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Operational User Requirements and Priorities for a Soldier's Integrated Headwear System

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ABSTRACT

Development of future infantry soldier systems with portable computing systems, advanced sensors, intra-section communications, head-mounted displays, and so on, has been ongoing among NATO nations for over a decade. Key to the success of any future soldier system will be the effective integration of capabilities and technologies on the head. Defence Research and Development Canada is undertaking a technology demonstration programme to investigate various designs and means of integrating headwear components and sub-systems: the Soldier's Integrated Headwear System (SIHS) programme. This programme will be faced with many design and capability trade-off decisions. To ensure that these decisions consider the aims and intent of the Canadian Army, and reflect the operational context for employment of such a future headwear system, an Infantry Subject Matter Workshop was held to acquire insight into operator priorities and the associated importance of various capabilities and technologies for a future infantry headwear system. The priorities and importance assigned to select system capabilities and usability criteria during this workshop provide the SIHS programme with the necessary guidance and direction for future headborne system design efforts.

RESUME

Depuis plus de dix ans, les pays membres de l'OTAN s'occupent de mettre au point des systèmes destinés au fantassin qui sont munis de systèmes informatiques portatifs, de capteurs évolués, de dispositifs de communications de section, d'affichages sur casque et d'autres dispositifs. Le succès des systèmes destinés au soldat dépend de l'efficacité de l'intégration des techniques et des capacités au casque. R & D pour la défense Canada lance un programme de démonstration de technologies pour étudier diverses conceptions et divers moyens d'intégration d'éléments et de sous-systèmes au casque : le programme du casque intégré du soldat (SIHS). De nombreuses décisions devront être prises dans le cadre du programme au sujet des compromis à faire en ce qui concerne la conception et les capacités du casque. Pour s'assurer de tenir compte des objectifs et des visées de l'armée canadienne dans la prise de ces décisions, de même que du contexte opérationnel dans lequel le futur casque du soldat sera employé, on a tenu un atelier à ce sujet à l'intention de l'infanterie pour mieux comprendre les priorités de l'opérateur et l'importance connexe de diverses techniques et capacités du futur casque intégré du fantassin. Les priorités et l'importance données à des capacités choisies du casque et aux critères servant à en déterminer l'utilisabilité, durant l'atelier, ont permis de donner l'orientation dont les responsables du SIHS ont besoin pour guider les efforts de conception du futur casque du soldat.

EXECUTIVE SUMMARY

Development of future infantry soldier systems with portable computing systems, advanced sensors, intra-section communications, head-mounted displays, and so on, has been ongoing among NATO nations for over a decade. Key to the success of any future soldier system will be the effective integration of capabilities and technologies on the head. Defence Research and Development Canada is undertaking a technology demonstration programme to investigate various designs and means of integrating headwear components and sub-systems: the Soldier's Integrated Headwear System (SIHS) programme. This programme will be faced with many design and capability trade-off decisions. To ensure that these decisions consider the aims and intent of the Canadian Army, and reflect the operational context for employment of such a future headwear system, an Infantry Subject Matter Workshop was held to acquire insight into operator priorities and the associated importance of various capabilities and technologies for a future infantry headwear system.

This study employed an interactive, computer-aided process for capturing Subject Matter Expert (SME) opinions and priorities. SMEs included nine infantry officers from a range of different stakeholder interests including Director Land Requirements, Infantry School, Director Nuclear Biological Chemical Defence, Infantry Battalions, and Infantry Liaison Officers. Descriptive statistics were applied to all data and these results are depicted graphically in the Results section of this report.

Based on the priorities and importance assigned by Subject Matter Experts to select system capabilities and usability criteria, the following general direction can be applied to any future headborne system design.

The SIHS headborne system should be designed with warfighting in mind; predominantly for high tempo operations (e.g. attacking, defending, fighting patrols). The highest priority system capability for the headborne system is protection. Chief among these is protection against high and low velocity fragments. Given the increasing prevalence of IEDs and VIEDs in today's conflicts, fragmentation protection will need to protect vital areas of the neck, the back of the head, and the face, in addition to the impact protection currently provided by conventional helmet designs. The blast injury threat has increased in an IED threat environment and SMEs recommended that protection against blast should be a high priority for research and design development. Similarly, blast and impulse noise injury to the ears has been identified as important from both a protection and a command and control perspective. The future headborne system also needs to integrate CB protection for skin and respiration although SMEs indicated that design preference should be given to warfighter effectiveness in conventional warfare scenarios and that they were willing to accept some tradeoffs in CB integration as long as CB protection was not compromised.

Enhancements to soldier vision were also considered a high priority capability, including daylight image enhancement, image intensification (night vision), thermal imagery, and I^2/IR fusion. Enhanced hearing was judged to be valuable but not as important as enhanced vision. SMEs assigned very high importance to the inclusion of GPS and radio antennae on the helmet, as well as any Combat ID detector technology. For camouflage, SMEs indicated that temperate and hot environments were most important and that any future system needed to manage light, noise, and thermal emissions to avoid detection by the enemy.

The highest priority usability considerations included thermal comfort in the heat, given the higher potential for heat casualties in hot, arid environments of ongoing and future conflicts. Compatibility with weapons, CB protective equipment, and corrective vision spectacles were seen to be essential for the dismounted rifleman role.

SME respondents rated a much higher proportion of usability considerations as “largely important” or better (67%), as compared to their ratings for system capabilities (31%). This emphasis on usability reinforces the notion that a successful headwear integration must be minimally invasive to the wearer, provide meaningful enhancements in soldier capability, be compatible with other clothing and equipment, seamlessly function within the activity, space, and environmental constraints of operations, and be easy to use and maintain. Insufficient consideration of human factors usability and soldier performance issues can render the most promising technologies and design concepts as failures in the eyes of soldiers critical of carrying additional weight and bulk on their heads.

SOMMAIRE

Depuis plus de dix ans, les pays membres de l'OTAN s'occupent de mettre au point des systèmes destinés au fantassin qui sont munis de systèmes informatiques portatifs, de capteurs évolués, de dispositifs de communications de section, d'affichages sur casque et d'autres dispositifs. Le succès des systèmes destinés au soldat dépend de l'efficacité de l'intégration des techniques et des capacités au casque. R & D pour la défense Canada lance un programme de démonstration de technologies pour étudier diverses conceptions et divers moyens d'intégration d'éléments et de sous-systèmes au casque : le programme du casque intégré du soldat (SIHS). De nombreuses décisions devront être prises dans le cadre du programme au sujet des compromis à faire en ce qui concerne la conception et les capacités du casque. Pour s'assurer de tenir compte des objectifs et des visées de l'armée canadienne dans la prise de ces décisions, de même que du contexte opérationnel dans lequel le futur casque du soldat sera employé, on a tenu un atelier à ce sujet à l'intention de l'infanterie pour mieux comprendre les priorités de l'opérateur et l'importance connexe de diverses techniques et capacités du futur casque intégré du fantassin.

Durant l'étude, on a eu recours à un processus interactif assisté par ordinateur pour saisir les avis et les priorités des experts en la matière, y compris neuf officiers d'infanterie représentant toute une gamme d'intérêts, dont le Directeur des Besoins en ressources terrestres, l'École d'infanterie, le Directeur de la Défense chimique, biologique, radiologique et nucléaire, les bataillons d'infanterie et les officiers de liaison de l'infanterie. Des statistiques descriptives ont été appliquées à toutes les données, et les résultats sont illustrés sous forme graphique dans la section du présent rapport qui traite des résultats.

D'après les priorités et l'importance que les experts en la matière ont données à des capacités choisies et aux critères d'utilisabilité, l'orientation générale qui suit peut être appliquée à la conception de tout futur casque.

Le casque mis au point dans le cadre du programme SIHS doit être conçu dans le contexte d'une situation de guerre, principalement des opérations de combat très dynamiques (comme les patrouilles de manœuvres offensives, de manœuvres défensives et de combat). La capacité du casque à laquelle il faut accorder la priorité la plus élevée est la protection, en particulier la protection contre les fragments projetés à grande vitesse et à faible vitesse. Étant donné la proportion croissante, dans les conflits modernes, de dispositifs explosifs de circonstance et de dispositifs explosifs de circonstance placés dans un véhicule, la protection contre la fragmentation doit couvrir les zones vitales du cou, l'arrière de la tête et la figure, couverture qui s'ajoute à la protection contre les chocs présentement assurée par les casques de conception classique. La menace de lésion par souffle a augmenté dans des conditions de menace de dispositifs explosifs de circonstance, et les experts en la matière ont recommandé de donner une grande priorité à la protection contre les effets du souffle dans les travaux de recherches et de conception. De la même façon, les lésions à l'oreille par souffle et par bruit impulsif ont été jugées importantes du point de vue de la protection et dans une perspective de commandement et de contrôle. Le futur casque doit aussi intégrer la protection biochimique de la peau et de l'appareil respiratoire, même si les experts en la matière ont indiqué que, dans le cadre de la conception, la préférence doit aller à l'efficacité du combattant dans des scénarios de guerre

classique et que, dans la mesure où la protection biochimique n'est pas compromise, ils sont prêts à accepter des compromis en ce qui concerne l'intégration de la protection biochimique.

Les améliorations à la vision du soldat ont aussi été jugées de haute priorité, y compris l'amélioration des images de jour, l'intensification d'images (vision nocturne), l'imagerie thermique et la fusion I^2/IR. L'amélioration de l'ouïe a été jugée précieuse, mais pas aussi importante que l'amélioration de la vision. Les experts en la matière ont donné une très grande importance à l'ajout au casque du système mondial de localisation (GPS) et de l'antenne radio, de même que de la technique de détection du dispositif d'identification au combat. Pour ce qui est du camouflage, les experts en la matière ont indiqué que les climats tempérés et chauds sont les plus importants et que tout futur système doit pouvoir gérer les émissions lumineuses, acoustiques et thermiques pour éviter la détection par l'ennemi.

Parmi les facteurs d'utilisabilité les plus hautement prioritaires, notons le confort thermique par temps chaud, étant donné les risques plus élevés de victimes de la chaleur dans des conditions chaudes et arides des conflits en cours et futurs. La compatibilité avec les armes, les lunettes correctrices et le matériel de protection biochimique a été considérée comme essentielle au fantassin débarqué.

Les experts en la matière ont jugé une proportion beaucoup plus grande de facteurs d'utilisabilité au moins « grandement importants » (67 %) par rapport aux cotes qu'ils avaient données aux capacités du casque (31 %). Cette importance accordée à l'utilisabilité renforce le principe selon lequel l'intégration réussie au casque doit être la moins envahissante possible pour la personne qui porte le casque, représenter des améliorations significatives de la capacité du soldat, être compatible avec les vêtements et le reste du matériel, fonctionner de façon transparente dans le cadre de l'activité, de l'espace et des contraintes ambiantes des opérations, tout en étant facile à utiliser et à maintenir. Si les questions de rendement du soldat et de l'utilisabilité ergonomique ne sont pas suffisamment prises en ligne compte, les techniques et les conceptions les plus prometteuses risquent de devenir des tentatives ratées aux yeux du soldat qui doit transporter une charge plus lourde et volumineuse sur la tête.

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1. INTRODUCTION

Development of future infantry soldier systems with portable computing systems, advanced sensors, intra-section communications, head-mounted displays, and so on, has been ongoing among NATO nations for over a decade. Key to the success of any future soldier system will be the effective integration of capabilities and technologies on the head. The requirements for protection, free-field perception, physical and thermal demands, computer displays, communications displays and input, and advanced sensors, power and data conduit, and antennae often conflict and the means of integration of these capabilities is significantly affected by the tasks to be performed by the soldier, compatibility with other clothing and equipment, and the ease of use and operation of key features and devices.

Defence Research and Development Canada is undertaking a technology demonstration programme to investigate various designs and means of headwear system integration: the Soldier's Integrated Headwear System (SIHS) programme. This programme will be faced with many design and capability trade-off decisions. To ensure that these decisions consider the aims and intent of the Canadian Army, and reflect the operational context for employment of such a future headwear system, an Infantry Subject Matter Workshop was held from 12-13 December 2002 at DRDC Toronto to acquire insight into operator priorities and the associated importance of various capabilities and technologies for a future infantry headwear system.

2. METHOD

The methodological process employed in this workshop and the associated SIHS requirements document are described below.

2.1 Data Capture Methods:

This study employed an interactive, computer-aided process for capturing Subject Matter Expert (SME) opinions and priorities. SMEs included nine infantry officers (2x Captain and 7x Major) from a range of different stakeholder interests including Director Land Requirements, Infantry School, Director Nuclear Biological Chemical Defence, Infantry Battalions, and Infantry Liaison Officers. The following process steps were undertaken.

1) **Requirements Review:** The preliminary SIHS requirements were circulated to all SMEs in advance of the workshop for review and consideration.
2) **Technology / Capability Briefings:** SMEs were provided with presentation briefings on future infantry headwear system capabilities and technologies to ensure that all participants had a similar understanding of the benefits, shortcomings, and concept of operation for each of the criteria to be evaluated.
3) **Development of Scenarios and Vignettes:** Three scenarios were developed to provide an operational context for the workshop ratings: warfighting, Nuclear/Chemical/Biological (NBC) operations, and peace support operations. Each scenario included three vignettes. For warfighting the vignettes included the attack, the defence, and patrolling. NBC operations included attack, defend, and

Release Other Than Attack (ROTA). Peace support included reacting to a hostile crowd, peacekeeping patrols, and observation post duty. SMEs were required to assign 100 percentage points to the nine vignettes according to their importance to the design of a future integrated headwear system.

4) **Importance Ratings:** Taking one section at a time, SMEs were briefed on the capabilities and technologies in a given section and the meaning of each item was discussed. SMEs then independently rated the importance of each item for each vignette using a computer software tool. Ratings were based on a five-point scale: 0 = no importance, 1 = slightly important, 2 = moderately important, 3 = largely important, and 4= extremely important.
5) **Priority Ratings:** Following their importance ratings, SMEs were required to prioritize all criteria in a given section by assigning 100 percentage points across the items according to their importance to the design of a future integrated headwear system.
6) **Focus Group Discussion:** Following each section, the results of all ten SMEs were consolidated into a single graph showing the range and average value for each participant. Using this graphical display of all SME ratings, a facilitated focus group discussion was used to explore similarities and differences, and to arrive at a group consensus rating for each item.

Descriptive statistics were applied to all data and these results are depicted graphically in the Results section of this report.

2.2 Preliminary SIHS Requirements:

As part of the SIHS system definition effort, a preliminary requirements document was drafted and used as a “straw man” to focus the discussion of design and capability priorities among SMEs in this study (Tack, 2005). To date, these headwear system requirements (see Annex A) represent a consolidation of requirements that were generated in other Canadian Army clothing and equipment projects (e.g. CG 634 helmet, visor, ballistic eyewear, the Soldier’s Information Requirements Technology Demonstration programme, the Integrated Protective Clothing and Equipment Technology Demonstration). The requirements document is preliminary and represents a “living” document that will be continuously updated through research and consultation with defence scientists, defence engineers, industry, and other allied NATO nations.

The preliminary requirements are organized into three blocks: System Capabilities, Usability Considerations, and Operation. System Capabilities include protection (ballistic, blast, puncture, blunt trauma, nuclear, chemical, biological, burn, noise, skin contact, and precipitation), enhancements and detectors (enhanced vision, enhanced hearing, and detectors), warnings and feedback (audio, visual), speech input and communications, visual displays, auditory displays, and camouflage. Usability Considerations include thermal comfort, physical comfort, physical limits, fit and adjustability, compatibility, encapsulation, drinking and food intake, ease of use, and perception (unaided vision and unaided audition). Operation includes power, data, and environmental requirements.

3 RESULTS

3.1 General SIHS Priorities

Question 1: For what operational role do you see the SIHS being most suited? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 1.

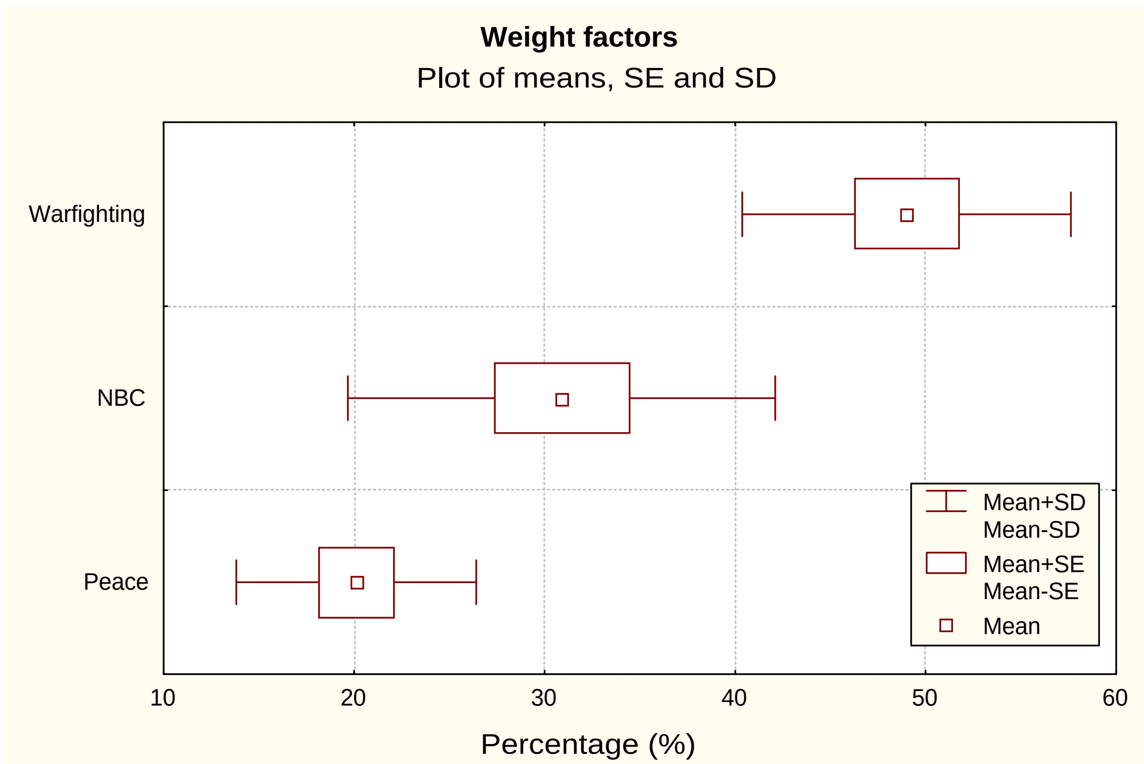

Figure 1: Operational Role Priorties

Generally, respondents indicated that warfighting (low to high intensity, without NBC) was their highest priority use for the SIHS (49 ± 9%). Warfighting was viewed at the most demanding and active soldier environment where the unique advantages of a functionally integrated helmet would be most realized. While Nuclear Biological and Chemical (NBC) warfare, including asymmetric threats, was rated as the next most important role (31 ± 12%) respondents were more divided on how important is was for the SIHS to have fully and seemlessly integrated NBC protection. Overall, the threat of NBC attack by a modern army was judged to be low and that, in the event of an attack, the electronic functionality of the SIHS would clearly be secondary to achieving the required NBC protection. Respondents preferred that the SIHS focus on achieving an optimized design for conventional warfare operations and were reluctant to trade off this optimization for NBC protection, which they believed could be achieved by more conventional means when required. The SIHS is not seen as important for Peace Support Operations (20 ± 7%). Respondents also believed that an SIHS designed for conventional warfare would be more than adequate for any peace operations but that the reverse would not be true.

Question 2: For what operational scenario do you see the SIHS being most suited? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 2.

Figure 2: Operational Scenario Priorties

Respondents indicated that the attack and defend scenarios in conventional warfare were the most important considerations for the SIHS design, followed by conventional warfare patrolling and attacking and defending in an NBC conflict. Reacting to hostile crowds in peace support operations warranted some consideration while NBC Release-Other-Than-Attack (ROTA) situations and the peace support tasks of patrolling and staffing an Observation Post (OP) were judged to be a low priority for SIHS.

Question 3: What priority would you assign to the following SIHS system capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 3.

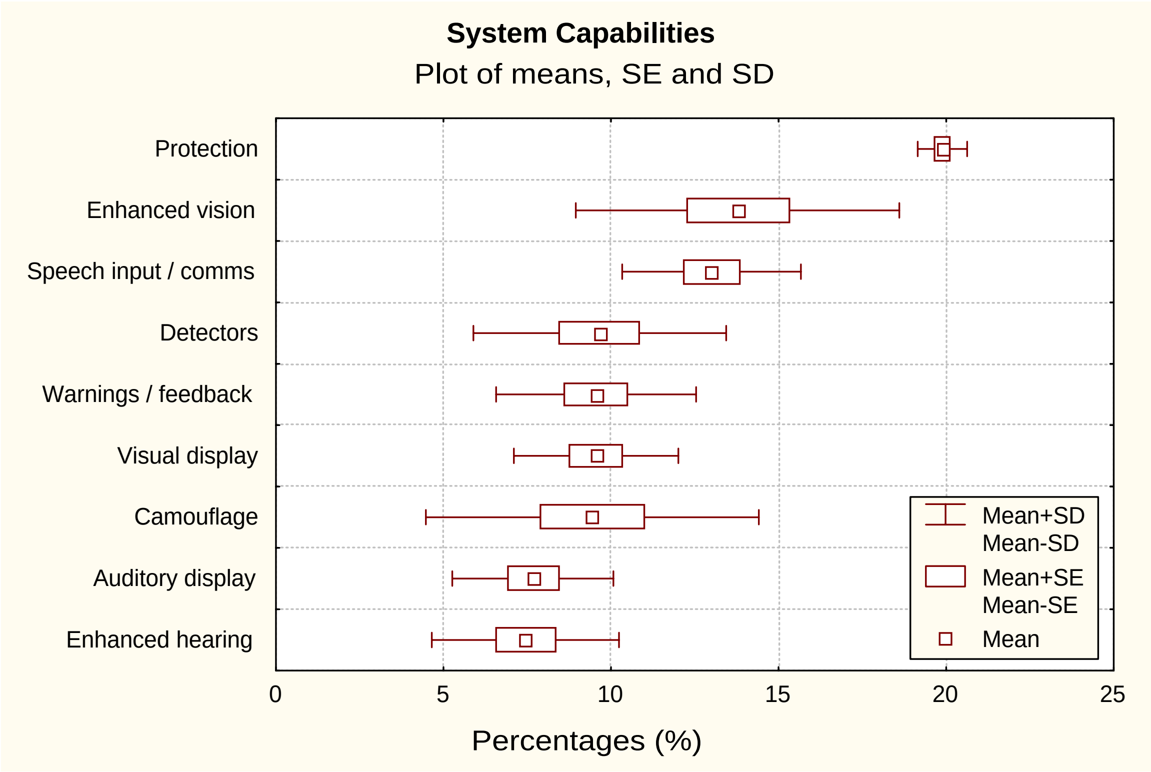

Figure 3: System Capability Priorties

Protection was consistently judged to be the highest priority consideration for SIHS (20 ± 1%). The benefits of enhanced vision (14 ± 5%) and speech communications (13 ± 3%) are most well understood by the respondents and were judged to be the next highest priority. All remaining capabilities were similarly rated between 7 – 10 percent. While priority values for some system capabilities scored relatively lower than others, many of these capabilities were still judged to be very important to the success of SIHS (e.g. visual and auditory displays).
Each of these system capabilities is discussed in more detail in the following section.

