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Human factors evaluation of the optical and CLASS sights fitted to the
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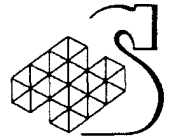
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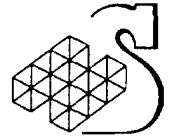


**Human Factors Evaluation of the
Optical and CLASS Sights Fitted to
the 84mm SRAAW**

**Submitted in Partial Fulfillment of
DCIEM Contract No. W7711-3-7197-05/01-XSE**

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1. Introduction

1.1. Aim

The aim of this study was to evaluate the compatibility of the M1 and U.S. PASGT helmets with the 84mm Short Range Anti-Armour Weapon (SRAAW), in each of the telescopic optical and CLASS sight configurations.

1.2. Weapon Description

The 84mm SRAAW provides the infantry platoon with an effective short range anti-tank weapon. The weapon is handled and fired by a team of two soldiers. The gun is breech loaded and percussion fired. Shoulder controlled firing can be performed from any of the normal rifle firing positions (ie. standing, kneeling, and prone). A bipod mount is provided to be used when firing in the prone position. The in-service weapon includes three types of sights: open sight, telescopic optical sight and luminous night sight.

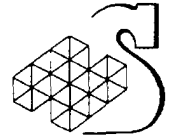
The M3 Airborne Infantry version of the 84mm SRAAW was evaluated during this trial using the telescopic optical sight and the new CLASS sight.

1.3. CLASS Sight

The Computerized Laser Sighting System (CLASS) comprises a full solution fire control system with eyesafe laser rangefinder, electro-optical module, ballistic computer and night vision device. This system integrates target information about range, movement, crossing speed and direction, meteorological conditions and ammunition characteristics, and displays target and firing data to the user through the eyepiece reticle.

The CLASS sight weighs about 5.0 kg and is mounted above and to the front of the SRAAW firing tube. The sight unit is 17.65 cm wide, 9.58 cm high and 27.75cm long, with an additional 6.65 cm for the eyepiece extension.

The CLASS sight was mounted to the M3 SRAAW using the optical sight mounting bracket. The adjustable pistol grip trigger was not installed for these tests.



2. Method

2.1. Overview

Twelve militia soldiers (11 males and 1 female), with experience firing the 84mm SRAAW, were selected from the helmet bid assessment trial to evaluate the compatibility of the M1 and PASGT helmets with the telescopic optical and CLASS sights. Subjects were required to adopt a prone firing posture and sight on a silhouette tank target. A prone firing posture was chosen as the most likely firing posture to elicit compatibility concerns with a helmet. Human Factors (HF) observers evaluated compatibility clash, firing posture, and sighting effectiveness. Subjects rated helmet compatibility with each sight condition and commented on compatibility and sighting performance issues.

2.2. Compatibility Testing Protocol

Each compatibility test began with the subject standing in a relaxed posture 1.5 meters behind the test weapon. On command from the Human Factors (HF) observer, the subject assumed a prone unsupported firing position and aimed at one of three distant targets (scaled T-54 MBT silhouette at 20 meters). HF observers balanced the sighting order among the three targets to reduce any practice effect and inspected each helmet/sight interface for compatibility concerns (Figure 1).

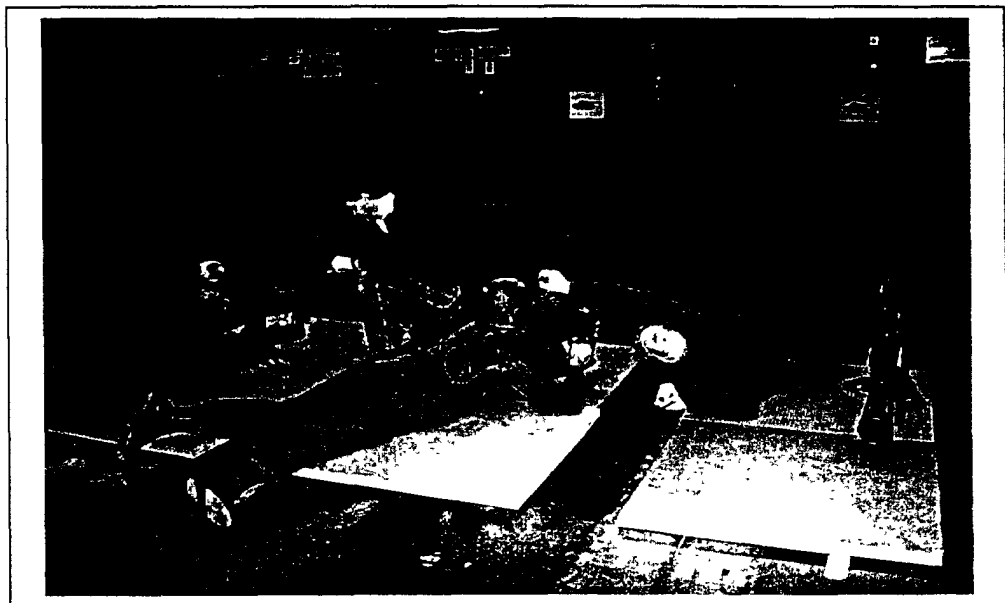
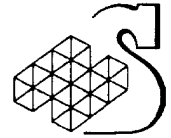


