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User-based validation of future assault rifle mass properties

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time course of the cyclic firing event. Additionally, exploration of weapon design-based performance modulators, manipulation of firing instruction (e.g., accuracy/time prioritization), and manipulation of target characteristics should be examined in order to better define the performance effects of varying energy transfer to the shooter during firing.

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Purpose: The weight of soldier small arms has risen dramatically as new technologies and capabilities have been added to weapons (e.g., sensors, laser designators, aiming and illumination aids, fire control systems). Under NATO RTG-SCI-178, a number of collaborative studies were undertaken to determine the maximum acceptable weight and optimal balance for future assault rifles. Canada's Future Small Arms Research (FSAR) project has followed up with several additional studies to validate and refine these requirements.

Methods: Several user-based trials have been conducted to date, including: three live marksmanship studies, two mobility studies, and three simulated marksmanship studies. For each study, conventional assault rifles (C7A2 or M16A4) or simulated weapon weight and balance test rigs were adapted to represent a range of weapon weights (from 2.5 to 8.4 kg) at each of a range of weapon *x*-axis centres of mass (CoM) from 7 cm forward to 19 cm aft of the current weapon horizontal CoM. These were tested with and without weapon supports to a limited degree. Tasks included extended weapon hold, live/simulated close combat target engagements using pivot and turn or Mozambique drills, and obstacle or combat mobility trials in order to determine the impact of weapon weight and balance on soldier performance. Questionnaires and focus groups were used to determine user acceptance of the weapon configurations tested.

Results: The research team have been able to map out acceptable weight and CoM combinations for future assault rifles. The range of acceptable weights ranges from 1.5 to potentially 7.5 kg in weight while acceptable CoM locations range from +7 cm to −19 cm in the fore-aft direction. Generally, heavier weapon weights may be tolerated if weapon centre of mass is aft of the current weapon system. A 6.9 kg back-weighted weapon appears to be the threshold for acceptability for unsupported conditions, however it may be possible to utilize a heavier weapon with minimal decrement in shooting performance if proper weapon support is provided.

Conclusions: Findings from these studies indicate that weapon systems should avoid having a CoM forward of the CoM of current conventional assault rifles. Weapon weight should not exceed 6.9 kg if weapon supports are not employed. Higher weights are feasible but additional testing is required to validate where, in the range of 6.9 to 8.5 kg, the threshold for acceptability occurs.

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Controlled Every Soldier A Rifleman (CESAR)

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Introduction: It is a core task of military personnel to train and maintain their marksmanship skills. However, during yearly organized national shooting competitions between different infantry units it became clear that the current shooting performance is not acceptable. The reasons for the decrease of performance (i.e. relationship between quantity of used ammunition and hits/miss) are diverse. Changes of military tasks, mandates and doctrines, decrease of marksmanship training as a result of reduction of training time, facilities, ammunition, 'improvement' of technology (e.g. calibre, aiming devices) are mentioned by the instructors. As the method of the armed forces to collect and analyse technical shooting performance per marksman and group was deficient, we applied in collaboration with Defence Research and Development Canada (DRDC) and Totalförsvarets Forskningsinstitut (FOI, Swedish Defence Research Agency) a joint method to quantify shooting performance per marksman and per unit.

Methods: This included the hit probability on military targets, the lethal hit probability and the mean radius of a group of shots on different distances. Next, we compared the (technical-on shooting range) marksmanship skills of experienced (infantry), familiar (logistics) and novice (recruits; before and after marksmanship training). Furthermore, we interfered into the recruit marksmanship training to be able to differentiate between recruits that are (a) only trained by a shooting simulator, (b) only trained by live-fire exercise on the shooting range, and (c) by both shooting simulator and life-fire training. We also added some extra experimental conditions during the trials with the expert and familiar marksmen, such as the impact of personal protective equipment (with and without protective vest), shooting positions (kneeling vs prone), and physical and mental load conditions (snap shooting within 4 s and running before shooting).

Results: The results showed that without induced pressure the experts and familiar marksmen showed only minor differences in their (technical-on range) marksmen skills. As soon as pressure was induced, the differences between the units increased. Initial analyses of the current recruit trials revealed that the recruits already achieved a reasonable level of marksmanship performance at the beginning of their basic military training; and that the performance of simulator group did not differ significantly from the live-fire group performances after the completion of their basic marksmanship training.

Conclusions: Results from these studies indicates that current methods for training and maintaining marksmanship skills is inadequate. Strategies are discussed for using human performance interventions to maximise skill acquisition and retention.

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The weight of soldier small arms has risen dramatically as new technologies and capabilities have been added to weapons (e.g., sensors, laser designators, aiming and illumination aids, fire control systems). Under NATO RTG-SCI-178, a number of collaborative studies were undertaken to determine the maximum acceptable weight and optimal balance for future assault rifles. Canada's Future Small Arms Research (FSAR) project has followed up with several additional studies to validate and refine these requirements.