3.2 Protection

Question 4: What priority would you assign to the following SIHS protection capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 4.

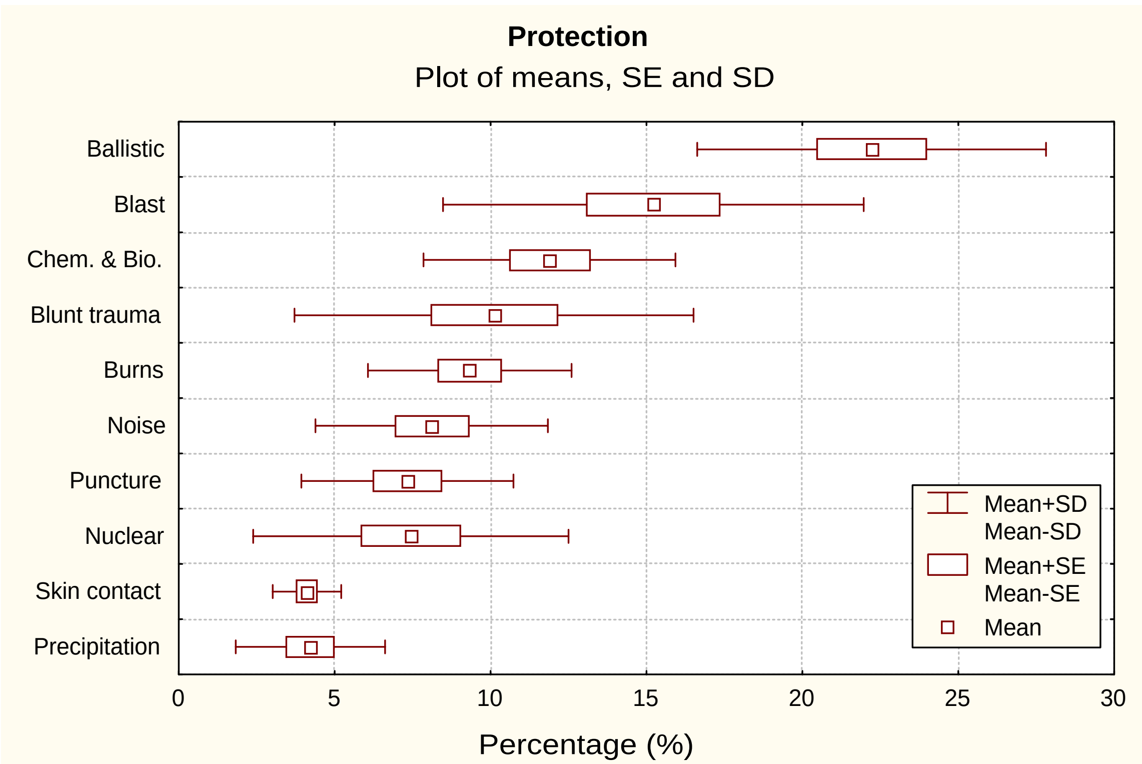

Figure 4: Protection Priorties

Ballistic protection was cited as the highest priority among protection capabilities (22 ± 6%), followed by blast (15 ± 7%), chemical/biological (12 ± 4%), and blunt trauma protection (10 ± 7%). While rated lower, several of the protection capabilities (e.g. puncture, nuclear, skin contact, and precipitation) were judged to have been addressed by the higher rated capabilities (e.g. providing suitable ballistic protection will address the puncture threat).
Each of these protection capabilities are discussed in more detail in the following section.

3.2.1 Ballistic Protection

Question 5: What priority would you assign to protecting against the following ballistic threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 5.

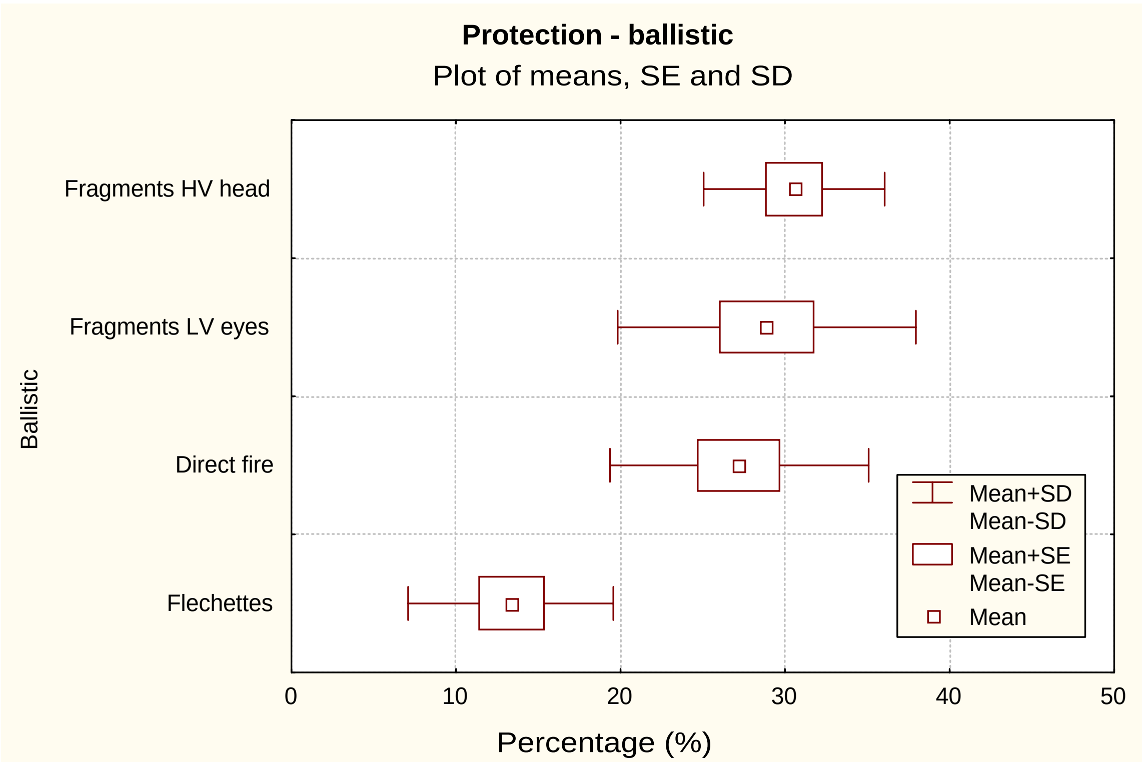

Figure 5: Ballistic Protection Priorities

As a priority, the SIHS design should protect against high velocity fragments to the head (31 ± 6%), low velocity fragments to the eyes (29 ± 10%), and direct fire weapons (27 ± 8%). Respondents were less concerned about protecting against flechette weapons (13 ± 7%). Respondents also rated the absolute importance of protecting against the four ballistic threats (see Figure 6). Protection against low and high velocity fragments was seen to be more important than protection against direct fire. This difference is likely explained by the respondent perception that the probability of exposure to fragmentation weapons was significantly higher than direct fire weapons, as indicated by epidemiological data of battlefield injuries. While rated noticably lower than the other threats flechette protection was still rated as moderately important.

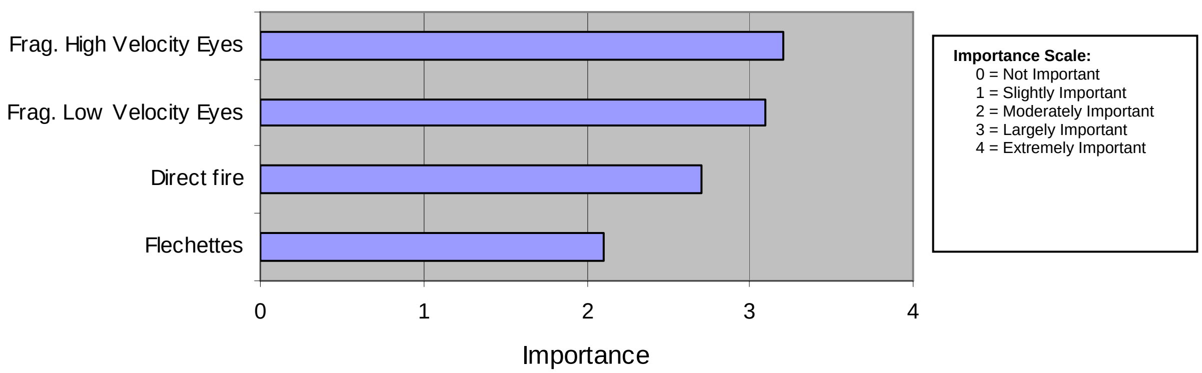

Figure 6: Ballistic Protection Consensus Importance Ratings

3.2.2 Blunt Trauma Protection

Question 6: What priority would you assign to protecting against the following blunt trauma threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 7.

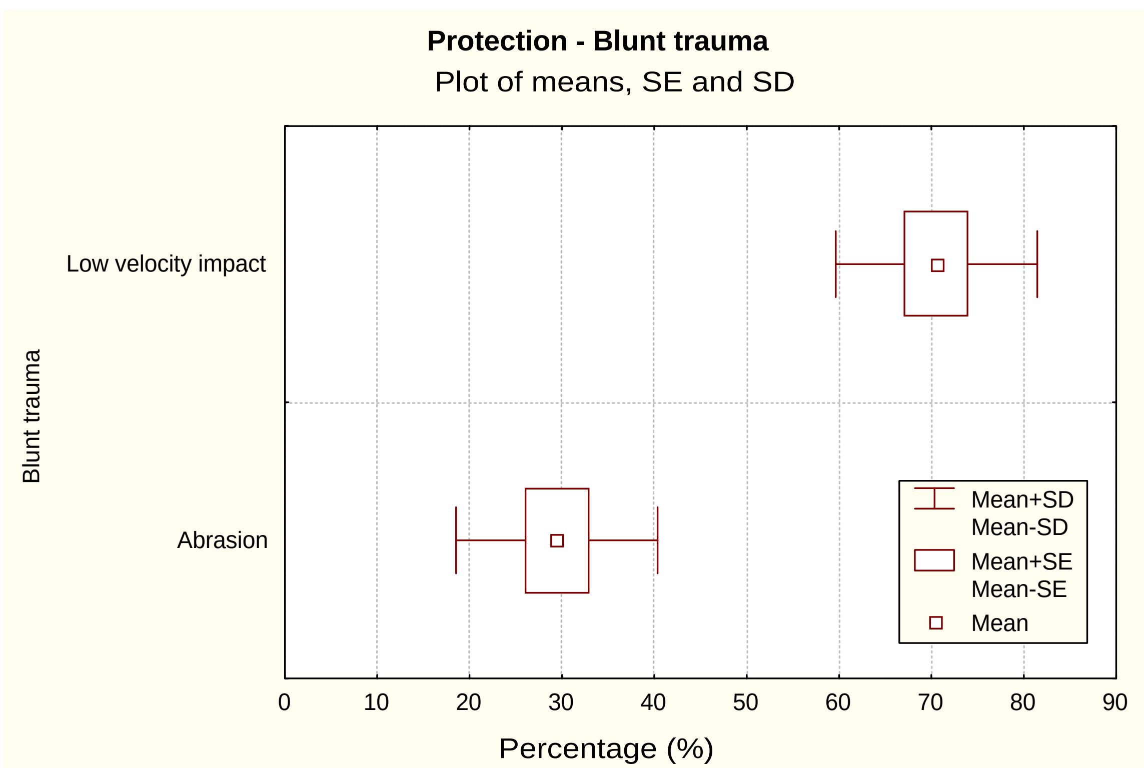

Figure 7: Blunt Trauma Protection Priorities

Protection against low velocity impacts (e.g. struck by thrown rocks or a bat, striking the head during a vehicle accident) was by far the highest priority threat for the SIHS design (71 ± 12%). In relative priority terms the need to protect against abrasion was seen to be low (29 ± 12%). In absolute importance terms, low velocity impact threats were considered less than "largely important" and abrasion only "moderately important" (see Figure 8).

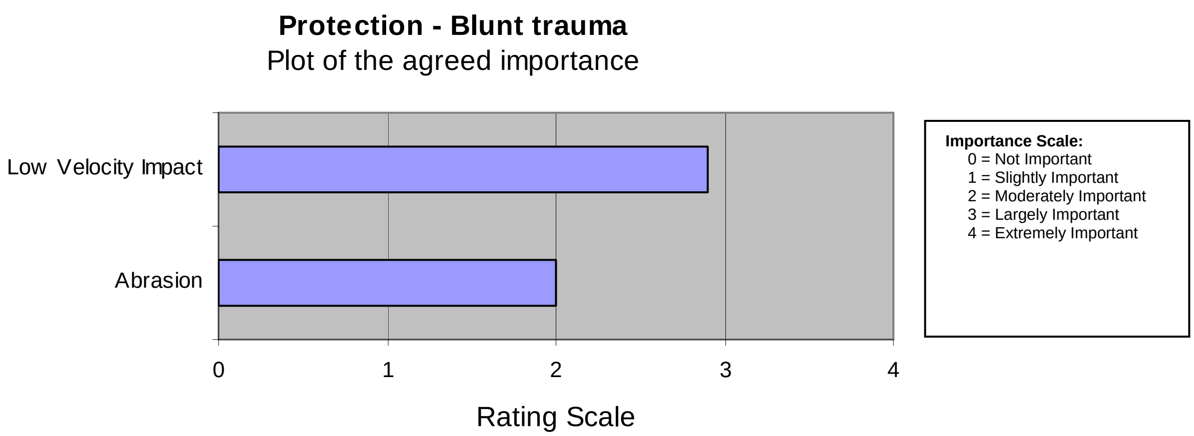

Figure 8: Blunt Trauma Protection Consensus Importance Ratings

3.2.3 Nuclear Protection

Question 7: What priority would you assign to protecting against the following nuclear threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 9.

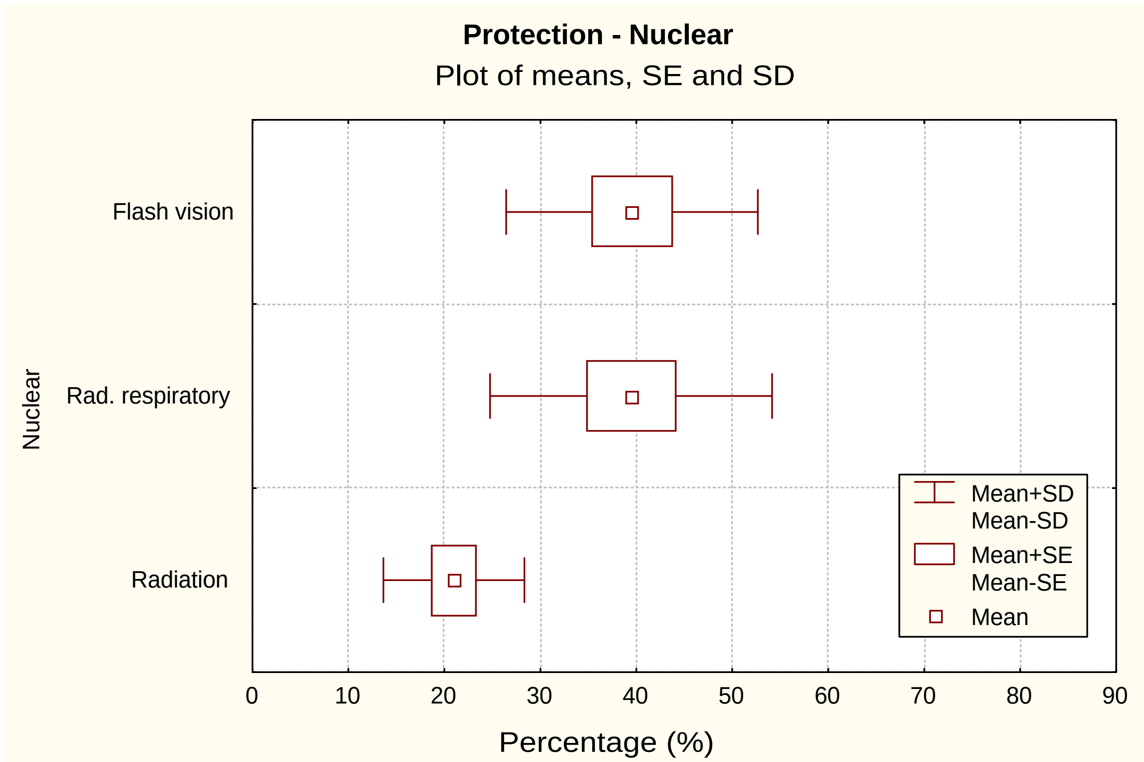

Figure 9: Nuclear Protection Priorities

Both nuclear flash (40 ± 14%) and respiratory protection (39 ± 16%) were judged to be a higher priority of effort for the SIHS design than radiation protection (21 ± 8%). While respondents rated the importance of radiation protection for the skin higher than nuclear flash (see Figure 10) most respondents felt that radiation protection for the skin would be already achieved through the provision of ballistic protection and other headwear coverings. Protection against nuclear flash was given a higher priority because the blinding effects of flash would be serious and there is currently no design solution. Overall, the importance ratings for nuclear protection were only moderate since respondents judged the risks of a conventional nuclear attack to be low.

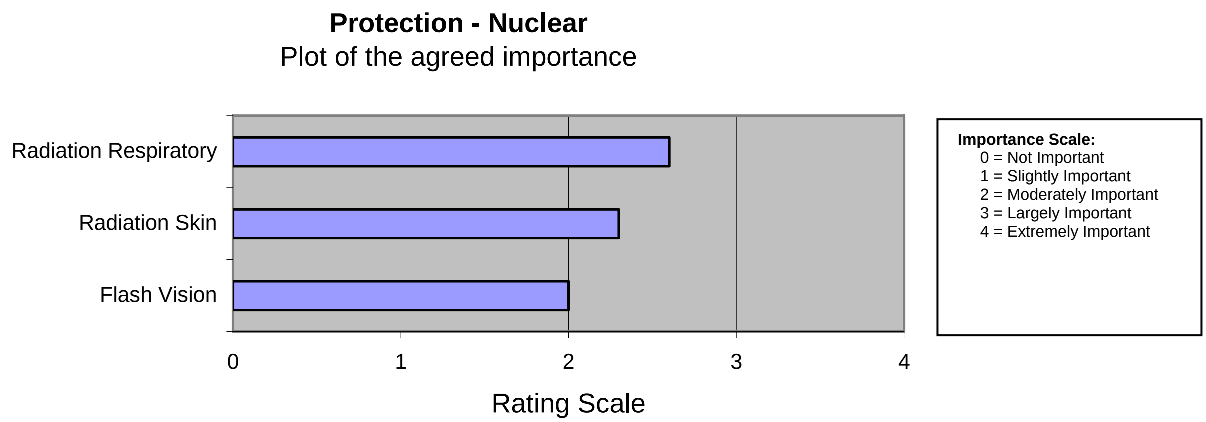

Figure 10: Nuclear Protection Consensus Importance Ratings

3.2.4 Chemical / Biological Protection

Question 8: What priority would you assign to protecting the following areas against chemical or biological threats? Allocate the 100 percentage points available.

Respondent results are summarized below in Figure 11.

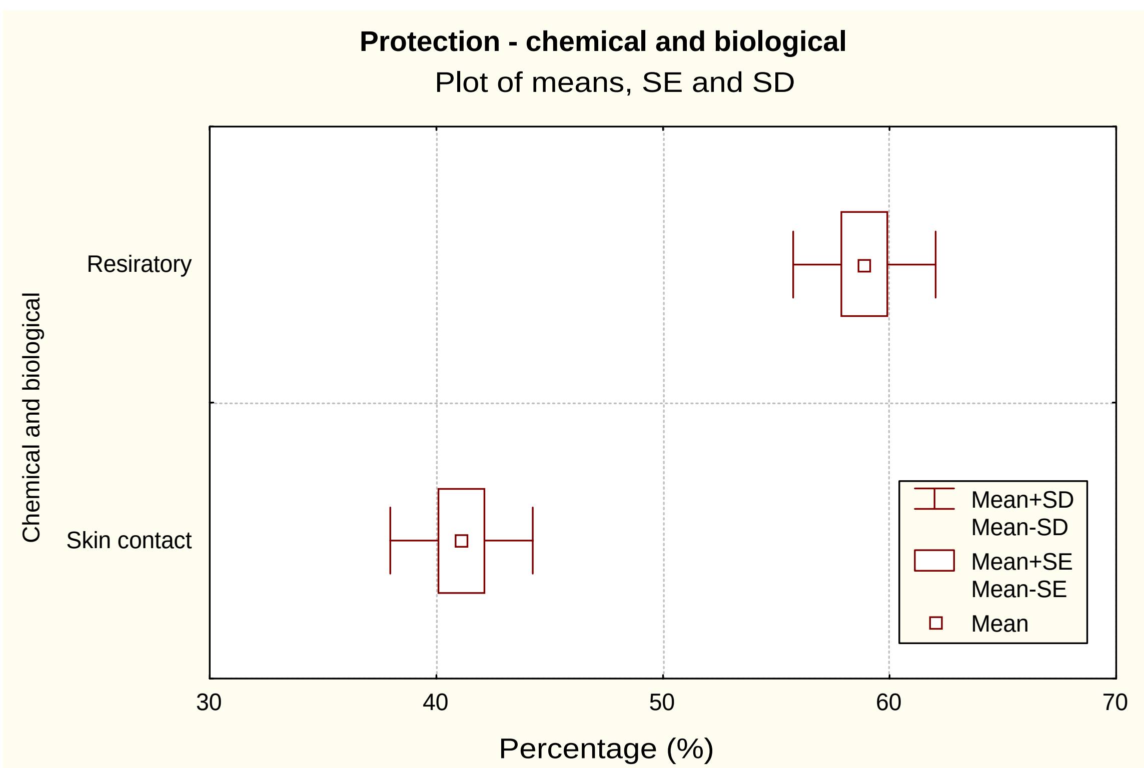

Figure 11: Chemical and Biological Protection Priorities

Respondents rated the priority for respiratory chemical/biological protection (59 ± 3%) as higher than the skin protection requirement (41 ± 3%), in the SIHS design and also rated the importance of respiratory protection as somewhat higher than skin protection. Respondents suggested that their ratings were indicative of both the higher threat posed to the respiratory system and the likely higher design challenge of integrating respiratory protection into an integrated helmet.