Figure 1: 84mm SRAAW Helmet Compatibility Evaluation



Time to acquire the target was recorded from the “go” command until such time as the subjects indicated they were sighted on the target and able to fire. The subject then remained in the firing posture and the following measurements were taken: helmet brim to sight eyepiece distance, helmet ear protector to barrel tube, and eye relief distance. HF observers also noted the extent of helmet brim and ear protector clash. Subjects were required to rate the compatibility of each helmet and weapon sight interface using the following seven point acceptability scale (Figure 2).

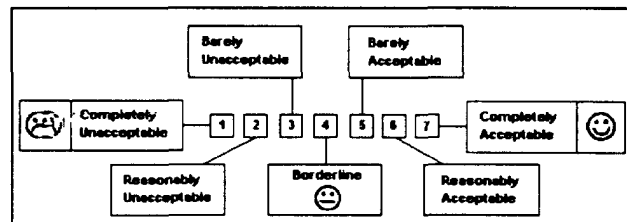
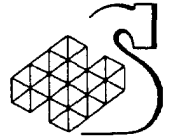


Figure 2: Standard Rating Scale

Each subject performed the test protocol first in the bare head condition to familiarize themselves with the weapon and sight, and to establish a subjective baseline for non-headwear compatibility. The order of presentation of the M1 and PASGT helmets was balanced between subjects to control for any practice effect. The order of presentation of the optical and CLASS sights was similarly balanced. Each subject performed the test protocol in each headwear and sight condition, using a repeated measures design.

Subjects were interviewed while in their firing posture to determine the sources of incompatibility (eg. clash, posture, etc), methods of user accommodation, and the effects of any incompatibility (eg. reduced sight picture, inability to position weapon, discomfort, etc).

Following testing of helmet compatibility in the prone firing posture, subjects were required to adopt a standing firing posture with the PASGT helmet for each sight condition. Subjects were interviewed regarding compatibility issues in an upright posture and HF observations were noted.



3. Results

The results of helmet compatibility with the 84mm SRAAW anti-tank weapon are described below for headwear acceptability, sighting performance timings, helmet clash and observer comments on firing postures.

3.1. Acceptability Ratings

Acceptability ratings data for compatibility are provided below for each headwear and sight combination (Table 1). Generally, regardless of the type of sight tested, PASGT helmet compatibility was rated significantly worse than the bare head and M1 helmet conditions ($p \leq .001$). As a baseline, the barehead condition was rated as *Reasonably Acceptable*. The addition of the M1 reduced compatibility to *Barely Acceptable* and the PASGT further reduced compatibility to *Borderline*.

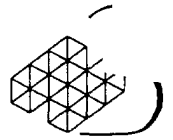
	Bare Head		M1 Helmet		PASGT	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Optical Sight	6.27	.79	4.73	1.56	3.27	1.68
CLASS Sight	6.08	1.73	5.75	1.60	4.83	1.64

Table 1: Acceptability Ratings

Bare head ratings were unchanged between the optical and CLASS sights, while ratings for both helmet conditions improved ($p \leq .01$). The largest improvement in compatibility occurred with the PASGT helmet (*Barely Unacceptable* for the optical sight to *Barely Acceptable* for the CLASS).

