavy barrel to retard heat buildup. It will be magazine fed and possess the capacity to be employed in a fully automatic role. The effective range of the AR should be comparable to the rifle. According to Chuck Taylor, author of *The Fighting Rifle*:

The automatic rifle is a small arm intended for short-term automatic fire missions against point targets. It is incapable of sustained automatic fire due to the lack of a quick-change barrel, which in turn, causes overheating, and the removal of the weapon from serviceable status. The AR is also fed from a detachable box magazine, not a belt, as is a true machine gun. Automatic rifles are NOT machine guns!¹³

An AR should be employed by an individual shooter and used in close combat. The AR, with its lower rate of fire, buffer spring, and greatly reduced recoil, gives added advantage of accuracy and shooter endurance. Unlike a light machinegun, an AR is designed to engage point or small area targets. It is intended to be a "mobile base of fire" around which the fire team maneuvers. The AR provides the maneuver element itself with an organic, moving volume of fire in the attack.

Only infantry could gain ground. To make possible the advance of infantry in such circumstances required that some weapon, dominant in its firepower, readily mobile, extremely accurate at short range, capable of being handled by one man and easily concealed, should be available to fill in the gap between the lifting of the artillery barrage and the moment at which the arme blanche could be used.¹⁴

Based on the generally held weapons definitions adopted, three ARs were acquired off-the-shelf to participate in the assessment with the M249 SAW. These three weapons were the Colt AR, the Ultimax 100 (manufactured by Singapore Arms), and the Heckler & Koch (HK) G36.

The Weapons

The Colt is a variant of the current M16A2 with the exact same sights and commonality of parts. The Colt AR weighs 15 pounds—8 more pounds than the M16A2. The additional weight is due primarily to a heavy barrel intended to retard heat buildup. Other alterations include a pistol grip attached to the fore end, a hydraulic buffer to retard recoil and rise, and a design change enabling the automatic variant to fire from the open bolt, reducing the possibility of cookoffs from excessive heat buildup. The Colt has a rate of fire of 650 rounds per minute.

The Ultimax 100 is similar in look to the M249 SAW. Like the SAW it fires from the open bolt but does not possess a spare barrel and is fed by magazine only. Because it weighs only 9 pounds, shooters can easily employ the Ultimax in a variety of methods. An adjustable gas regulator with 3 settings allows for a rate of fire varying from 450 to 600 rounds per minute.

The HK is a lightweight rifle capable of being fired in a fully automatic role from the closed bolt. The version tested had optical sights with an over/under system. The lower sight system has a 3.5 magnified scope with multiple crosshairs. The upper system was an aim point dot variation for limited visibility shooting. Total weight of the weapons system tested was 7 pounds. The rate of fire is 650 rounds per minute.

Testing

Phase I began 21 July 2001 with the receipt of the test bed of ARs. Forty-eight Marines en route to the battalion from their recent graduation at the School of Infantry were selected as the test bed shooters in order to eliminate as much preexisting bias concerning the SAW as possible. The tradeoff for using new Marines was a lack of marksmanship understanding and a failure to grasp open-bolt firing concepts. The 48 Marines were divided into four 12-man squads labeled A, B, C, and D. Marines in each squad were then numbered 1 through 12. Each squad

was armed with one of the four weapons systems (Colt, HK, Ultimax, and SAW). Each weapon was then zeroed to the individual shooter. Once a weapon was zeroed to a specific Marine, the other three Marines in his number series would shoot for an offset aim point; i.e., shooter A1 zeroed the SAW and then shooters B1, C1, and D1 used offset aim points for the SAW. All number one shooters would shoot all four of the number one weapons on each test. This allowed a much quicker transition from weapon to weapon throughout the test.

Eight separate tests were designed to assess the accuracy of the three AR candidates and the SAW in various operational situations. The main focus of these tests was to determine if the ARs were more accurate than the SAW in various attitudes, ranges, and conditions.

Class	SAW	Colt	Ultimax	HK
1st	2	7	1	2
2d	8	19	10	6
3d	19	12	12	7
4th	19	10	25	33

Table 1. Test 1 results.

Test 1 was the M249 SAW paper qualification course fired from 36 yards. The purpose of this test was to use the M249's strongest event to establish a baseline for comparison. The other weapons would compete against the SAW in its most favored environment. The most accurate weapon for this event was the Colt and the least accurate the HK. Table 1 shows that shooters using the Colt qualified in the first or second class two and a half times higher than shooters using the other weapons.