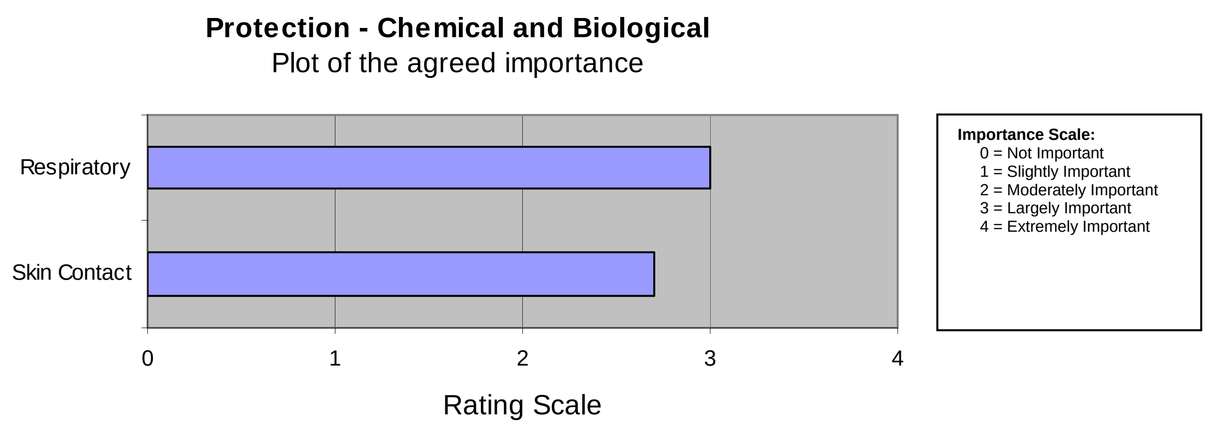

Figure 12: Chemical and Biological Protection Consensus Importance Ratings

3.2.5 Burn Protection

Question 9: What priority would you assign to protect against the following burn threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 13.

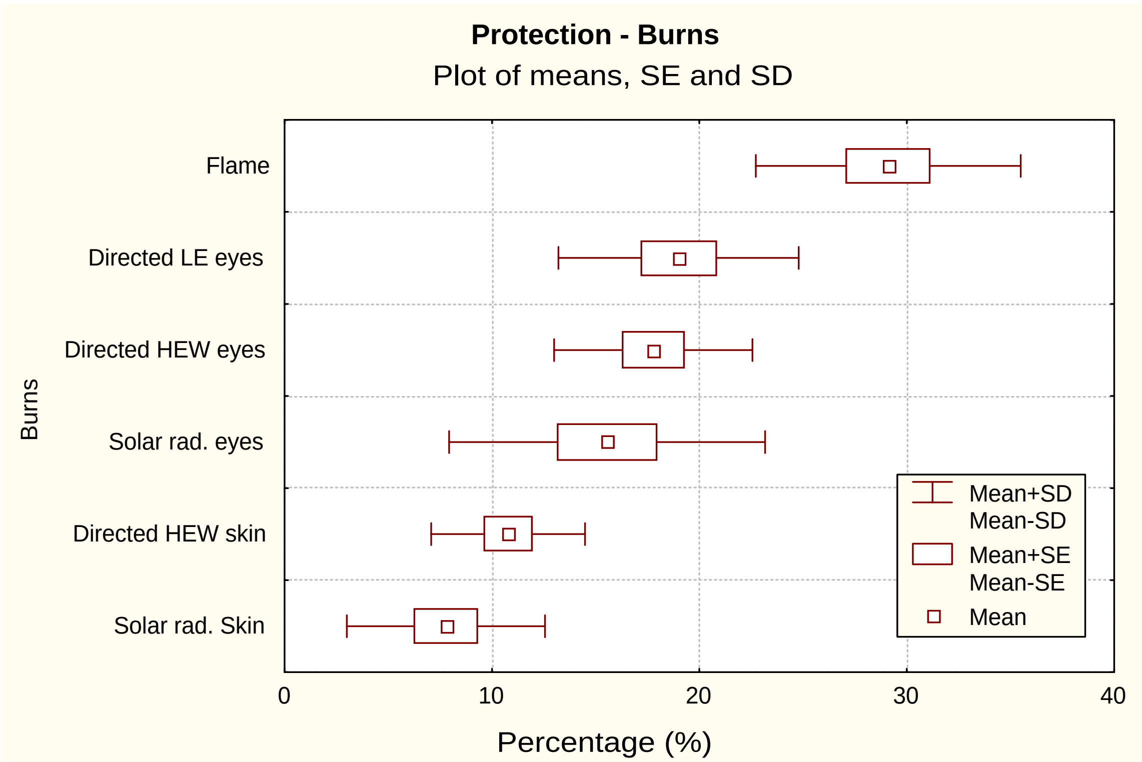

Figure 13: Burn Protection Priorities

The requirement to protect against flame threats was given higher priority among respondents (29 ± 7%) than directed energy or solar threats. In their importance ratings (see Figure 14) respondents rated Low Energy (LE) directed energy threats to the eyes as higher than flame. This is likely owing to the perception that low and high (HEW or High Energy Weapon) directed energy threats were likely to be more common on the modern battlefield than flame exposure. While respondents believed that solar protection to the skin and eyes was necessary and moderately important they felt that these threats could be readily defeated with existing, conventional methods and, therefore, didn't warrant a higher priority of design effort.

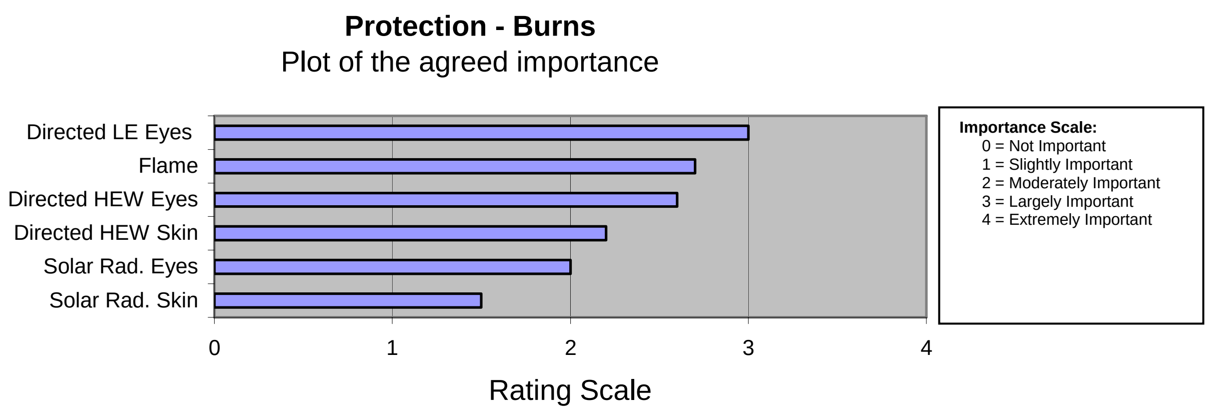

Figure 14: Burn Protection Consensus Importance Ratings

3.2.6 Noise Protection

Question 10: What priority would you assign to protecting against the following noise threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 15.

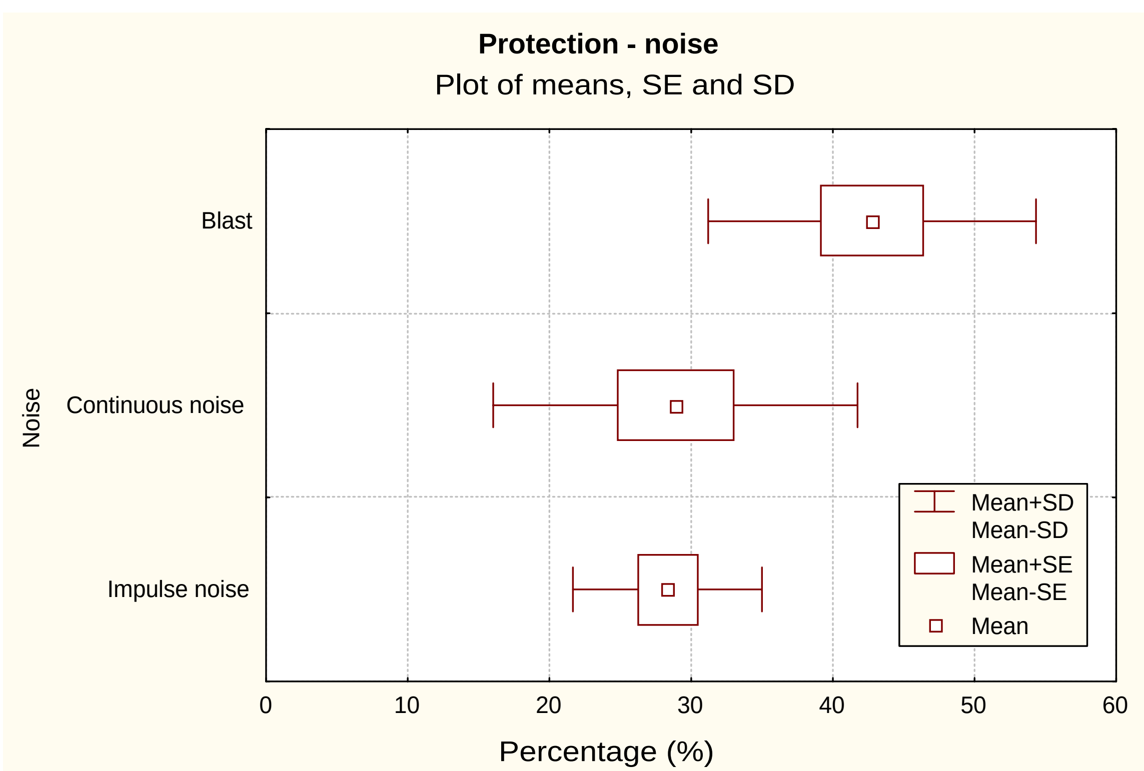

Figure 15: Noise Protection Priorities

While all noise threats were judged to be similarly important (see Figure 16), respondents gave a higher design priority to blast protection since it poses a significant integration challenge and few conventional design methods exist to defeat the threat. It was widely recognized that little was known about the injury mechanisms and design attributes that contribute or mitigate blast wave injuries to the head.

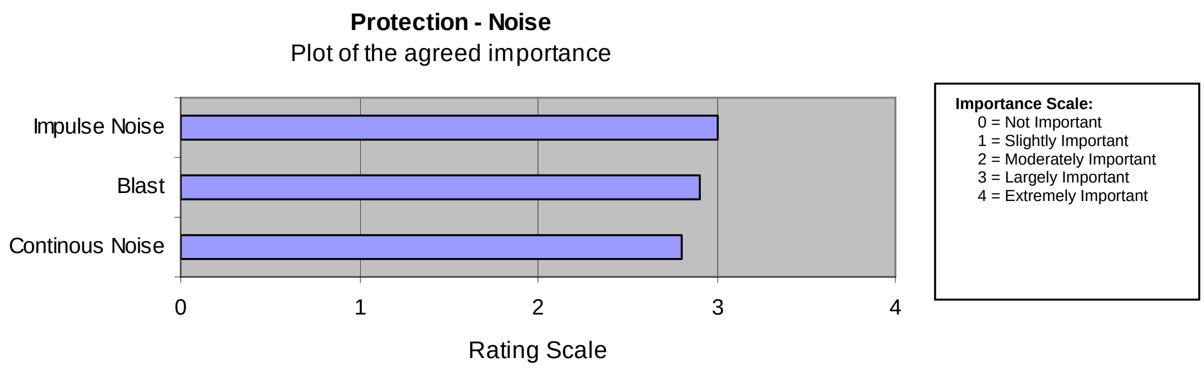

Figure 16: Noise Protection Consensus Importance Ratings

3.2.7 Skin Contact Protection

Question 11: What priority would you assign to protecting against the following skin contact threats? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 17.

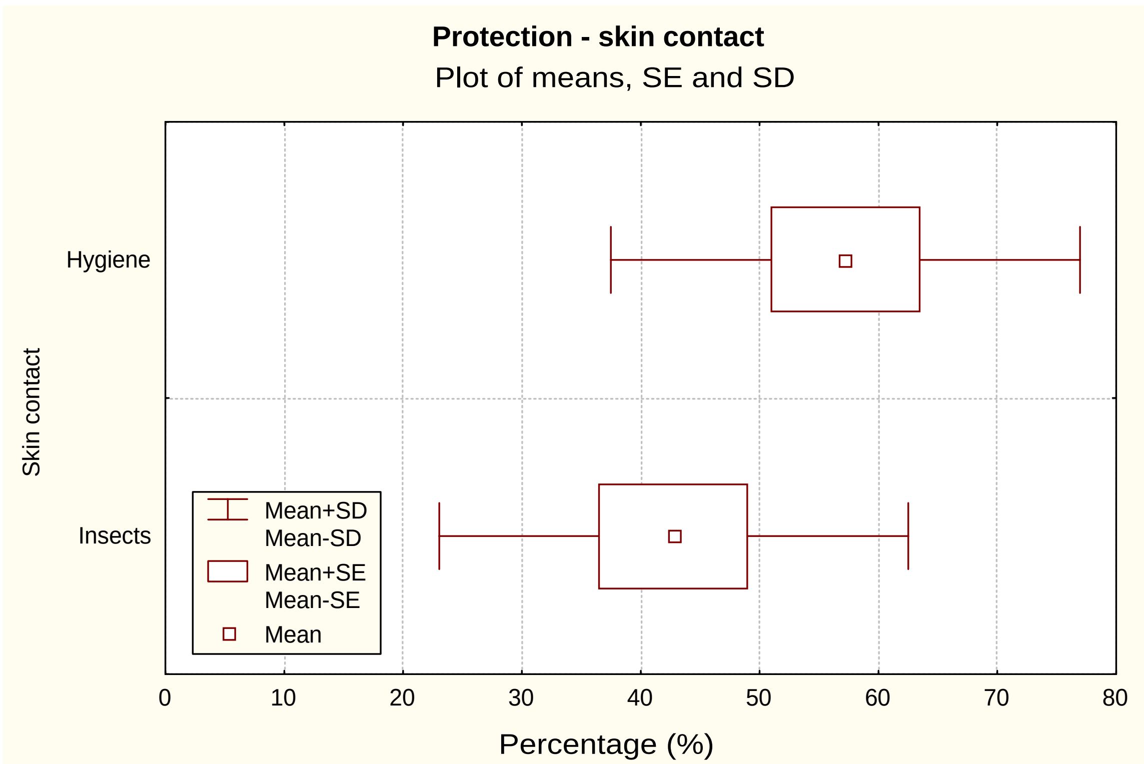

Figure 17: Skin Contact Protection Priorities

In both cases, respondents judged skin protection against insects and hygiene issues to be only moderately important. Skin hygiene issues were seen to be a higher priority than insects since the latter can be addressed by repellants whereas prolonged hygiene issues may affect the wearability of the helmet.

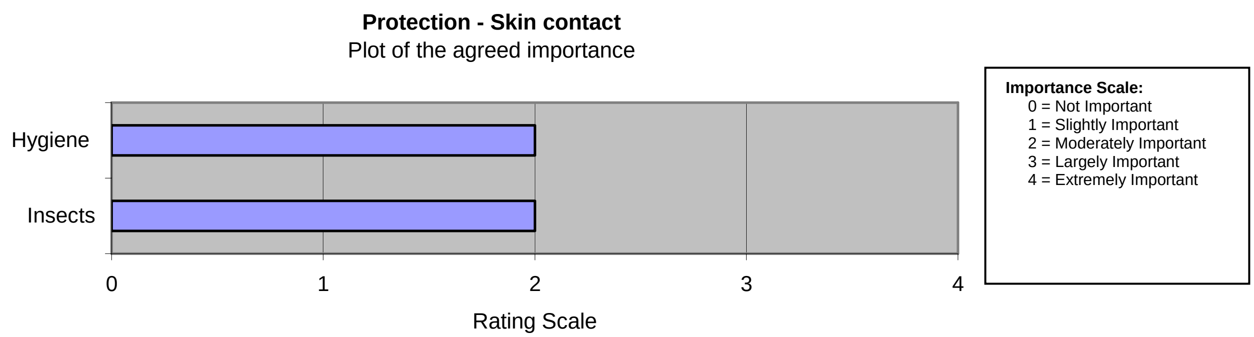

Figure 18: Skin Protection Consensus Importance Ratings

3.3 Vision Enhancement

Enhancing vision was rated as the second highest priority for system capabilities.
Question 12: What priority would you assign to the following vision enhancement capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 19.

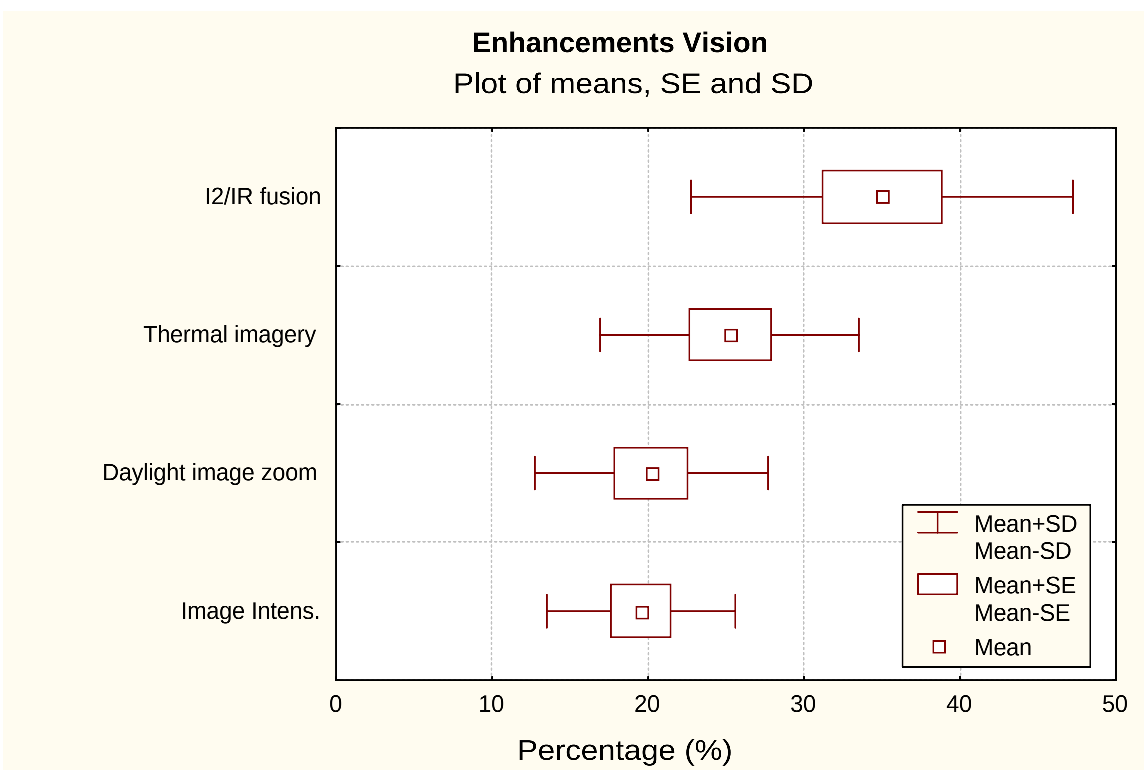

Figure 19: Vision Enhancement Priorities

In terms of design priority, respondents ranked I2/IR fusion devices (35 ± 13%) higher than thermal imagery (25 ± 9%), which in turn was rated higher than either daylight image (20 ± 8%) and night vision enhancement (20 ± 6%). Fusion imagery was seen to offer the benefits of both improved thermal and image intensification imagery and was seen to be a higher design priority than the other singular vision enhancement technologies alone.

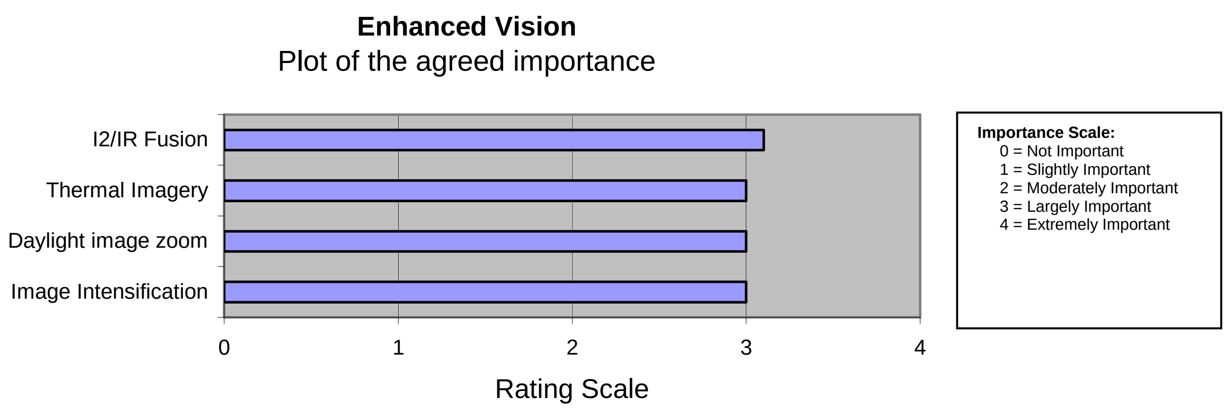

Figure 20: Vision Enhancement Consensus Importance Ratings

All forms of vision enhancement were judged to be "largely important" (Figure 20) since visual information on the battlefield was seen to be essential to success.

3.4 Hearing Enhancement

Question 13: What priority would you assign to the following hearing enhancement capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 21.