3.2. Sighting Timings

Sighting data (time to sight on a tank target in seconds) are provided below for each headwear and sight combination (Table 2). Sighting the weapon required significantly more time when wearing the PASGT than the M1 helmet ($p \leq .05$). Sighting times were also longer for the CLASS than optical sight when used in the bare head and M1 helmet conditions ($p \leq .05$).



	Bare Head		M1 Helmet		PASGT	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Optical Sight	5.87	1.62	5.50	1.47	7.75	2.46
CLASS Sight	6.66	1.76	6.54	1.54	7.12	2.76

Table 2: Target Acquisition Timings (seconds)

3.3. Helmet Clash

Human factors observers noted the degree of helmet brim and ear protector clash with each of the weapon/sighting systems. The following four point scale was used by each HF observer to categorize clash in terms of the subject's ability to easily position the head and achieve a good sight picture.

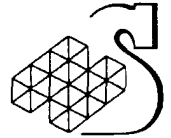
- 0 No compatibility clash.
- 1 Low. Just noticeable helmet contact.
- 2 Medium. Some difficulty positioning the head at the eyepiece.
- 3 High. Considerable difficulty positioning the head and acquiring a sight picture.

Descriptive data for these observations are summarized below (Table 3) for brim and ear protector clash, for each sight and helmet combination.

		Optical Sight		CLASS Sight	
		M1	PASGT	M1	PASGT
Brim	Mean	0.8	1.5	0.6	0.8
	s.d.	0.8	1.0	0.7	0.5
Ear Protector	Mean	1.4	2.8	0.6	1.6
	s.d.	1.0	0.6	0.5	0.8

Table 3: Clash Ratings

Brim: No significant differences were identified for the extent of brim clash between the optical and CLASS sights while wear either the M1 or PASGT helmets.



Ear Protector: For both the M1 and PASGT helmets, clash was significantly reduced from the optical to the CLASS sight. Clash with both sight systems was significantly worse for the PASGT than the M1 helmet ($p \leq .001$).

3.4 Firing Posture

Firing postures varied considerably between the optical and CLASS sights for both prone and standing firing postures.

Prone Firing: In the prone firing position, the M3 SRAAW was supported on the floor using the bipod mount. Photographs of prone firing with the optical and CLASS sights are provided in Annex A-1.

Optical Sight: Soldiers were generally able to adopt a comfortable sighting posture with the optical sight.

CLASS Sight: The CLASS sight reticle was positioned somewhat higher (1-2 cm) and further back on the firing tube (~7 cm) than the optical sight. This positional difference resulted in several postural problems during prone firing. To engage the eyepiece, subjects were required to adopt extreme head and neck extension postures. Several subjects indicated that the posture was uncomfortable and difficult to maintain or keep stable.

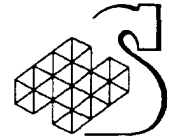
As well, with the head and shoulder carriage positioned closer to the back of the firing tube, most subjects were unable to fully grasp the front grip with their left hand. Subjects typically supported the base of the grip with extended fingers or the palm of their hand. Unable to secure the front grip, some subjects were concerned about loss of weapon control during firing.

Due to the need for compensatory trunk extension to assist in head/neck extension, the bipod mount was often lifted off the ground, no longer providing a base of support to the weapon.

Standing Firing: . Photographs of standing firing with the optical and CLASS sights are provided in Annex A-2.

Optical Sight: The lower, forward position of the optical sight, while acceptable for prone firing, posed several problems during standing firing. The location of the shoulder butt pad positioned the shoulder carriage and upper torso well back from the optical sight eyepiece. To position the eye at the sight eyepiece, subjects were required to engage in extreme head and neck flexion. In many cases, subjects were still unable to acquire a suitable sight picture. In an attempt to reduce the extent of head and neck flexion, some subjects twisted their torso into the weapon, thereby shortening the eyepiece distance somewhat. The twisted torso, however, tended to be at the expense of adequate shoulder support for the butt plate and barrel tube. As well, the need for extreme head and neck flexion also encouraged greater helmet brim clash with the sight.

CLASS Sight: Soldiers reported that they were easily able to adopt a comfortable sighting posture with the CLASS sight when in the kneeling or standing postures.