Test 2 was a quick-kill course established at Range 105A. Shooters engaged three targets from the standing, kneeling, and prone positions with nine rounds in a time frame of 20 seconds. A target hit was valued at 1; a miss was valued at 0. The quick-kill targets were established at ranges of 25, 50, and 100 yards. The purpose of Test 2 was to determine the accuracy of the weapons in the critical, last 100 yards of an assault. The Marines used all of the field firing positions to duplicate the firing methods of combat Marines in urban or jungle warfare. Table 2 shows the results of Test 2.

25 Yards				50 Yards				100 Yards			
Weapon	Hits	Rounds	Accuracy	Weapon	Hits	Rounds	Accuracy	Weapon	Hits	Rounds	Accuracy
SAW	130	432	30.09%	SAW	119	432	27.55%	SAW	100	432	23.15%
Colt	161	432	37.27%	Colt	161	432	29.86%	Colt	176	432	40.74%
Ultimax	130	432	30.09%	Ultimax	130	432	24.54%	Ultimax	131	432	30.32%
HK	139	432	32.18%	HK	139	432	28.94%	HK	120	432	27.77%

Table 2. Test 2 results.

During Test 2 minor issues developed with each of the weapons systems. Shooters repeatedly had negligent discharges with the Colt, attributable to the Marines forgetting the difference between the closed-bolt M16A2 and the open-bolt AR. The young Marines kept riding the bolt home on a live round, thereby firing the round. With the Ultimax, the shooters realized that the sights were set too low in the rear. Once they achieved stock weld the sights proved to be lower than the eye could see, forcing stock weld to be broken and causing the shooter to search for the sights. With the HK the 3.5 power magnification proved too much at 25 and 50 yards but beneficial at 100 yards. Overmagnification at shorter ranges slowed down the presentation of the weapon onto the target. For the M249 SAW, the weight and length in general made this an extremely cumbersome weapon in field firing positions. Another problem resulted from the commonality of the Colt AR and the M16A2. The familiarity led to initial accuracy, as the young Marines had not yet become familiar with the other weapons.

Figure 1. Extracted Table I from FM 23-9.

RD	Range (M)	Time (Sec)	RD	Range (M)	Time (Sec)
1	50	3	11	100	8
2	200	6	12	200	
3	100	4	13	150	10
4	150	5	14	300	
5	300	6	15	100	9
6	250	7	16	250	
7	50	3	17	200	6
8	200	6	18	150	5
9	150	5	19	50	6
10	250	7	20	100	

Weapon	Hits	Rounds	Saved Rounds	Accuracy
SAW	231	1920	1	12.04%
Colt	427	1920	64	23.00%
Ultimax	368	1920	69	19.88%
HK	386	1920	173	22.10%

Table 3. Test 3 results.

Test 3 was fired from the prone position, using bipods for stability, engaging popup targets ranging in distance from 50 to 300 meters, with a varied time limit (See Table 3.) A 20-target exposure using 40 rounds was fired from *Field Manual 23-9 (FM 23-9)*, *M16A1 and M16A2 Rifle Marksmanship* Table I. (See Figure 1.) This evaluation determined quick reaction from a defensive position to an attacking enemy.

Figure 2.

Task	Range (M)	Time (Sec)	Rounds
1	200	5	6
2	300	10	6
3	100	10	6
4	300	15	6
5	100, 300	20	12
6	200, 300	20	12
7	100, 200, 300	25	18

Test 4 occurred on the same range as Test 3, firing Table II of *FM 23-14, M249 Light Machinegun in the Automatic Rifle Role* (see Figure 2), the SAW transition course of fire. A shooter in the prone position with 66 rounds engaged popup targets ranging in distance from 100 to 300 meters with a varied time limit. (See Table 4.) This test again gave the M249 the benefit of the doubt by firing a course of fire designed for the light machinegun. However, the only weapon that could qualify as a light machinegun, the M249 SAW, posted the worst results.

Weapon	Hits	Rounds	Saved Rounds	Accuracy
SAW	279	3168	327	09.82%
Colt	384	3168	580	14.84%
Ultimax	323	3168	642	12.79%
HK	330	3168	338	11.66%

Test 5 was fired using long-range popup targets without team leader assistance. Targets ranged from 250 to 800 meters. (See Figure 3.) Testing employed a 20-target exposure firing 100 rounds per weapon from a supported prone position with varied time exposures. (See Table 5.)