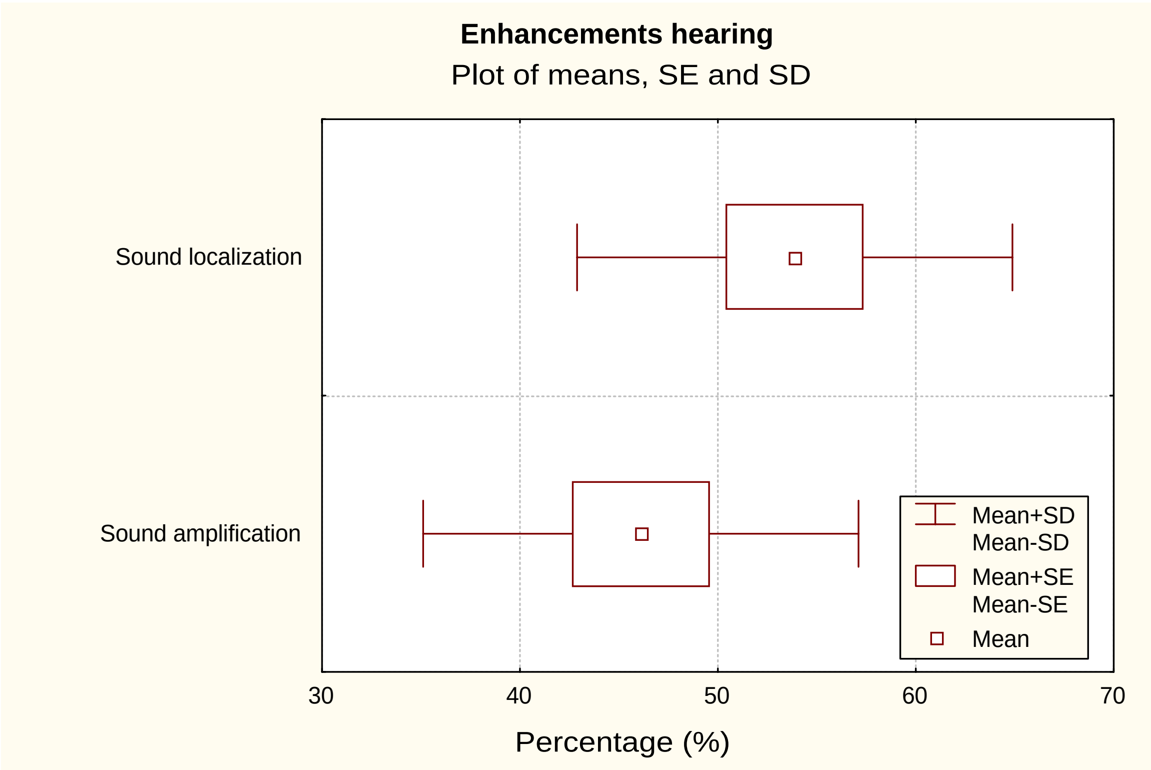

Figure 21: Hearing Enhancement Priorities

Overall, auditory enhancement was rated less than visual enhancement as a design priority. There was considerable discussion regarding the conditions and use of auditory enhancement which affected the outcome priorities and ratings between enhancing localization versus amplification. While amplification was seen to be useful for detection of sounds in an Observation Post context, most respondents agreed that localization was more critical to survivability and lethality during the fire fight, locating the enemy or snipers, and situational awareness in general.

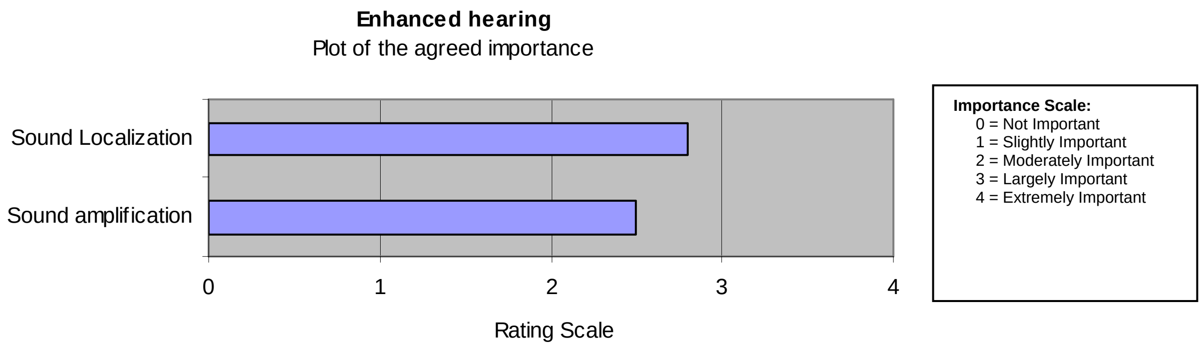

Figure 22: Hearing Enhancement Consensus Importance Ratings

3.5 Detectors

Question 14: What priority would you assign to the following SIHS detector capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 23.

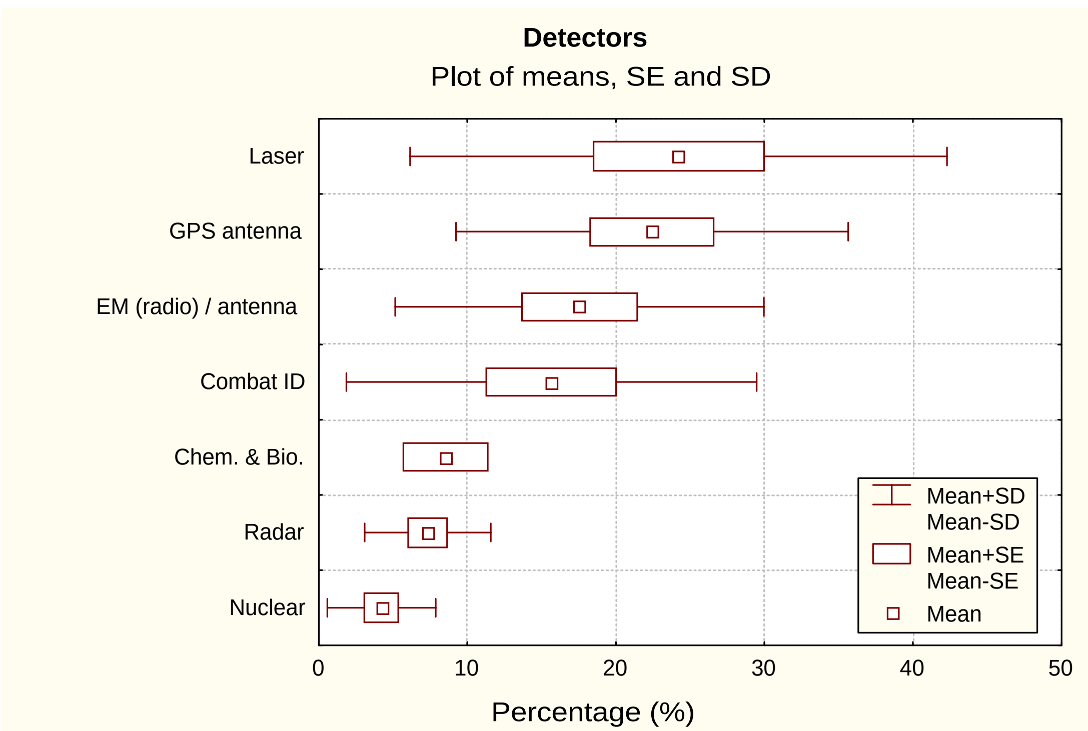

Figure 23: Detector Priorities

Respondents ranked laser detection devices (24 ± 19%) higher than GPS (22 ± 14%) and EM or radio antennae (18 ± 13%), which in turn was rated higher than combat ID (16 ± 15%) and chemical/biological, radar, and nuclear detectors. Laser detectors were given the highest design priority due to the integration challenge and the likely proliferation of low and medium power lasing devices on the future battlefield.

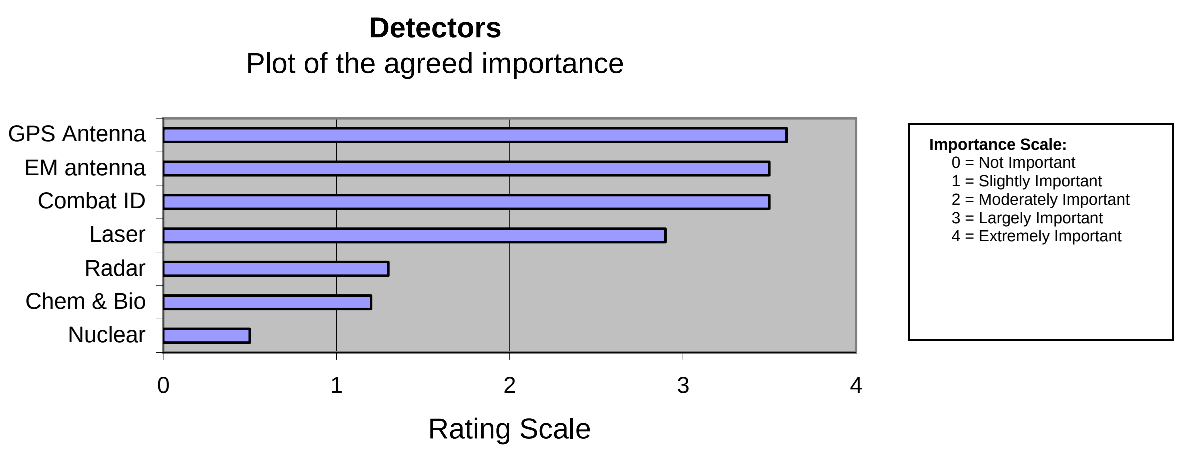

Figure 24: Detector Consensus Importance Ratings

In terms of importance to mission success, GPS and radio antenna, and combat ID were identified as "largely to extremely important", whereas laser detectors were only rated less than "largely important. Both the GPS and radio antennae were considered essential to the soldier system of the future, where signal loss to radio communications or position information could be critical. Placement on the helmet was seen to be important for achieving the best reception and the least likelihood of signal interruption. Combat ID detectors on the helmet itself were seen to be important since the head is usually the most exposed feature.

3.6 Warnings and Feedback

Question 15: What priority would you assign to the following SIHS warning and feedback capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 25.

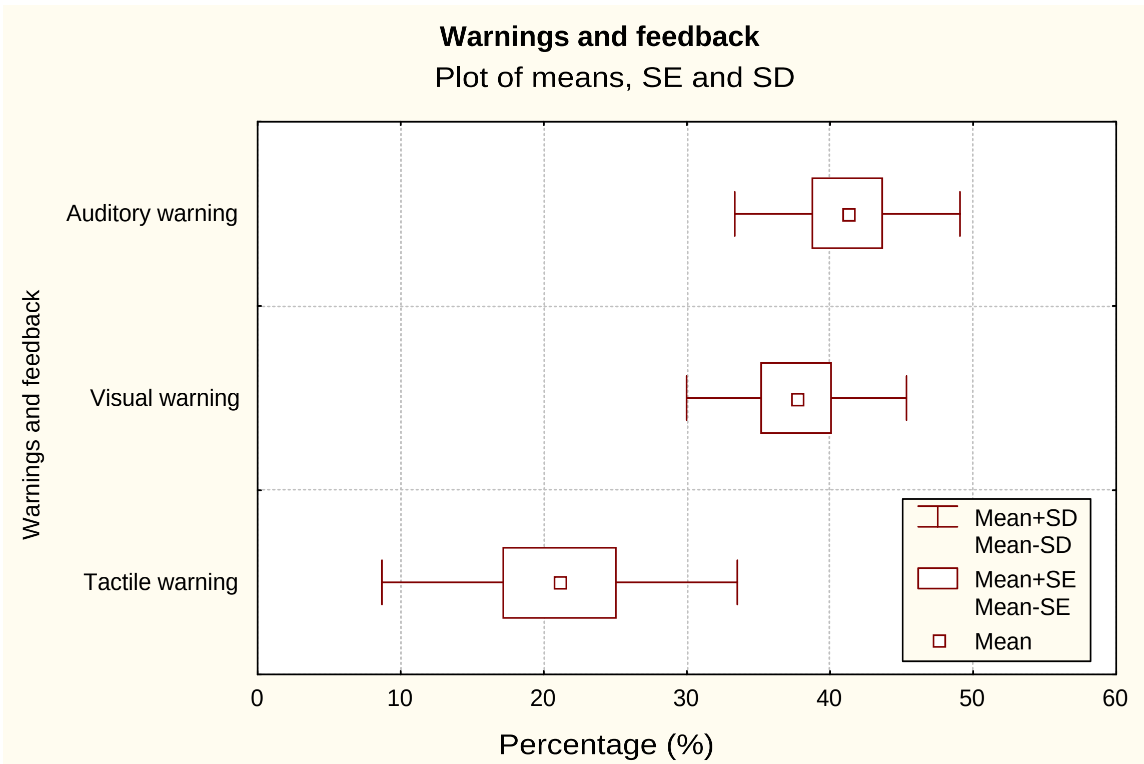

Figure 25: Warning/Feedback Priorities

Respondents rated the priority of auditory warnings (41 ± 8%) and visual warnings (38 ± 8%) higher than tactile warnings (21 ± 13%). SMEs indicated that the preference for auditory versus visual warnings was dependent on the mission situation, although the auditory modality would likely be preferred in most cases. Auditory warnings were rated as “largely important” since the SMEs believed that information displayed in the soldier’s vision should be minimized so as not to obstruct their free-field vision for acquiring local situation awareness.
Respondents were unsure about tactile warning systems and were not inclined to rate it very highly in relation to the more prevalent visual and auditory methods. However, SMEs did acknowledge that the tactile display modality could offer benefits in stealthy situations and when the visual and auditory systems were overloaded.

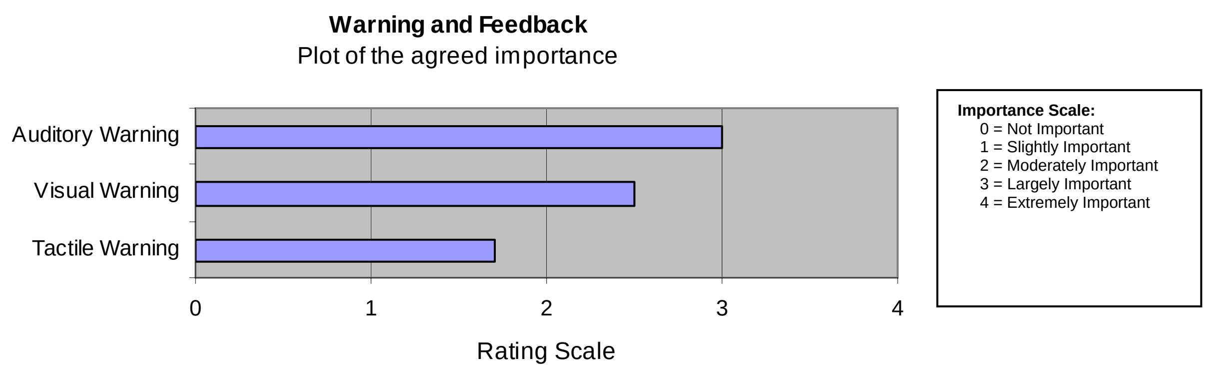

Figure 26: Warning/Feedback Consensus Importance Ratings

3.7 Camouflage – Unwanted Emissions

Question 16: What priority would you assign to the following SIHS unwanted emissions camouflage? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 27.

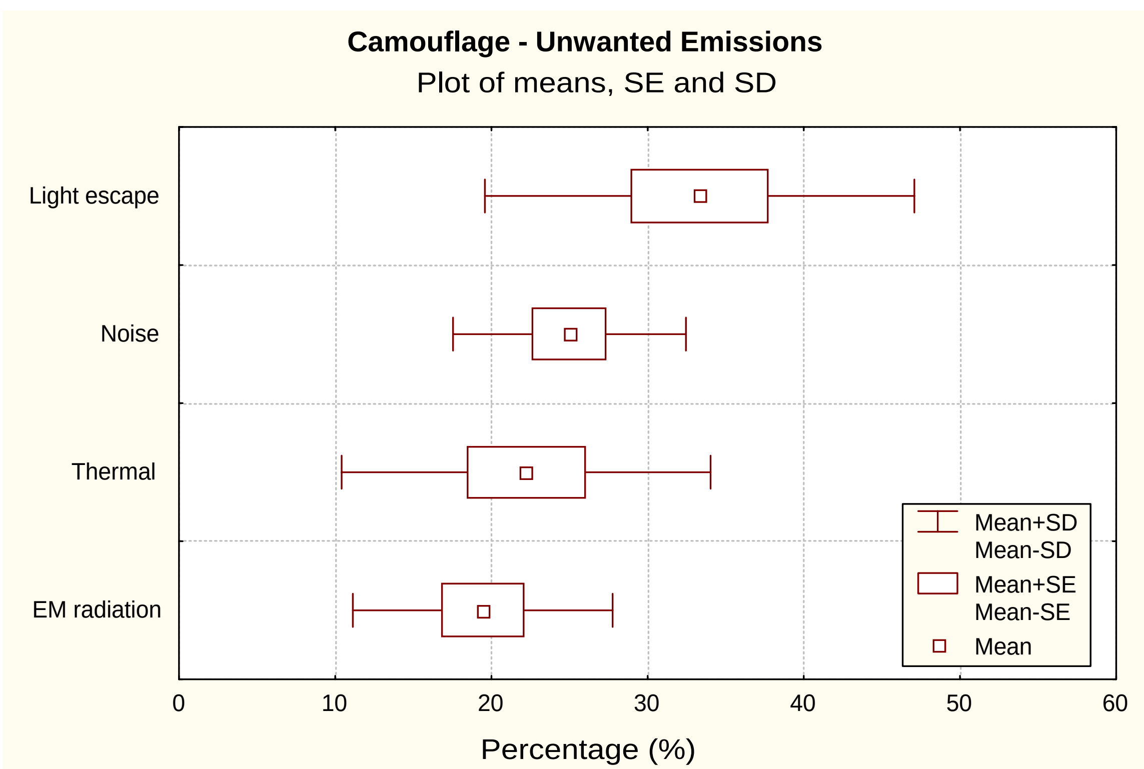

Figure 27: Unwanted Emissions Camouflage Priorities

Respondents indicated that the control of unwanted light emissions (33 ± 15%) warranted the highest camouflage priority, followed by noise (25 ± 8%), thermal (22 ± 13%), and electro-magnetic (19 ± 9%) emissions. Control of unwanted light and noise were rated as most important (i.e. “somewhat less than largely important”) since SMEs believed that these sources could be detected by a “low technology” enemy. Light emissions were most concerning since it could be readily detectable by an enemy at greater distances.

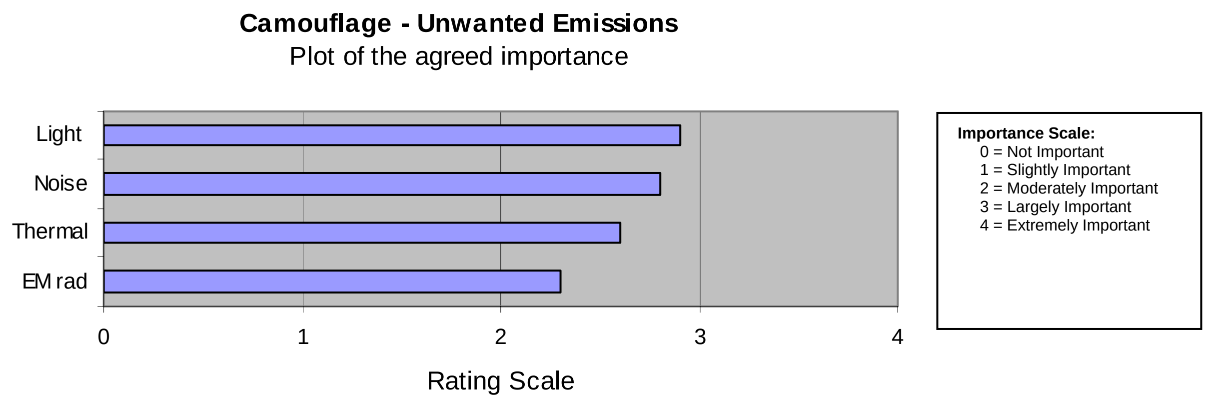

Figure 28: Unwanted Emissions Consensus Importance Ratings

3.8 Camouflage - Environment

Question 17: What priority would you assign to providing camouflage for the following environments? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 29.

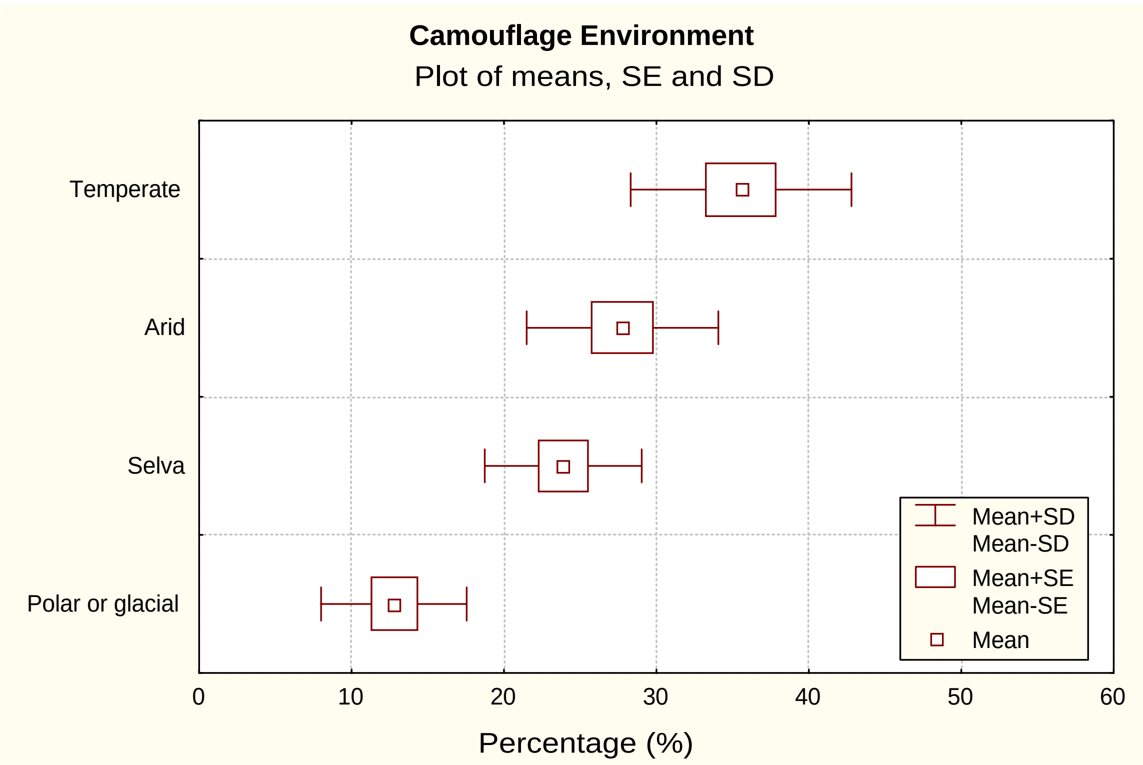

Figure 29: Environmental Camouflage Priorities

Respondents rated temperate (36 ± 8%) and arid (28 ± 7%) terrain camouflage as a higher priority than selva (24 ± 5%) or arctic (13 ± 5%) terrains. Temperate and arid terrains were considered the most likely environments for future and ongoing conflicts, although all SMEs noted that most combat in the future will be fought in urban terrain.