4. Discussion

Sight Compatibility: The 84mm SRAAW has long been recognized as a compatibility concern during helmet wear, when using the telescopic optical sight. This concern was evident in this study when subject ratings decreased significantly from the bare head to the M1 helmet condition. Since the M1 helmet is easy to adjust and shift on the head during sighting, compatibility was still considered acceptable. Wearing the PASGT helmet resulted in unacceptable ratings due to subject difficulties in accommodating the helmet ear protector clash with the firing tube, especially given the narrow stand-off afforded by the optical sight.

The greater stand-off position of the CLASS sight significantly reduced the compatibility clash problems between the ear protector and firing tube. As such, subjects rated compatibility with the CLASS sight as significantly improved over the optical sight, for both the M1 and PASGT helmets.

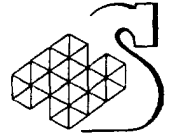
Sighting times to acquire a tank target in the bare head and M1 helmets were significantly longer for the CLASS sight than the optical sight. This small but significant difference is likely attributable to lack of subject familiarity with the new CLASS sight system. The PASGT helmet also required significantly more time during sighting than the other headwear conditions. Most of this difference is attributable to the optical sight condition where the PASGT ear protector clash often resulted in significant accommodation delays. In this context, we would consider the PASGT helmet representative of the other non-metallic helmets evaluated during the 1995 helmet bid assessment trial.

Firing Posture: During prone firing, the CLASS sight posed significant posture problems in head/neck extension and difficulties in grasping the front grip. Both factors introduced postural discomfort and problems with postural maintenance, difficulties in targeting stability and concerns with weapon control. However, the position of the CLASS sight proved well suited to an upright torso posture (ie. standing, kneeling or sitting).

The reverse was true of the optical sight. The optical sight proved best suited to prone firing but introduced significant postural and stability concerns when firing in an upright torso posture.

For either sighting system to be effective in both prone and upright firing postures, the relationship between the sight eyepiece, shoulder butt pad and hand grips must be adjustable to allow the soldier to achieve the best sight position possible to suit their individual size, shape and sighting preferences.

Any design modification to sight positioning should include a controlled human factors fitting trial with experienced SRAAW users representing a complete range of soldier sizes. Having established a preferred range of sight adjustability, prototype sight mounts should undergo controlled human factors firing trials, with experienced SRAAW users, to confirm that compatibility and performance objectives have been achieved. Firing trials could be performed either with a training simulator (eg. the DCIEM FATS facility) or live firing with full or sub-calibre rounds.