The results from Test 5 identified difficulties for a single shooter to engage targets beyond 300 meters. To effectively and accurately engage targets at these ranges, weapons systems need to be operated by a team, fired from a tripod, and assisted by team leaders using magnified optics.

Tests 6 and 7 (see Tables 6 and 7 for test results) consisted of field firing at elevated targets (simulating urban patrol engagements) placed at distances of 100 to 150 meters. The targets were automated, three-dimensional "Ivan" popup targets. A 5-target exposure was used and engaged with 15 rounds with no time limit, but total time for each shooter was recorded. Shooters fired from standing and kneeling positions with and without the field protective mask.

Test 8 consisted of night fire on an automated range with targets arrayed from 75 to 300 meters. (See Figure 4.) Ambient light was less than 20 percent. All weapons were zeroed with PEQ-2s using the laser bore light prior to the range. (See Table 8.) The Ultimax 100 was not tested because there was no way to mount the PEQ-2 to the weapon.

The final evaluation of the assessment was aimed at capturing intangible characteristics and qualities of the weapons that numeric data could not capture. Marines involved in the test filled out a shooter evaluation questionnaire that attempted to capture the intangibles of each weapon. The comparison of these questionnaires with actual range performance produced some interesting results. On average, during Tests 1 through 4 the 48 shooters preferred the weapons in the following order: Ultimax 100, HK, Colt, and M249 SAW. The questions on the questionnaire focused on nine areas: (1) overall performance, (2) using system sights, (3) detecting and identifying targets, (4) adjusting windage, (5) adjusting elevation, (6) adjusting weapons zero, (7) maintaining zero, (8) malfunctions, and (9) stoppages. Even though the Colt fired the most accurately in most stages, it was next to last in shooter preference.

Recommendations for modifications were requested for each of the weapons systems. The M249 and Colt were viewed as too heavy. The HK failed to stay on target in burst fire while the Ultimax sight system did not present to the eye at all. When the shooter laid his cheek on the stock of the weapon and achieved a proper stock weld he found the sights of the weapon lay below the line of sight capability of his eye. Accuracy—although according to raw data better than the current M249 SAW in every test—was of such a limited amount as to be statistically insignificant. Only on Test 3 did any weapon outperform the SAW by more than 10 percent accuracy.

"Automatic fire is inherently less accurate than semiautomatic fire."¹⁵ The difficulty becomes achieving a balance between weapons that provide a combination of the accuracy of semiautomatic fire while maintaining the ability to employ full automatic fire when required. This is the reason the Marine Corps modified its BARs so they could fire semiautomatically—to provide both capabilities.

Infantrymen feel strongly about replacing the M249 SAW with a true AR inside the fire team but feel just as strongly about keeping the M249 SAW for its automatic fire suppressive capability. Given the results of this assessment, accuracy alone is not a strong enough reason to replace the M249 SAW. However, most would argue that accuracy was never the problem with the M249 SAW. The problem with the M249 SAW was the lack of mobility when manned by an individual while attempting to move at the pace of a rifle team.

The M249 SAW provides the accuracy that fire teams and squads require. The quantitative tests of Phase I proved the variation in accuracy between the M249 SAW and its competitors small enough to not be worth the time, money, and effort to replace it. Despite the mitigation of the accuracy issue, the M249 SAW could not meet the requirements of mobility and semiautomatic fire accuracy.

Table 4. Test 4 results.

Figure 3.					
RD	Range (M)	Time (Sec)	RD	Range (M)	Time (Sec)
1	250	10	11	400	10
2	400	10	12	500	
3	800	15	13	700	20
4	300	10	14	300	
5	500	10	15	800	20
6	700	15	16	400	
7	300	10	17	600	20
8	400	10	18	800	
9	600	15	17	300	10
10	800	15	20	500	10

Weapons	Hits	Rounds	Saved Rounds	Accuracy
SAW	148	4800	0	3.08%
Colt	219	4800	290	4.86%
Ultimax	216	4800	280	4.78%
HK	151	4800	243	3.31%

Table 5. Test 5 results.

Standing results without masks			Standing results with mask		
Weapon	Accuracy	Time (Sec)	Weapon	Accuracy	Time (Sec)
SAW	4.73%	1132	SAW	6.12%	1013
Colt	10.70%	1355	Colt	9.18%	1138
Ultimax	9.80%	1272	Ultimax	8.64%	1300
HK	13.51%	1621	HK	10.99%	1926

Table 6. Test 6 results.