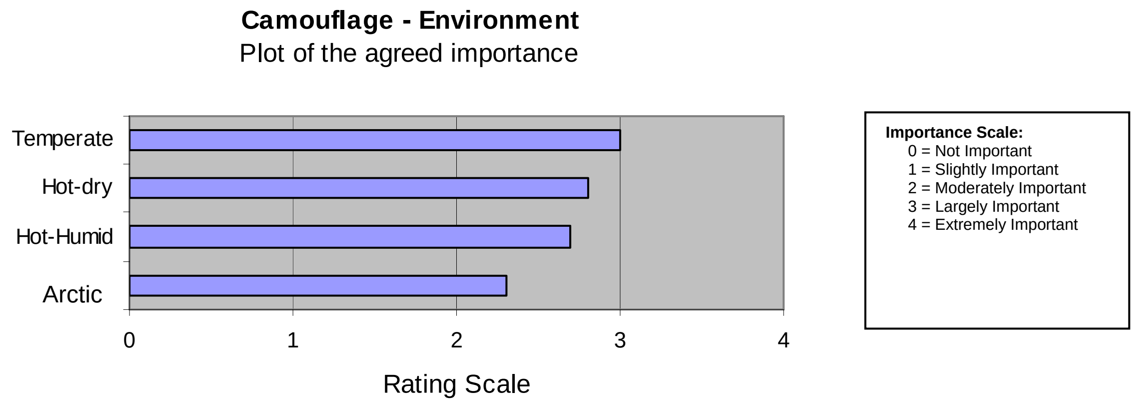

Figure 30: Environmental Camouflage Consensus Importance Ratings

3.9 Usability

Question 18: What priority would you assign to the following SIHS usability considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 31.

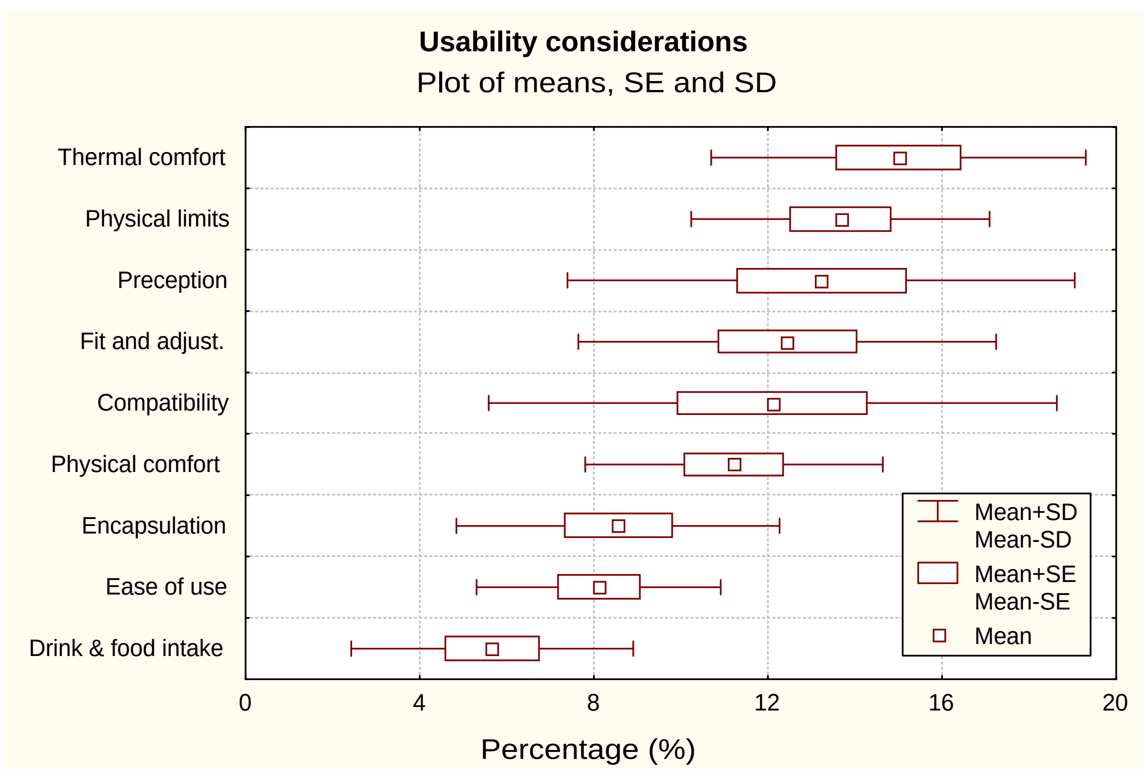

Figure 31: Soldier Usability Priorities

Respondents assigned the highest usability priorities to thermal comfort (36 ± 8%), physical limits (36 ± 8%), free-field perception (36 ± 8%), fit and adjustment (36 ± 8%), compatibility with weapons and equipment (36 ± 8%), and physical comfort (36 ± 8%).

3.9.1 Thermal Comfort

Question 19: What priority would you assign to the following thermal comfort considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 32.

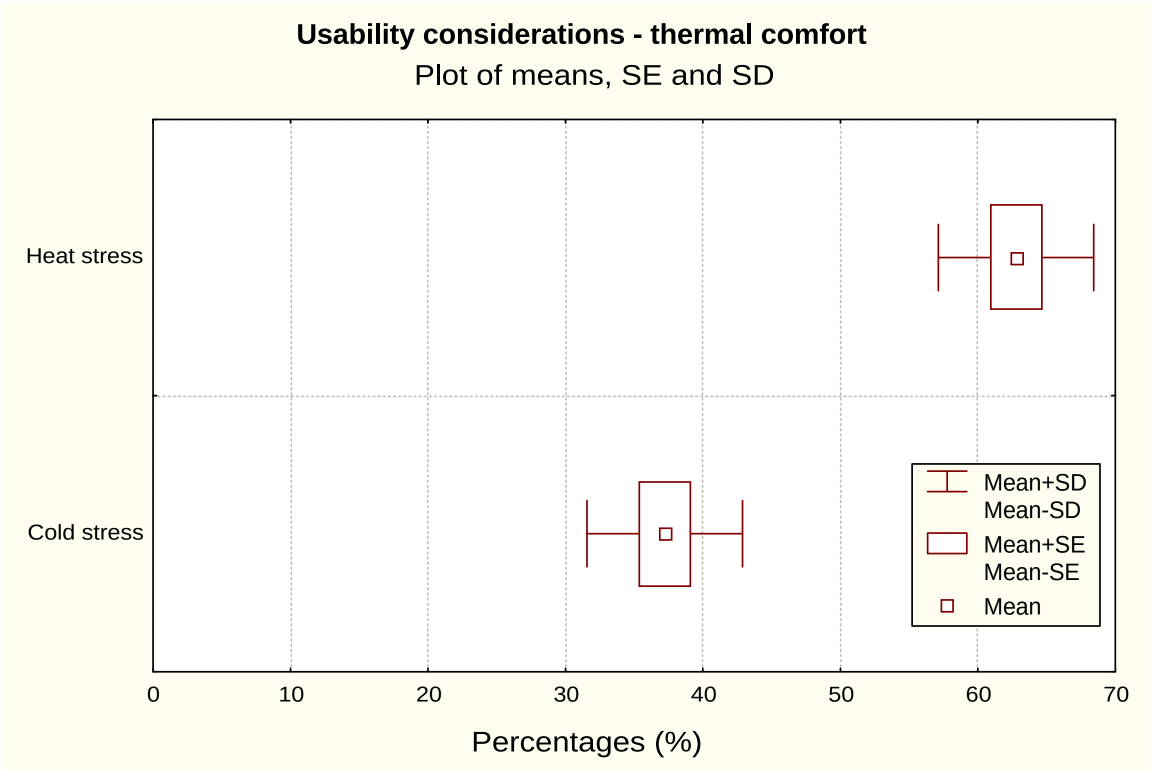

Figure 32: Thermal Comfort Priorities

In Figure 32, respondents rated heat stress (63 ± 6%) as the highest thermal comfort priority over cold stress (37 ± 6%). SMEs suggested that cold stress was easier to manage since adding or removing layers of insulation (e.g. balaclava or head-over) has been effective in the past. Heat stress is more common, even in temperate conditions, and heat casualties remain a concern.

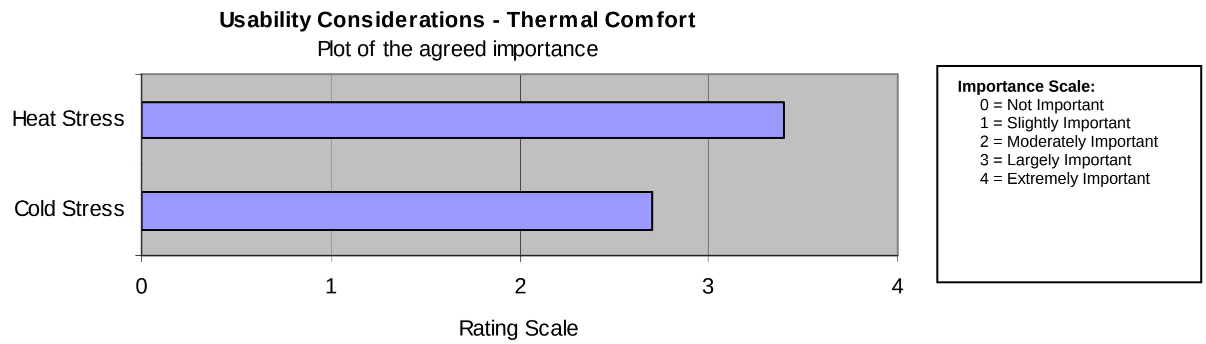

Figure 33: Thermal Comfort Consensus Importance Ratings

Managing heat stress was also rated between "largely and extremely important" while cold stress was only rated as "moderately to largely important" (Figure 33).

Question 20: What priority would you assign to the following physical limit considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 34.

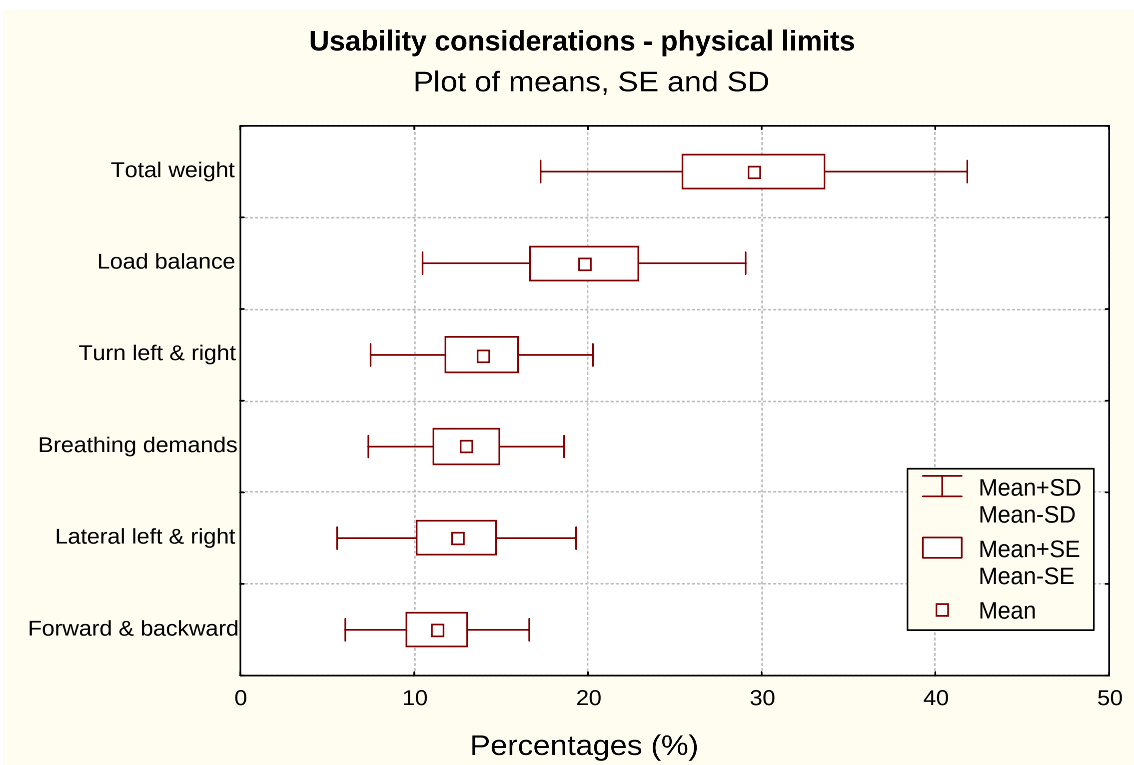

Figure 34: Physical Limits Priorities

In Figure 34, respondents rated the effects of total headborne weight (30 ± 12%) and load balance (20 ± 9%) as the highest priorities for controlling physical limits in the design of any headborne system. However, importance ratings for all aspects of physical limits were rated as "largely important" (Figure 35).

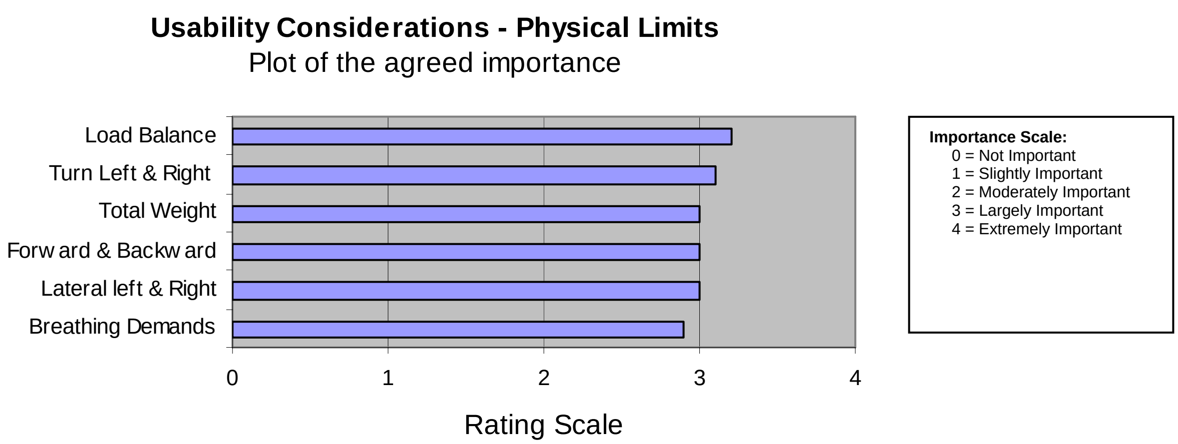

Figure 35: Physical Limits Consensus Importance Ratings

SMEs noted that, while total weight was a critical factor in neck fatigue and injury, the balance of forces on the head and neck would be the most significant factor in soldier acceptance. In fact, most agreed that a well balanced helmet design would enable the total weight of the headborne system to be greater.

Question 21: What priority would you assign to the following perception usability considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 36.

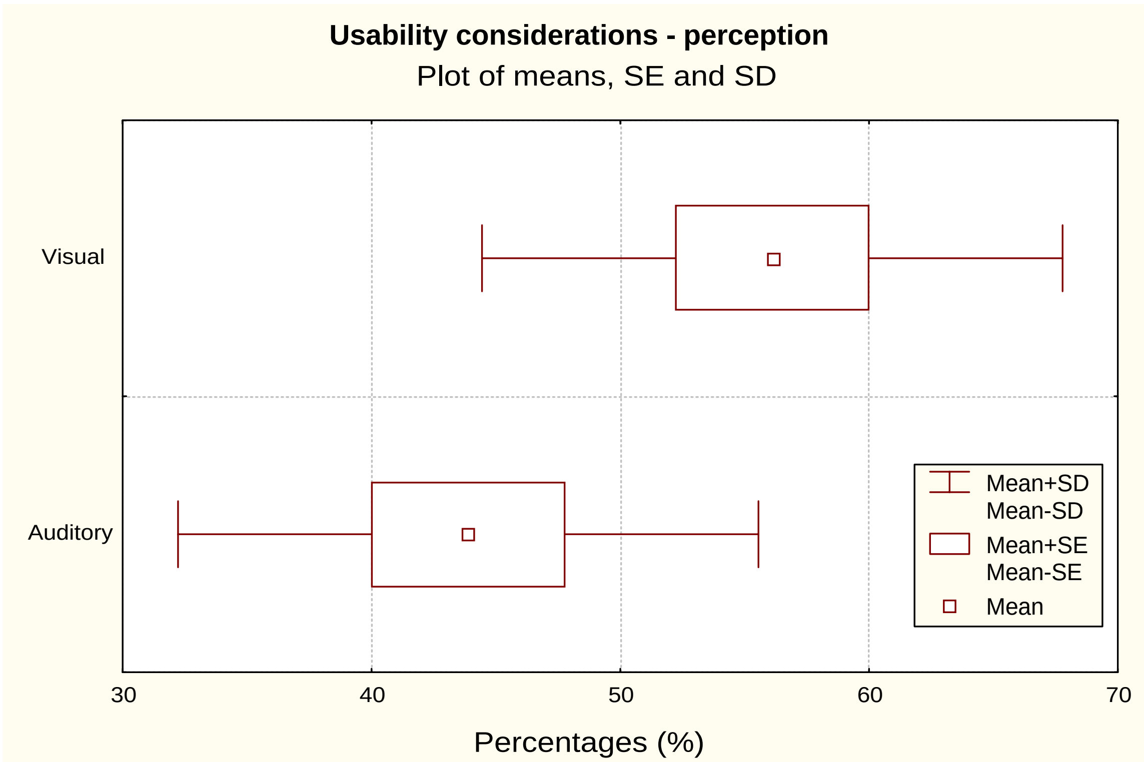

Figure 36: Perceptual Priorities

In Figure 36, respondents rated free-field visual perception (56 ± 12%) as having a somewhat higher priority in the headborne system design than free-field auditory perception (44 ± 12%).

Question 22: What priority would you assign to the following visual perception considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 37.

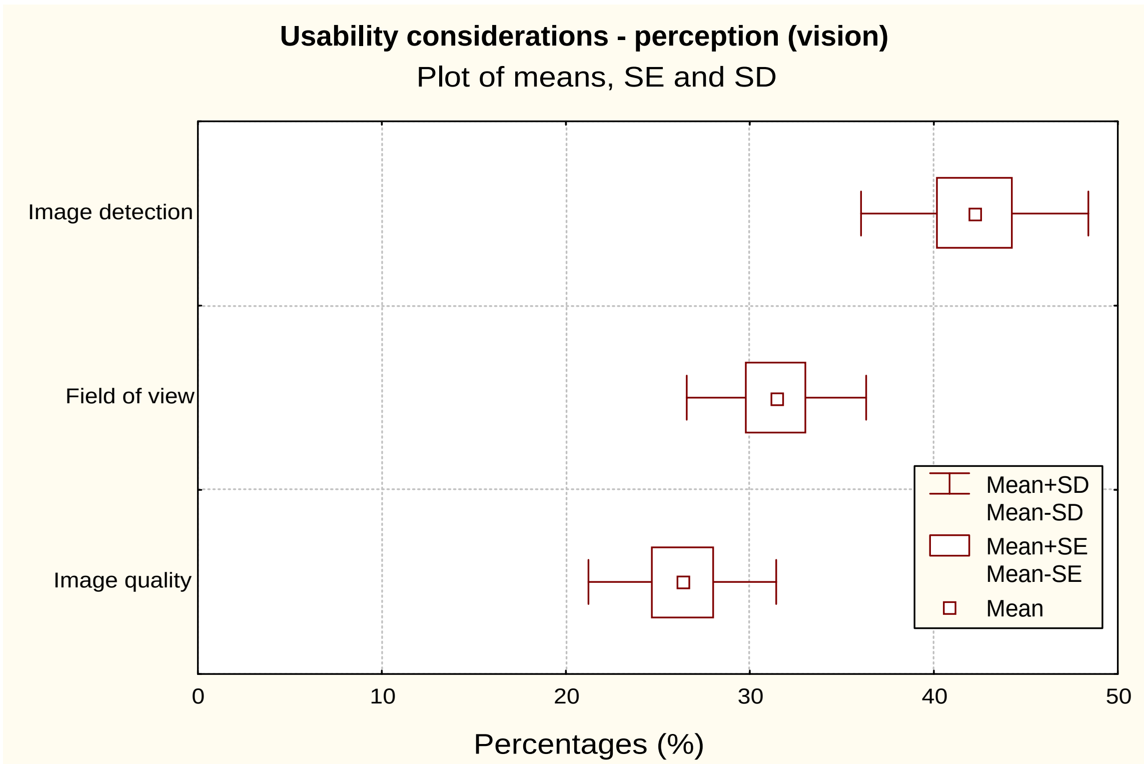

Figure 37: Visual Perception Priorities

In the area of visual perception (Figure 37), respondents rated image detection (42 ± 6%) as the highest priority, over field of view (31 ± 5%) and image quality (26 ± 5%). However, SMEs rated all of these factors as similarly “largely important”.

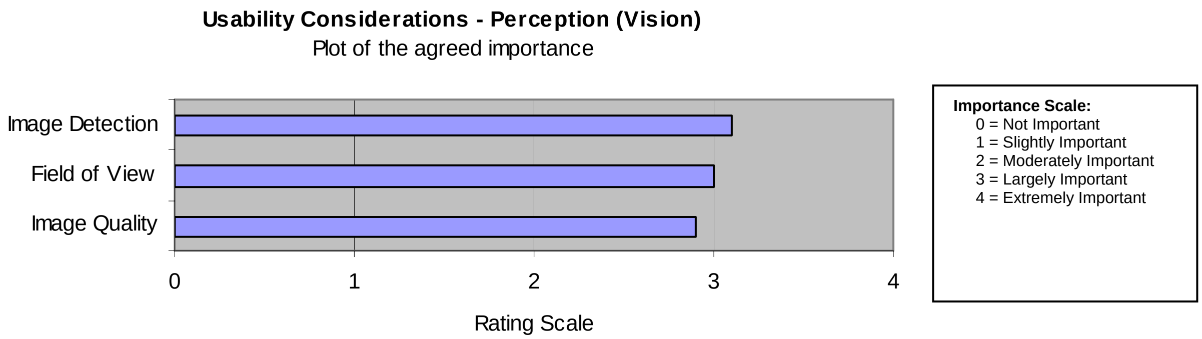

Figure 38: Visual Perception Consensus Importance Ratings

Question 23: What priority would you assign to the following auditory perception considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 39.