**Annes A
Firing Postures**

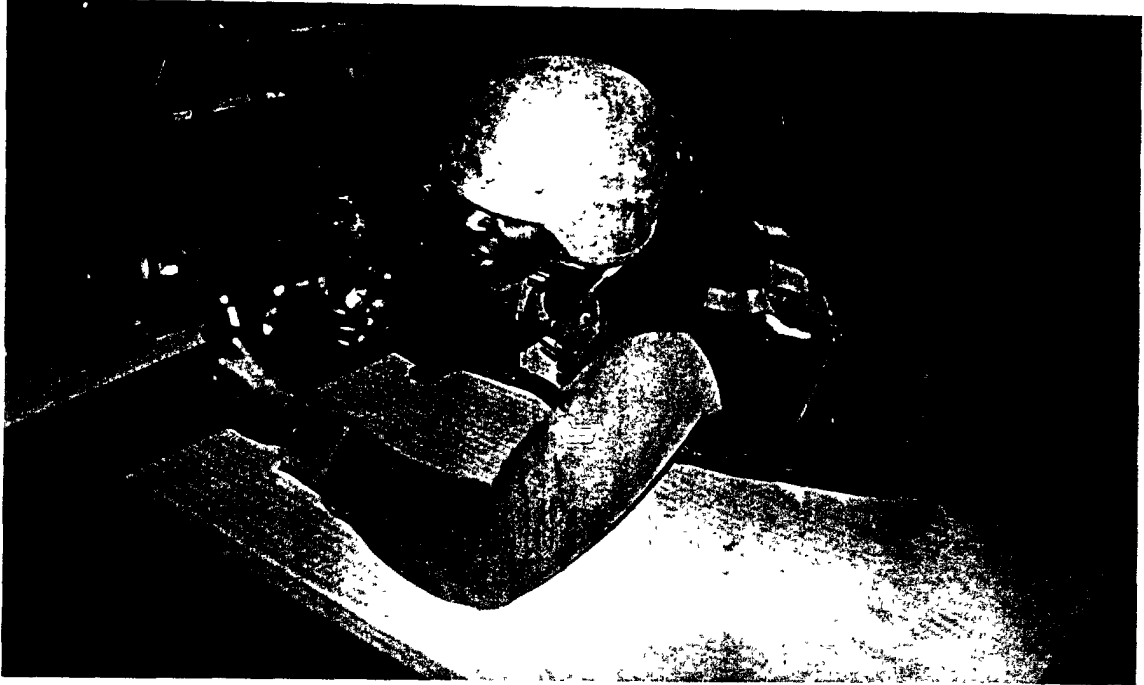


Figure 1: M3 with Optical Sight, Prone Firing Posture

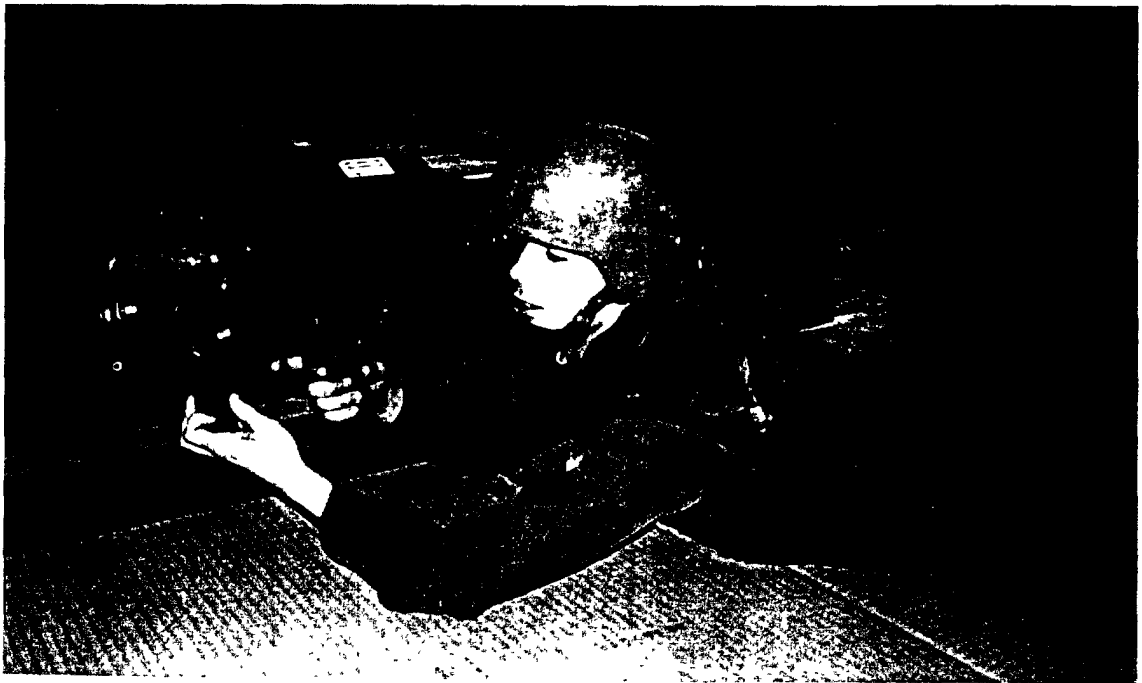
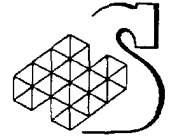


Figure 2: M3 with CLASS Sight, Prone Firing Posture



**Annes A
Firing Postures**



Figure 3: M3 with Optical Sight, Standing Firing Posture



Figure 4: M3 with CLASS Sight, Standing Firing Posture

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14. ABSTRACT

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Twelve militia soldiers (11 male and 1 female), with experience firing the 84mm SRAAW, were selected from the helmet bid assessment trial to evaluate the compatibility of the M1 and PASGT helmets with the telescopic optical and CLASS sights. Subjects were required to adopt a prone firing posture and sight on a silhouette tank target. A prone firing posture was chosen as the most likely firing posture to elicit compatibility concerns with a helmet. Human Factors (HF) observers evaluated compatibility with each sight condition and commented on compatibility and sighting performance issues.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

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