Kneeling results without masks			Kneeling results with mask		
Weapon	Accuracy	Time (Sec)	Weapon	Accuracy	Time (Sec)
SAW	3.85%	1116	SAW	5.40%	1131
Colt	8.24%	1309	Colt	10.63%	1304
Ultimax	10.70%	1410	Ultimax	9.00%	1459
HK	11.22%	1490	HK	14.59%	1753

Table 7. Test 7 results.

Task	Range (M)	Time (Sec)	RD
1	200	5	6
2	300	10	6
3	100	10	6
4	300	15	6
5	100,300	20	12
6	200,300	20	12
7	100,200,300	25	18

Figure 4.

Weapon	Hits	Rounds	Saved Rounds	Accuracy
SAW	43	3102	728	1.81%
Colt	50	3102	526	1.94%
Ultimax	Not available for this event.			
HK	88	3102	641	3.58%

Table 8. Test 8 results.

Unfortunately, the competitors tested during Phase I of the AR assessment do not appear to offer what the Marine Corps needs. As stated previously, the HK failed to stay on target in burst fire while the Ultimax sight system did not present to the eye at all. The commonality of the Colt AR with the M16A2 appeared to be advantageous. Yet the Colt proved to be the only weapon that experienced negligent discharges during the firing of 120,000 rounds. This fault resulted, in part, from young Marines failing to understand the open-bolt system but also, in part, from weapon design. Open bolts are inherently dangerous. Traditionally, we fear carrying an open-bolt weapon in the condition one mode of ready to fire. The primary shooter can be trained to be safe with the weapon, but primary shooter casualties will soon place the weapons in untrained hands, quickly leading to friendly fire hazards.

Using the assessment as a "jumping off" point, at the conclusion of Phase I of the AR test, a universal need statement (UNS) was drafted and submitted through 1st MarDiv. The statement requested that the M249 be replaced with a "true" AR. The weapon envisioned would fire 5.56mm ball ammunition, be capable of receiving the M16A2's 30-round magazine, and would possess a selector lever that went from safe to automatic to semiautomatic (in that order), weigh less than 12 pounds loaded, employ sights equal to the M16A2, use clip-on bipods, and have a 450 to 600 rounds per minute rate of fire.

Phase I testing did not provide a "yes" to the original question—"is an AR more accurate than the M249 SAW?" It did, however, highlight the need for a mobile AR, capable of semiautomatic fire at the fire team level. Further, it illuminated the need to address the future employment and role of the M249 SAW light machinegun and a "true" AR in the fire teams, squads, and platoons of the Marine Corps.

Because of the results achieved in Phase I, testing carried forth with the same automatic weapons into Phase II. Experimental squad and platoon organizations were constructed in order to examine the idea of consolidating the SAWs at various levels of command. The next article in this series will fully address the AR UNS submitted by 1st MarDiv and the issues that arose from the experimental organizations.

Notes

1. Gudmundsson, Bruce I., *Stormtroop Tactics: Innovation in the German Army, 1914–1918*, Praeger, Westport, CT, 1989, p. 23.
2. Jones, Archer, *The Art of War in the Western World*, Oxford University Press, New York, 1987, p. 483.
3. English, John A. and Bruce I. Gudmundsson, *On Infantry*, Praeger, Westport, CT, 1994, p. 59.
4. *Ibid.*, p. 53.
5. Jones, p. 483.
6. *Ibid.*, p. 56.
7. English, p. 164.
8. *Ibid.*, p. 165.
9. Eby, SgtMaj John M., *Automatic Rifle Data* (e-mail to author, 24 January 2002, Marine Corps Air-Ground Combat Center (MCAGCC) Twentynine Palms), p. 1.
10. Grundy, Ray A., (e-mail to author 21 January 2002, MCAGCC Twentynine Palms), p. 1.
11. Eby, p. 2.
12. Grundy, p. 2.
13. Taylor Chuck, *The Fighting Rifle*, Paladin Press, CO, 1984.
14. Hutchinson, G.S., *Machine Guns: Their History and Tactical Employment*, 1938.
15. *FM 23–9*, pp. 4–7 and 4–8.

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>>CWO3 Eby is the Marine gunner, 7th Marine Regiment.

[Top of page](#)
[Back to Web Articles](#)