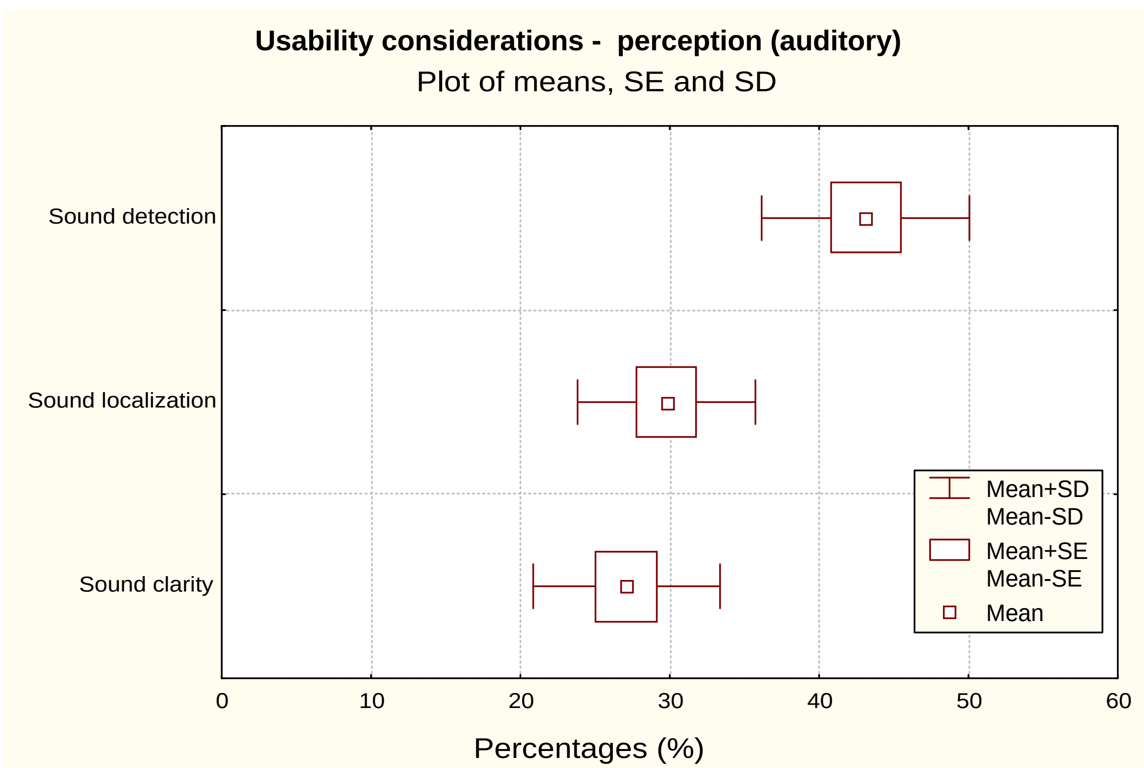

Figure 39: Auditory Perception Priorities

In the area of auditory perception (Figure 39), respondents rated sound detection (43 ± 7%) as the highest priority, over sound localization (30 ± 6%) and sound clarity (27 ± 6%). SME ratings of importance suggest that sound detection and localization are more important (“largely important or better”) to the headborne design than sound clarity (between “moderately and largely important”).

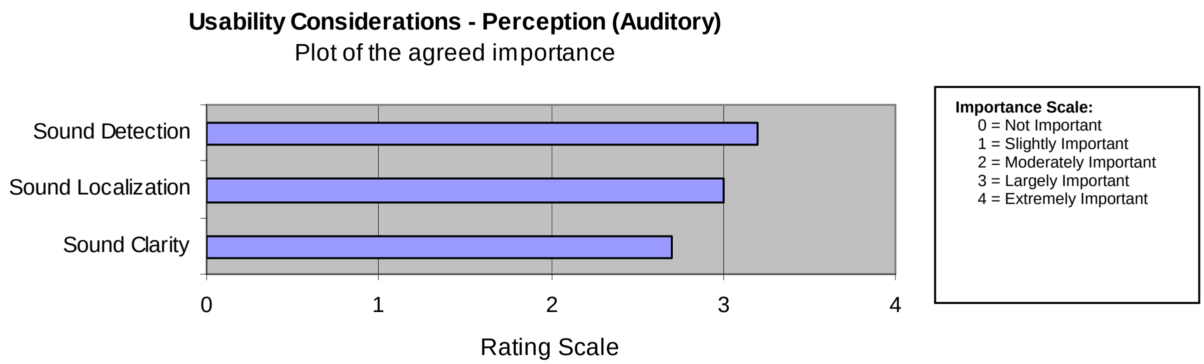

Figure 40: Auditory Perception Consensus Importance Ratings

Question 24: What priority would you assign to the following fit and adjustability considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 41.

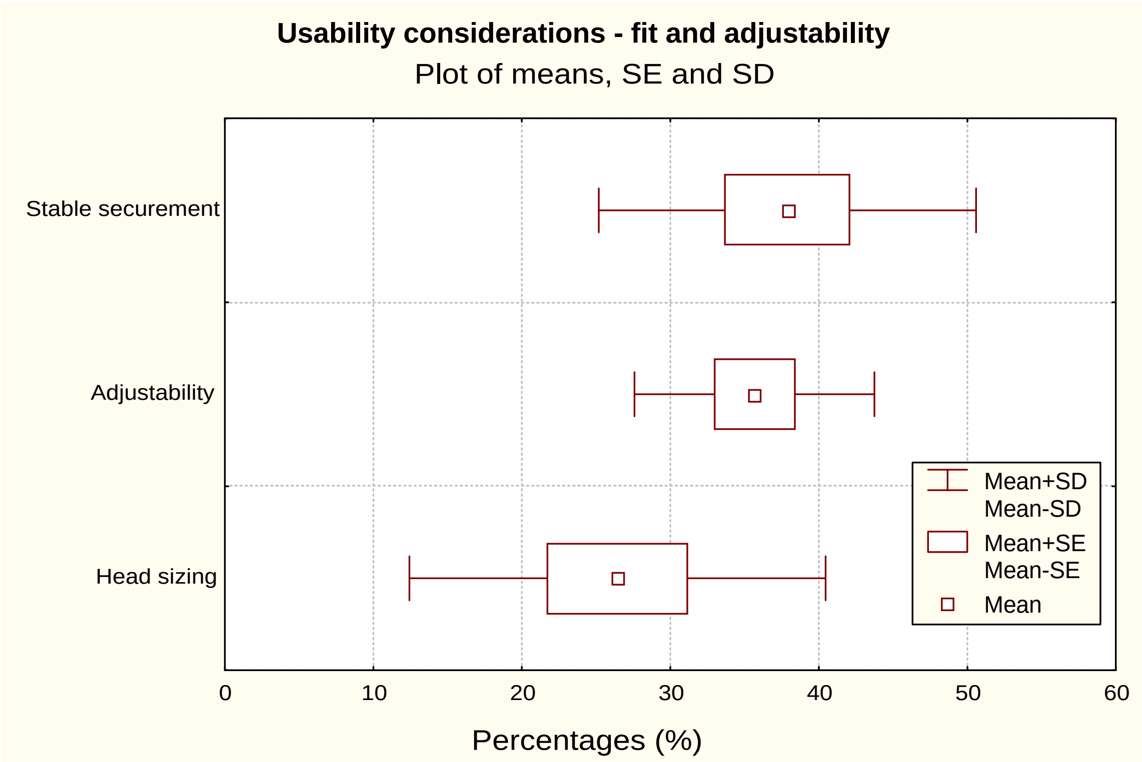

Figure 41: Fit and Adjustability Priorities

For helmet fit and adjustability priorities (Figure 41), respondents rated stable securement (38 ± 13%) and adjustability (36 ± 8%) as the highest priorities, followed by head sizing (26 ± 14%). In their importance ratings SMEs placed more emphasis on stable securement ("largely to extremely important") than adjustability ("largely important"), and considerably more than head sizing ("moderately to largely important") (Figure 42).
The use of integrated vision enhancement sensors and visual displays on future headborne systems, SME believed that a stable head platform would be most important for ensuring these other technologies can be used effectively.

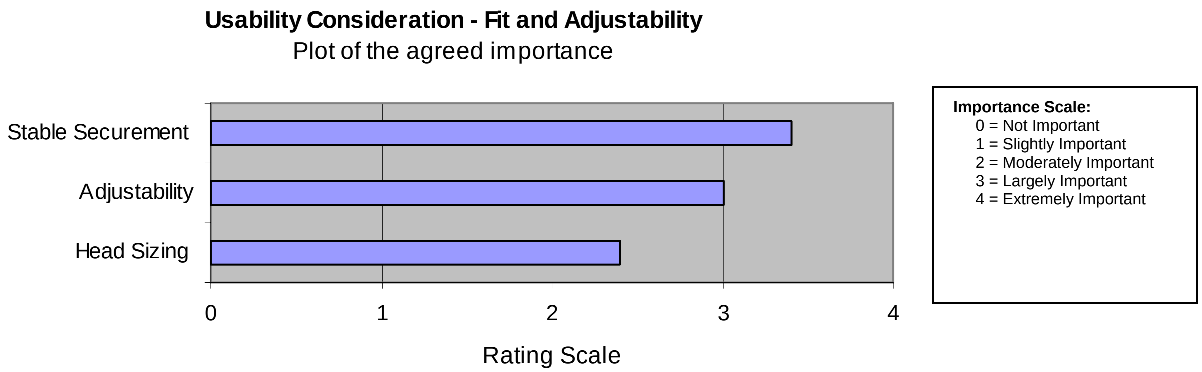

Figure 42: Fit and Adjustability Consensus Importance Ratings

Question 25: What priority would you assign to the following SIHS compatibility considerations? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 43.

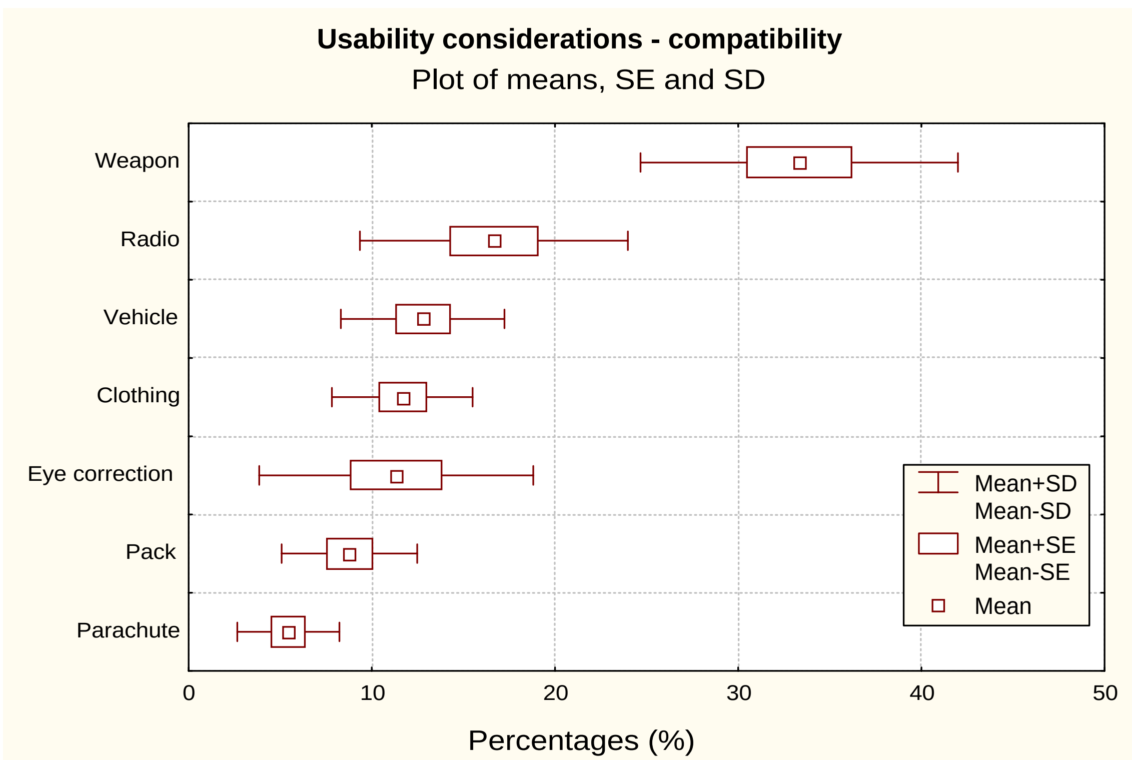

Figure 43: Compatibility Priorities

For compatibility priorities (Figure 43), respondents rated weapons compatibility (33 ± 9%) highest, followed by radio compatibility (17 ± 7%) as a distant second. In their importance ratings SMEs considered weapon and radio compatibility to both be key design issues ("largely to extremely important"). Compatibility with corrective eyewear was also essential ("largely important") (Figure 44).

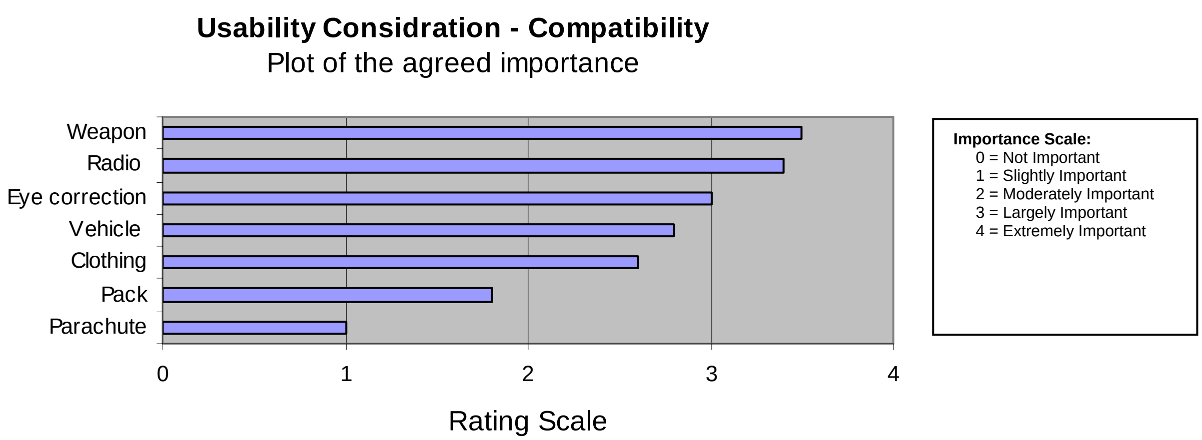

Figure 44: Ballistic Protection Consensus Importance Ratings

Question 26: What priority would you assign to the following physical comfort capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Figure 45.

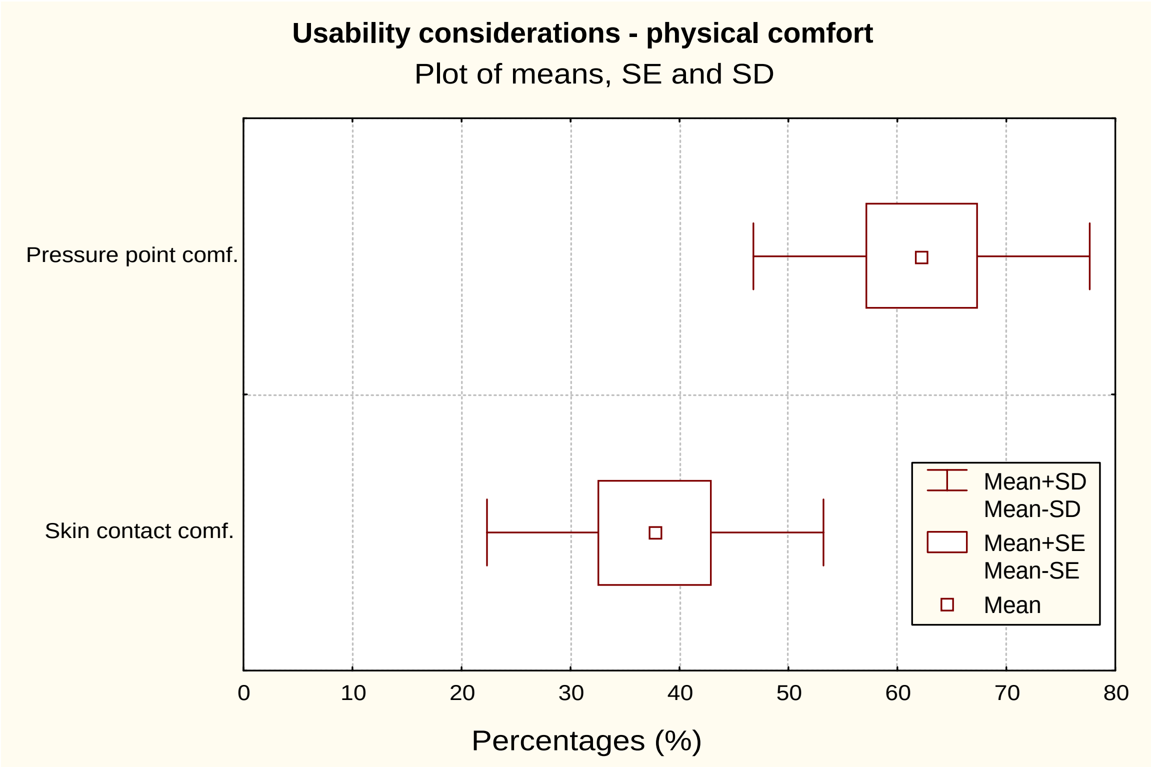

Figure 45: Physical Comfort Priorities

For physical comfort priorities (Figure 45), respondents rated pressure point comfort (62 ± 15%) significantly higher than skin contact comfort (38 ± 15%). These ratings were matched by the SME importance ratings with pressure point comfort ("largely important") being rated noticeably higher than skin contact comfort ("moderately to largely important") (Figure 46).

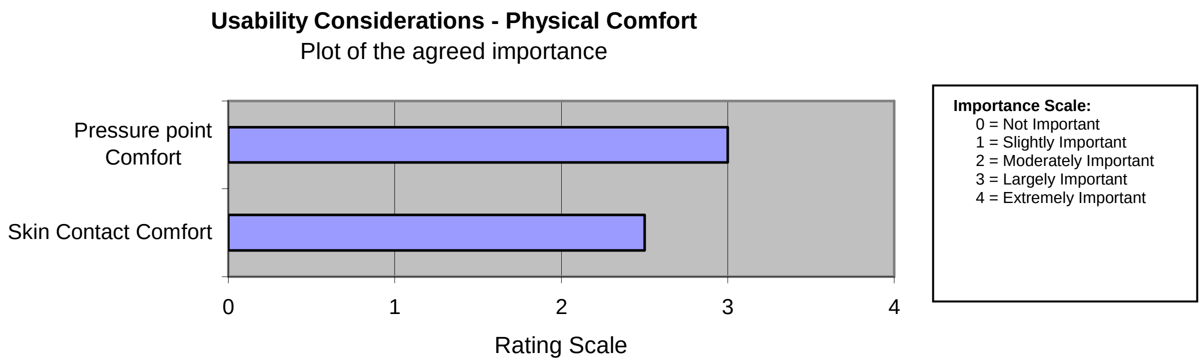

Figure 46: Physical Comfort Consensus Importance Ratings

Question 27: What priority would you assign to the following SIHS ease of use capabilities? Allocate the 100 percentage points available according to your priorities.

Respondent results are summarized below in Table 47.

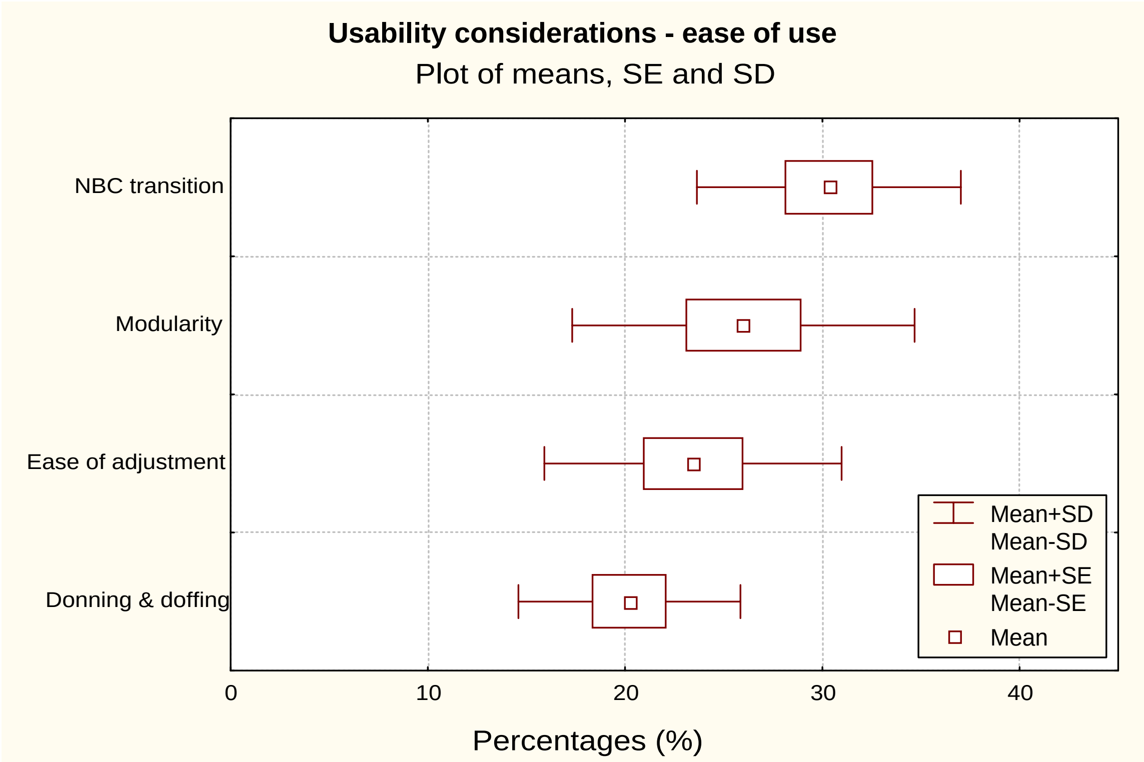

Figure 47: Ease of Use Priorities

For ease of use priorities (Figure 47), respondents rated NBC transition (30 ± 7%) somewhat higher than modularity (26 ± 9%), ease of adjustment (23 ± 8%), and donning & doffing (20 ± 6%). Similarly these criteria were also rated as similarly important at“largely important” or slightly better (Figure 48).

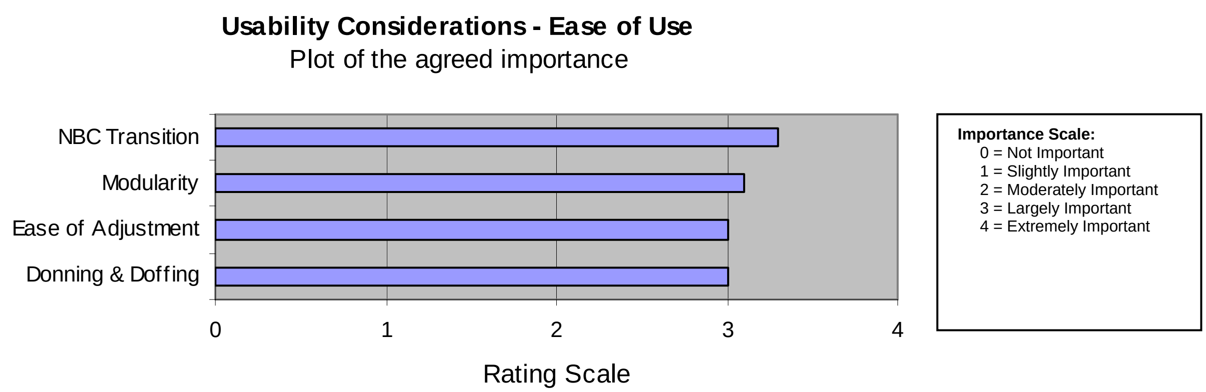

Figure 48: Ease of Use Consensus Importance Ratings

Question 28: What importance would you assign to the following SIHS ingestion considerations?

Respondent results are summarized below in Figure 49.

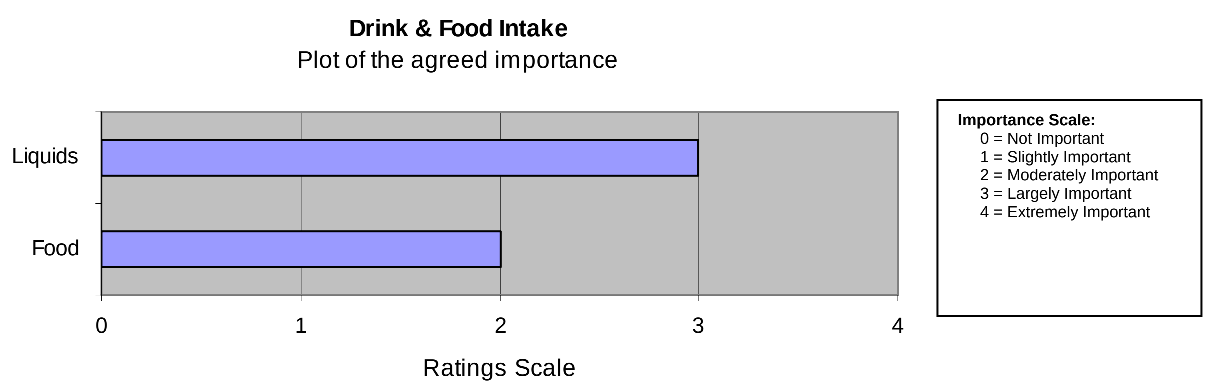

Figure 49: Intake Consensus Importance Ratings

Respondents indicated that liquid intake for the purpose of maintaining adequate hydration was significantly more important to the SIHS design than eating. Eating can be more infrequent and scheduled to suit breaks in the operational situation whereas hydration must be able to occur more frequently and must be able to be performed on the move.

3.10 Summary of Importance Ratings

Importance ratings for System Capabilities and Usability Criteria were sorted from the highest to lowest rating and are displayed in Figures 50 and 51 respectively. Generally, the Usability Criteria were rated higher than the System Capabilities requirements. For Usability, 67% of ratings were "largely important" or higher whereas only 31% were rated as highly for System Capabilities.

Within System Capabilities, the highest ratings were assigned to antennae, protection, communications, and enhanced vision. The GPS and radio antennae were the highest rated detectors, followed closely by a Combat ID detector. Protection ratings were highest for fragmentation (high and low velocity), CB respiratory, directed energy (low for eyes), and impulse noise threats. Communications devices for audio display and speech input, as well as enhanced vision with fusion, image intensification, and thermal imagery, were also rated "largely important" or higher. Lowest ratings were assigned to low threat, low severity protection capabilities (e.g. solar, nuclear flash, insects) and low likelihood detectors for a headborne system (e.g. radar, CB, nuclear).

Within Usability Criteria, compatibility with weapons, radios, CB protective equipment, and vision correction devices (e.g. spectacles) were rated very highly. Thermal comfort for heat and pressure point comfort were important, as were the control of physical limits in the design of the headborne system (i.e. total weight, load balance, and range of head/neck motion). Any future headborne system must provide stable securement, good fit adjustability, and be easy to don and doff. By its design, the headborne system shall not obstruct or diminish free-field hearing or vision, and shall minimize encapsulation stress. Component capabilities will be modular and the design shall ensure that a soldier can easily access fluids for hydration. Lowest ratings were given for food intake and compatibility with the rucksack and parachute.

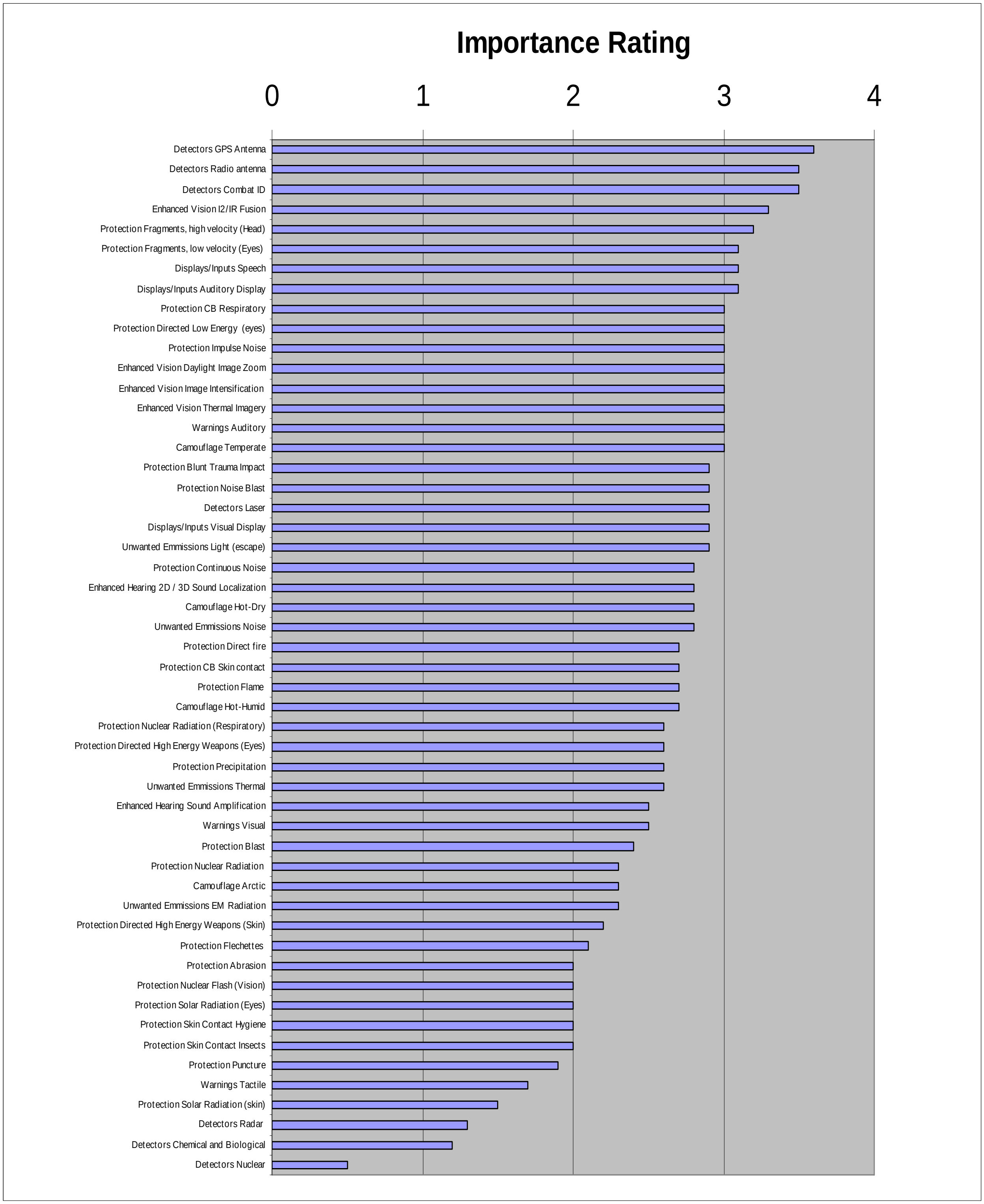

Figure 50: System Capabilities Summary

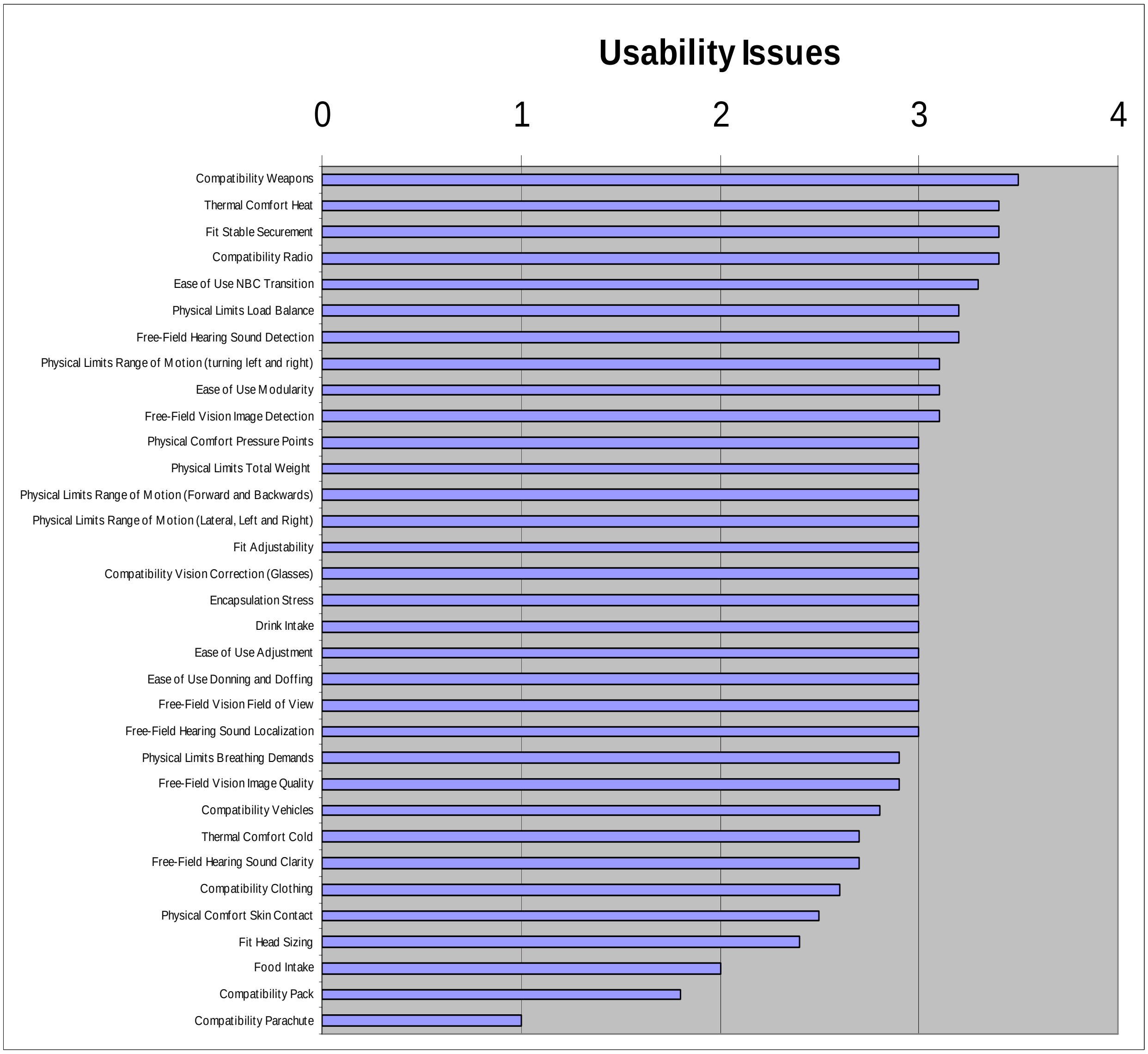

Figure 51: Usability Criteria Summary

4 Discussion

Based on the priorities and importance assigned by Subject Matter Experts to select system capabilities and usability criteria, the following general direction can be applied to any future headborne system design.

The SIHS headborne system should be designed with warfighting in mind; predominantly for high tempo operations (e.g. attacking, defending, fighting patrols). The highest priority system capability for the headborne system is protection. Chief among these is protection against high and low velocity fragments. Given the increasing prevalence of IEDs and VIEDs in today's conflicts, fragmentation protection will need to protect vital areas of the neck, the back of the head, and the face, as well as the "skull cap" and impact protection currently provided by conventional helmet designs. The blast injury threat has increased in an IED threat environment and SMEs recommended that protection against blast should be a high priority for research and design development. Similarly, blast and impulse noise injury to the ears has been identified as important from both a protection and a command and control perspective. The future headborne system also needs to integrate CB protection for skin and respiration although SMEs indicated that design preference should be given to warfighter effectiveness in conventional warfare scenarios and that they were willing to accept some tradeoffs in CB integration as long as CB protection was not compromised.

Enhancements to soldier vision were also considered a high priority capability, including daylight image enhancement, image intensification (night vision), thermal imagery, and I^2/IR fusion. Enhanced hearing was judged to be valuable but not as important as enhanced vision. SMEs assigned very high importance to the inclusion of GPS and radio antennae on the helmet, as well as any Combat ID detector technology. For camouflage, SMEs indicated that temperate and hot environments were most important and that any future system needed to manage light, noise, and thermal emissions to avoid detection by the enemy.

The highest priority usability considerations included thermal comfort in the heat, given the higher potential for heat casualties in hot, arid environments of ongoing and future conflicts. Compatibility with weapons, CB protective equipment, and corrective vision spectacles were seen to be essential for the dismounted rifleman role.

SME respondents rated a much higher proportion of usability considerations as "largely important" or better (67%), as compared to their ratings for system capabilities (31%). This emphasis on usability reinforces the notion that a successful headwear integration must be minimally invasive to the wearer, provide meaningful enhancements in soldier capability, be compatible with other clothing and equipment, seamlessly function within the activity, space, and environmental constraints of operations, and be easy to use and maintain. Insufficient consideration of human factors usability and soldier performance issues can render the most promising technologies and design concepts as failures in the eyes of soldiers critical of carrying additional weight and bulk on their heads.

5 REFERENCES

Tack, D.W. (2005) Development of Soldier Integrated Headwear System Requirements. DRDC Toronto CR 2005-028, Department of National Defence.

ANNEX A:

PRELIMINARY HEADWEAR SYSTEM REQUIREMENTS

A: SYSTEM CAPABILITIES

1. PROTECTION

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
1.1 Ballistic				
	1.1 Direct Fire	The IHS shall protect against direct fire threats.	Representative threats include: ρ V50 of 710 m/s for Rifle 7.62 Ball (9.5 gm) ρ V50 of 800 m/s for 5.56 SS109 (4.0 gm) ρ V50 of 360 m/s for Pistol 9mm NATO (8.04 gm) ρ V50 of **610 m/s** for **1.1 g** (1.1 Ballistic protection)	Integrated protective clothing and equipment performance baseline 970481A p 13 Canadian Helmet p4
	1.2 Fragments (head)	The IHS shall protect the head against fragmentation weapon threats. There shall be no spall resulting from a fragment impact.	ρ V50 of 700 m/s for 1.1 gm fragment (634 m/s minimum)	Integrated protective clothing and equipment performance baseline 970481A p 14
		Following fragment strike, the backface transient deformation of the ballistic helmet shell shall not impact the head.	ρ Backface deformation not to exceed 20 mm when struck by a non-perforating 1.1g fragment-simulating projectile at 560 m/s ρ The indent is less than 20 mm at **580** m/s (1.1 Ballistic protection	Canadian Helmet p4
	11.1 Fragments (eyes)	The IHS shall protect the eyes against fragmentation weapon threats. There shall be no spall resulting from a fragment impact.	ρ V50 of 200 m/s for 1.1 gm fragment (acceptable but protection level for head preferred) ρ The visor has V50 of better than **210 m/s** for FSP of **0.325g (1.1 Ballistic impact)** ρ To ensure adequate protection coverage for the eyes, a probe test will be used. There shall be no contact with the headform eye from the nasal and superior directions, at angles less than 60^{o} from the inferior direction and 110^{o} from the temporal direction.	Integrated protective clothing and equipment performance baseline 970481A p 14

	11.2 Low Velocity Particles (eyes)	The IHS shall protect the eyes against low velocity particles (e.g. sand, dust).		
	1.3 Flechettes	The IHS shall protect against flechette threats.	Representative threats include: ρ V50 of 500 m/s for 2.2 mm diameter/1.4 gm flechette (grenade) ρ V50 of 1400 m/s for 1.9 mm diameter/0.66 gm flechette (small arms) ρ V50 of 400 m/s for 2.5 mm diameter/1.28 gm flechette (TK gun) ρ V50 of 350 m/s for 2.25 mm diameter/0.82 gm flechette (artillery)	Integrated protective clothing and equipment performance baseline 970481A p 15
1.2 Blast				
	1.4 Blast	The IHS shall protect the wearer's head against blast effects.	ρ 50 kPa positive pressure for 1.0 second. ρ 57 kPa positive pressure for 10 msec.	Integrated protective clothing and equipment performance baseline 970481A p 15
1.3 PUNCTURE				
	1.6 Puncture	The IHS shall prevent or resist shell penetration by sharp objects.	ρ Penetration not to exceed 5mm with a 42 joule bayonet strike ρ	Integrated protective clothing and equipment performance baseline 970481A p 20
1.4 BLUNT TRAUMA				
	1.5 Impact (low velocity)	The IHS shall attenuate low velocity impact to the head.	ρ 2*50* G for a 90 Joule crown impact *(Parachutist)* ρ *250 G for 65J impact at any other location on the helmet ballistic shell (Parachutist)* ρ 150 G for a 55 Joule crown impact *(Dismounted inf.)* ρ *150 G for 30J impacts at any other location on the helmet ballistic shell (Dismounted Inf.)* 1.9.1 HIC less than 1000 for head/helmet crash at **5 m/s** against hard surface. 1.3.2 The head is protected against collision with **heavy objects** or resulting from a **fall.** **(**1.3.2 Collision with objects)	Canadian Helmet p5

	1.7 Abrasion	The IHS shall protect the head against external abrasion mechanisms to the maximum extent possible.		Integrated protective clothing and equipment performance baseline 970481A p 21
1.5 NUCLEAR				
	11.6 Nuclear Flash	The IHS shall provide open eye protection for nuclear flash.	ρ open eye protection of optical density 4.0, shutter closure of optical density of 3.0 in 90 msec ρ 1.4.2 Flash optical density **3.5**-4 wide wavelength band	Integrated protective clothing and equipment performance baseline 970481A p 22 --EDU-2/P, PLZT
	Radiation Particles	The IHS shall provide a barrier against beta and alpha emitting radioactive particles from contacting the skin surfaces of the head.		Integrated protective clothing and equipment performance baseline 970481A p 22
	1.14 Harmful radiation	1.6.1 Head and neck are protected against nuclear heat flash.	1.6.1 No surpassing of pain threshold (Stoll-Chianta) for 60 J/cm2 in 1 sec. Less than 20% 2nd and 3rd degree skin burn at 120 J/cm2 in 1 sec.	
		1.6.2 EM 1.6.2 Protection against EM radiation desired.		
		1.6.3 Radioactivity 1.6.3 Protection against low dose radio-activity desired.		

1.6 CHEMICAL / BIOLOGICAL				
	1.11 Percutaneous NBC (Skin)	The IHS shall provide liquid and vapour percutaneous chemical agent resistance within 30 seconds (15 seconds preferred) of a chemical attack from a TOPP medium state and 180 seconds (90 seconds preferred) from a TOPP low	**Permeation shall be less than the breakthrough values defined below after 16 hours exposure to a challenge concentration o 10 microgram/liter.** ρ HD agent – breakthrough value 4 microgram/cm^2 ρ GD agent – breakthrough value 6 microgram/cm^2	Integrated protective clothing and equipment performance baseline 970481A p 21
		The IHS shall provide a barrier to percutaneous biological agents and natural disease vectors within 30 seconds (15 sec preferred) of a biological attack from a TOPP medium state and 180 seconds (90 sec preferred) from a TOPP low state.		Integrated protective clothing and equipment performance baseline 970481A p 22
		The IHS shall provide 48 hours of percutaneous protection.	1.2.2 Skin protection against liquid: 5-10 g/m2 in **24 hours**, against vapour: Ct = 30 g.min/m3 1.2.2 Liquid agents will not reach the skin in less than **6 hours**.state.	Integrated protective clothing and equipment performance baseline 970481A p 22
	21.4 De-contamination	The IHS shall be capable of being decontaminated in the field under normal operational conditions.		
	21.1 NBC Protection (Respiratory)	The IHS shall provide respiratory protection against agents and vapour concentrations for the durations / persistence levels specified in the NATO Triptych respirator requirements.	ρ NATO Triptych Standard (AC/255) ρ 1.2.1 Protection factor for war agents is 10^4, for biological agents in aerosol phase 10^5. Aerosol and gas filter capacity should be sufficient for a week. Ct: gases 25 g.min/m3, Sarin 35 g.min/m3	17
	21.7 CO_2	No hyperventilation due to CO_2 build-up.	ρ The average concentration of CO_2 during inhalation portion of the breathing cycle shall not exceed 2.5 % by volume ρ *CO_2 Concentration* ρ *3-6% headaches, dyspnea and perspiration* ρ *6-10% headaches, dyspnea, perspiration, tremers, visual disturbance and unconsciousness* ρ *over 10% Unconsciousness* ρ CO_2 less than 1%, dead space less than 200 ml.	JSCESM p8 *Industrial Gas Division Air products and chemicals, Inc.*

1.7 BURNS				
	1.8 **Flame**	The IHS shall provide burn protection to the face and head. 1.7 Head and **neck** are protected against flames and heat radiation from fire.	ρ Thermal Protective Performance of TTP 30	Integrated protective clothing and equipment performance baseline 970481A p 19 --ASTM 4108-87--
		The materials in the shell shall inhibit flammability and be self-extinguishing.	• *Shall not sustain a flame in ambient air when the source is removed* • *Will not melt when in contact with surfaces having a temperature of 200° C or less* •	Integrated protective clothing and equipment performance baseline 970481A p 19
			• *See 4.3.5 shell resistance to fire test*	Canadian Helmet p9 and 16
	1.10 Solar Radiation (Skin)	The IHS shall provide effective protection against sunburn from UVA and UVB when fully and continuously exposed to direct sunlight for 8 hours.	1.8.1 Solar radiation of 1000 W/m2 will not increase interior temperature more than 5 C over air temperature.	Integrated protective clothing and equipment performance baseline 970481A p 21
	11.5 Solar Radiation (eyes)	The IHS shall provide effective protection against eye damage from UVA and UVB when fully and continuously exposed to direct sunlight for 8 hours.	ρ 1% maximum transmittance for UVB and UVA.	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2

	1.9 Directed Energy Weapons (Skin)	The IHS shall provide burn protection to the skin and eyes against exposure to continuous-wave and pulsed lasers.	ρ > 2x10*2 J/cm2 for 0.3-1.1 um pulse (skin) ρ > 0.1 W/cm2 for 10.6 um continuous (skin) ρ > 5x10*-6 J/cm2 for 0.3-1.1 um pulse (eyelids)	Integrated protective clothing and equipment performance baseline 970481A p 19 --ANSI Z136.1 (1993)-
	11.3 Directed Energy Weapon Eyes (high power)	The IHS shall protect the eyes against high-powered continuous-wave and pulsed lasers.	ρ > 5x10*-6 J/cm2 for 0.3-1.1 um pulse	Integrated protective clothing and equipment performance baseline 970481A p 19
	11.4 Directed Energy Weapon Eyes (low power)	The IHS shall the eyes and vision equipment from the damaging effects of low power lasers (e.g. ranging, designating, targeting, or guidance lasers).	ρ open eye protection for 10 sec. exposure of 1 mW/cm2 against Ruby (694 nm), Neodymium Yag and glass (1060-1064nm), and Doubled Neodymium YAG (532nm) ρ Protection of vision equipment will be provided for visual and image intensifier frequencies, as well as threats in the thermal 3 – 5 and 8 – 14 micron bands. ρ The optical density should be at least 4.0 for a radiant exposure of 20 mJ/cm2 for Q-switched emissions less than 40 nanoseconds and greater than 1 ns. ρ 1.4.1 Laser optical density **3.5**-4 at **694-1060 nm**	Integrated protective clothing and equipment performance baseline 970481A p 23
1.8 NOISE				
	15.1 Blast	The IHS shall protect the ears against blast effects.	ρ 50 kPa positive pressure for 1.0 second. ρ 57 kPa positive pressure for 10 msec.	Integrated protective clothing and equipment performance baseline 970481A p 15
	15.2 Impulse Noise	The IHS shall provide hearing protection from impulse noise loading for a typical battlefield day (16 hrs).	ρ *135 dBA maximum pulse* ρ *Threshold of pain:* ρ *115 dBA to 140 dBA*	S.F.U. http://www.sfu.ca/sonic-studio/handbook/Threshold_of_Pain.html

	15.3 Continuous Noise	The IHS shall provide hearing protection from high continuous or intermittent noise levels for a typical battlefield day.	ρ Exposure levels: ρ 85 dBA for 16 hour duration exposure ρ *90 dBA for 8 hours duration exposure* ρ *92 dBA for 6 hours duration exposure* ρ *95 Dba for 4 hours duration exposure* ρ *97 dBA for 3 hours duration exposure* ρ *100 dBA for 2 hours duration exposure* ρ *103 dBA for 1 ¼ hours duration exposure* ρ *105 dBA for 1 hour exposure*	12,13 S.F.U. http://www.sfu.ca/sonic-studio/handbook/Damage-Risk_Criteria.html NIOSH http://www.cdc.gov/niosh/98-126.html
1.9 SKIN CONTACT				
	1.12 Skin Contact Hygiene	The helmet system, inclusive of the shell, suspension and harness, shall not support fungus growth.		Canadian Helmet p9
	1.10 Insects	The IHS shall protect against biting insects and prevent ingress of insects into the helmet interior.	Openings less than 2 mm slit or mesh. (1.10 Insects separate criteria)	Integrated protective clothing and equipment performance baseline 970481A p 20
1.10 PRECIPITATION				
	1.13 Precipitation	The helmet shell shall not gain more than 5% in weight following water immersion. *In addition to protective coating of the helmet shall show no softening, peeling or blistering after water immersion*		Canadian Helmet p10
	1.13 Precipitation	When closed, the IHS shall provide a water-resistant barrier to precipitation, even under high winds.	The waterproof properties of the system shall be in accordance with STANGA 4364 1.8.4 The IHP is drip proof in upright and supine position. No dripping in the collar.	Integrated protective clothing and equipment performance baseline 970481A p 18

2. ENHANCEMENTS AND DETECTORS

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
2.1 ENHANCED VISION				
	14.1 Daylight Image Zoom	The IHS shall provide a daylight image zoom capability (either integrated into the IHS or displayed in the IHS display from another device) to enhance daylight detection, recognition, and identification of battlefield targets.	*Magnifications:* ρ *7:1 change in magnification can be tolerated by pilots*	*A. p 140*
	14.2 Image Intensification	The IHS shall provide an image intensification enhancement capability (either integrated into the IHS or displayed in the IHS display from another device) for nighttime detection, recognition, and identification of battlefield targets.		
	14.3 Thermal Imagery	The IHS shall provide a thermal vision capability (either integrated into the IHS or displayed in the IHS display from another device) to enhance daylight and nighttime detection, recognition, and identification of battlefield targets.		
	14.4 I2/IR Fusion	The IHS shall support the capability for I^2/IR fusion (either integrated from devices on the IHS or from other devices) to enhance day and night vision performance.		
	14.5 Detection Performance	The enhanced vision capability of the IHS shall improve target detection ranges.	Example 90% target detection ranges for person target: ρ Normal clear day = 2340 m ρ Normal clear night = 1600 m ρ Poor visibility day = 570 m ρ Poor visibility night = 460 m	Integrated protective clothing and equipment performance baseline 970481A p 37

	14.6 Recognition Performance	The enhanced vision capability of the IHS shall improve target recognition ranges.	Example 90% target recognition ranges for person target: ρ Normal clear day = 800 m ρ Normal clear night = 570 m ρ Poor visibility day = 200 m ρ Poor visibility night = 110 m	Integrated protective clothing and equipment performance baseline 970481A p 38
	14.7 Identification Performance	The enhanced vision capability of the IHS shall improve target identification ranges.	Example 90% target identification ranges for person target: ρ Normal clear day = 570 m ρ Normal clear night = 290 m ρ Poor visibility day = 110 m ρ Poor visibility night = 60 m	Integrated protective clothing and equipment performance baseline 970481A p 38
2.2. ENHANCED HEARING				
	18.1 Sound Amplification	Sounds shall be detected at greater ranges than natural free field hearing, when using the selective IHS capability to display amplified sound.	ρ The IHS shall provide up to a 10 dB gain in sound amplification through the use of an IHS integrated device or displayed from a remote device. Ideally, this sound amplification capability would be directional on the head or a remote device.	34 Integrated protective clothing and equipment performance baseline 970481A p 37
	18.2 2D or 3D Sound Localization	Localization of sound with the IHS (i.e. range and bearing) shall be as effective as free-field localization in both horizontal and vertical planes. Ideally, sound will be represented in such a way as to indicate the distance to the sound source.		
2.3. DETECTORS				

	9.1 Detectors	The IHS shall be capable of being a mounting surface for a number of possible detector systems (i.e. laser and radar detectors, chemical / biological / radiation detectors, GPS and radio antennae, etc).	ρ The integration design of all IHS detectors shall conform to the IHS load forces (see Requirement 4.) and snagging (see Requirement 6.1) requirements.	
	9.2 Laser Detectors	It shall be possible to mount laser detector devices on the IHS.	The IHS-mounted detectors shall be capable of detecting (95%) the following laser radiation types: ρ Laser range finder (pulsed) ρ *Designator (continuous wave)* ρ Directed energy weapon low power (continuous wave) ρ Directed energy weapon high power (pulsed) ρ The placement of laser detectors shall ensure that the bearing of the laser source can be determined to within 200 mils.	Integrated protective clothing and equipment performance baseline 970481A p 34
	9.3 Radar Detectors	It shall be possible to mount radar detector devices on the IHS.	ρ The IHS-mounted radar detectors shall be capable of detecting signals in the Ku, X, and MM bands at a distance of 5 km with a 90% probability of detection. ρ The placement of radar detectors shall ensure that the bearing of the radar source can be determined to within 800 mils.	Integrated protective clothing and equipment performance baseline 970481A p 35
	9.4 NBC Detectors	*It shall be possible to mount NBC detector devices on the IHS.*	ρ *90% detecting the following:* ρ *Nerve agent , <0.1 mg/m3 120sec and <5mg/m3 30 sec* ρ *Blistering agent, <10 mg/m3 30 sec* ρ *Blood agent < 20 mg/m3 30 sec* ρ *Identify agent type and concentration levels*	*Integrated protective clothing and equipment performance baseline 970481A p 35*
	9.5 Combat ID		ρ	

3. WARNINGS / FEEDBACK

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
	17.2 Auditory Warnings	The IHS auditory display shall be capable of one and two element warning displays to achieve distinctive, complex sounds at a minimum of **20 dBA** above the ambient noise environment.	ρ *Detectability of sound:* ρ *Signal level 16 dB above the masked threshold will be sufficient for situations requiring rapid response to a signal* ρ *Warning Signal should be less than 30 dB above the masked threshold, in order to minimize operator annoyance and the disruption of communications* ρ *Nonauditory channels should be considered for environments that require sound levels above 115 dB* ρ *Tonal display:* ρ *The pitch of warning sound should be between 150 and 1,000 Hz.* ρ *Signal should have at least four dominate frequency components, within the first 10 harmonics, in order to minimize masking affect* ρ *Signal should have harmonic rather than inharmonic spectra* ρ *The frequency range of the signal should be restricted within 500 to 5000 Hz, with the dominate frequency components within the range of 1,000 to 4000 Hz.*	12,13 D p118, 119
		The IHS warning signals must be capable of being sufficiently distinctive such that they are unambiguously recognized within 0.5 seconds of initiation. In the worst case, signals must convey full meaning within 2.5 seconds of initiation.		13
	Visual Warnings	(see Visual Display Section)		13

4. SPEECH INPUT / COMMUNICATIONS

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
4.1 Input	19.1 Radio Communications	The IHS shall provide an input capability (e.g. microphone) for radio communications.	ρ The IHS display shall enable the wearer to comprehend at least 90% of displayed speech correctly. ρ The speech intelligibility of the IHS auditory displays shall enable the wearer to achieve 90% as measured by the phonetically balanced (PB) monosyllabic word intelligibility test or a minimum score of 97% on the modified rhyme test (MRT).	12, 13
	19.2 Speech *recognition* to Computer	The IHS shall provide a voice-input capability to a voice recognition system.	ρ The IHS microphone shall provide sufficient sound clarity and low *background* noise levels to ensure a voice recognition system accuracy of 95 – 99%	50
	19.3 Microphone Snagging	**The microphone design shall ensure that the risk of any snagging, which could lead to neck injury, microphone loss, or system damage, is minimized.**		
	19.4 Non-detection	The IHS microphone shall have sufficient sensitivity and clarity to enable whispered communication.		
	19.5 Thermal Comfort	The IHS microphone shall not generate undue heat build-up or restrict airflow ventilation.		
4.2 Local Capability	20.1 Local Speech	The IHS shall provide the capability for local speech communication in all IHS configurations, including full encapsulation.	ρ **While wearing the IHS in any configuration, the User shall be able to engage in normal voice communications to a minimum distance of 5 m.** ρ **The User shall be able to engage in whispered voice communications to distance of 2 m.**	Integrated protective clothing and equipment performance baseline 970481A p 56

		The IHS shall not reduce or limit the speech intelligibility of local speech communication. 2.3.1. The system will guarantee intelligibility in a **noisy environment**.	ρ The speech intelligibility of the IHS in local voice communications shall meet the requirements in 18.1 for the listener. ρ *Ambient noise levels less than 50 dB, Since voice level increase when noise levels are above 50 dB* ρ *For ambient noise impact on Telephone conversation:* ρ *Less than 60 dB ambient noise satisfactory* ρ *60 to 75 dB ambient noise Difficult* ρ *Greater than 75 dB ambient noise unsatisfactory* ρ 2.3.1. The system will guarantee intelligibility in a **noisy environment**.	S.F.U. http://www.sfu.ca/sonic-studio/handbook/Speech_Interference_Level.html

5. VISUAL DISPLAY

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
	13.1 Display Resolution	The resolution of the IHS display shall be sufficient to enable the User to detect, recognize, identify, and interpret all textual, graphic, pictorial, and video imagery to the extent required in each soldier task.	ρ The IHS display shall provide a minimum resolution of 640 x 480 (VGA). A resolution of 800 x 600 (SVGA) is preferred. ρ *1600 X 1200 Ultrasharp and Ultra XGA + TFT* ρ *1400 x 1050 Super XGA*	10,19
		The IHS display shall maximize display resolution (i.e. 1 arc minute) by optimizing the relationships between pixel size, visual distance, visual angle, and field of view.	***Visual limits:*** ρ *1 arc minute / pixel* ρ *60 pixels / degree* ρ *0.291 milliradian / pixel*	10,19 C. p64, A. p122
	13.2 Display Luminance	Display luminance shall be adjustable by the User to enhance display luminance to adapt of the range of possible ambient lighting conditions (e.g. bright sun to night).	***Ambient lighting conditions:*** ρ *10,000 fc sunlit white cloud* ρ *0.02 fc complete darkness*	A. p 48, B. p 70

	13.3 Display Contrast	Factors affecting display contrast (i.e. ambient illumination, luminance, symbol or text size, environmental conditions, and presentation duration) shall be adjustable by the User to enhance display legibility.	***Contrast ratio (rule of thumb):*** ρ *minimum 6 Shades of grey (SOG)is recommended for display monochromatic video* ρ *minimum contrast ratio value of 3:1, with 7:1 as preferred value for display text*	14 A. 119
	13.4 Display Colour	Where colour coding is used, the IHS display shall be capable of displaying the number of colour levels necessary to satisfy the task requirements and conforms to User conventions.	**Colour conventions:** ρ Red = error, malfunction ρ Flashing Red = emergency condition ρ Yellow = caution, re-check ρ Green = go, ready ρ White = status indicator	12
		The IHS display shall be capable of displaying a minimum of 256 colours to support the display of alarms, warnings, maps, photographs, and video imagery.		**14**
	13.5 Dark Adaptation	When complete adaptation is required, the illumination of the IHS display shall be low-luminance red light.	ρ Low-luminance = 0.07 – 0.34 cd/m^2. ρ Red light = greater than 620 nm.	13
		When only partial adaptation is required, the IHS display shall provide adjustable low-luminance ambient illumination (preferably integral), as appropriate for specific applications.		**13**
		The rods are not sensitive to red light, so the eyes can be exposed to red light and still retain dark adaptation.	***Rod vision only for luminance levels below 10^{-3} cd/m^2***	***B. p37 - 39***
	13.6 Display Position	For critical display information or for viewing complex imagery, the IHS display information shall be capable of being displayed within close proximity to the User's normal line of sight	ρ Information should be capable of being displayed within 265 mrad (i.e. 15^{o}) of the normal line of sight (typically 15^{o} below horizontal).	12

		The position of the IHS display information shall be adjustable.	ρ Focus = +2 to – 6 diopters. ρ Fore / Aft adjustment = 16 mm. ρ Tilt = 8^{o} minimum. ρ Eye relief = 25 mm minimum ρ Interpupillary distance = 52 to 72 mm ρ Up / Down adjustment = 16 mm. ρ *Interpupillary distance = 50 to 74 mm (capture most adult females and males) C. p125* ρ *Interpupillary distance = 50 to 73 mm (MIL-STD-1472D) C. p125* ρ *Exit pupil greater than 10mm dia. C. p91* ρ *Exit pupil minimum diameter of 14mm A. p140-141*	19, C.p89 (eye relief) C. p91 and 125 A. p 140-141
		The information displayed by the IHS shall be capable of being positioned at an off-set angle to the User's primary field of view for the purposes of referral tasks.	ρ The IHS display shall minimize any obstructions and distortions to the User's free field of view.	
		The position of the IHS display shall be able to be movable by the User to support a requirement for either left or right eye dominance.		
	13.7 Physical Comfort	The weight of the IHS display complete shall not exceed static and dynamic load limits.	ρ Sustained static joint forces at the neck shall not exceed 20% of the maximum voluntary contraction forces for a 50th percentile male (19.1 kg MVC). ρ Dynamic joint forces at the neck, during ballistic movements with incumbent acceleration forces, shall not exceed the maximum voluntary contraction forces for a 50th percentile male. ρ By its design, the integration of the IHS display shall minimize inertial forces and ensure that center of gravity requirements are not exceeded (see Requirement 4.3).	**42**
		The weight of the IHS display complete shall not exceed local muscular fatigue requirements.	ρ The duration of infrequent static joint forces, generated during IHS wear, shall not exceed the proportions of the maximum voluntary contraction force of a 50th percentile male, as determined by the Rohmert Curve. ρ The frequency of rhythmic contractions (i.e. contraction per minute), generated during IHS wear, shall not exceed the proportions of the maximum voluntary contraction force of a 50th percentile male, as determined by the Molbech Scale.	22

		The location of the IHS display shall remain secure, in relation to the eye, during vigorous physical activity and shall not require excessive tightening of the helmet retention to achieve the necessary stability.		
		The IHS display shall not cause ocular differences or mismatches in colour, brightness, or focus.		
	13.8 Thermal Comfort	The IHS display design shall not generate undue heat build-up or restrict airflow ventilation.		
	13.9 Display Response Time	Response times to the IHS display shall be no more than 250 ms for the detection and reaction to any displayed stimulus, provided that the User is anticipating the incoming information.		**27**
	13.10 Text	IHS displays shall be capable of displaying text in conformance to conventional design principles for printed text.	**Style standards:** ρ Width to height ratio = 75 – 80% ρ Stroke width = 1/7 – 1/8 symbol height (for maintaining dark adaptation), 1/6 – 1/7 (no maintenance of dark adaptation). ρ Spacing = minimum of one stoke width. ρ Word spacing = minimum of one character width. ρ Line spacing = minimum of ½ character width. **Image size:** ρ Alphanumeric characters should be scaled to subtend at least 15 minutes of visual arc, other complex shapes should subtend 20 minutes of visual arc.	14 13,14
	13.11 Symbols	IHS displays shall be capable of displaying symbology and graphics in compliance with the HCI guidelines detailed in MIL-HKBK-761A.		10,15
	13.12 Graphic	IHS displays shall be capable of displaying coloured maps, photographs, and video imagery.		

	13.13 image refresh rates	*IHS display shall be capable of image refresh rates of above 80 Hz in order for the soldier to not perceive flicker by the screen*	***Image refresh rates:*** ρ *Displays extended to more than 20°, and the luminance exceeds 100fL, then the display appears to flicker for frequencies up to about 80 Hz*	*C. p219*

6. AUDITORY DISPLAY

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
	17.1 Auditory Displays	The design of IHS auditory displays shall conform to the requirements and guidelines established in MIL-STD-1472D, MIL-STD-1800A, and MIL-HDBK-759B.		12,13,14
	17.3 Display Speech Intelligibility	The IHS shall not reduce or limit the speech intelligibility of radio communications or synthetic speech displays.	ρ The IHS wearer shall enable the wearer to comprehend at least 90% of displayed speech correctly. ρ The speech intelligibility of the IHS auditory displays shall enable the wearer to achieve 90% as measured by the phonetically balanced (PB) monosyllabic word intelligibility test or a minimum score of 97% on the modified rhyme test (MRT).	12,13
	17.4 Display Response Time	Response times to the IHS display shall be no more than 250 ms for the detection and reaction to any displayed stimulus, provided that the User is anticipating the incoming information.		27
	17.5 Local Voice Communications	In the event that free-field hearing is obstructed (e.g. full encapsulation), the IHS shall provide a means of receiving and displaying free-field voice communications.	ρ While wearing the IHS in any configuration, the User shall be able to detect and comprehend free-field voice communications at a minimum distance of 5 m.	Integrated protective clothing and equipment performance baseline 970481A p56
	17.6 Radio Communications	The IHS shall provide a means of displaying speech from radio communications.		
		The IHS shall be capable of displaying different radio net traffic to each ear.		

	17.7 Multiple Channel Displays	The IHS auditory displays shall be capable of displaying the same or different information to the right and left ear.	ρ The signal quality of the auditory displays shall ensure high signal clarity and low noise. ρ The displays shall ensure that three-dimensional sound can be clearly and accurately displayed to both ears.	
	17.8 Audio Signals	The IHS audio display shall be capable of generating auditory tones or periodic displays of automatic communication of limited information content (e.g. alarms, warnings, states).	ρ Auditory tonal information shall be displayed in the frequency range between 200 – 5000 Hz. ρ The temporal characteristics of the auditory display shall ensure that signals can be displayed for a minimum of 100 msec, with a 25 msec rise and fall time. Onset rates of 1 dB/msec with the final level below 90 dB are desirable. ρ The IHS auditory signals shall be capable of presenting tonal information at a level of 6 – 30 dB above the masking threshold (ambient noise level at the ear). In situations that require a rapid response to a signal, the IHS signal shall be capable of being presented 16 dB above the masking threshold.	13 D. p120 D. p118

7. CAMOUFLAGE

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
7.1 ENVIRONMENT				
	7.1 Specular Glare	The IHS shell shall have a matte finish, both wet and dry, which does not exhibit a gloss rating exceeding one (1) unit under any specified geometry.		Canadian Helmet p10
	7.2 IR Reflectance	The finish of the exterior shell shall have near IR reflectance values that comply with the reference and limit curves in Appendix 1 of STANAG 2338.		Canadian Helmet p10
	7.3 Colour	The shell colour shall conform to the luminance and chromaticity values of GREEN 383.	ρ Luminance = Y 6.3 – 8.3 ρ Chromaticity = X 0.328 +- .008, y 0.365 +- .008	Canadian Helmet p10
	7.4 Patterns	The IHS shall accommodate the following helmet patterns. Covers can be used.	ρ UN Operations ρ Temperate CADPAT pattern ρ Arctic camouflage ρ Desert CADPAT pattern	Canadian Helmet p13
	7.7 Silhouette	The IHS shall not significantly increase the silhouette of the wearer when compared to current operational clothing.	ρ The increase in silhouette shall not be greater than 10% when compared to current operational clothing.	17
	7.8 2.6 Camouflage means	The soldier will be able to mount camouflage materials to the IHP	ρ Provide a net or frame with a 30 mm mesh that keeps antenna's, sensors and visor clear.	
7.2 UNWANTED EMISSIONS				
	7.5 Aural Non-detection	The IHS shall provide for minimum auditory non-detectability of audio displays, warnings, communications equipment, etc.	Minimum non-detection ranges for the following situations: ρ Motionless, stealthy quiet = 2 m ρ Motionless, using voice comms = 15 m ρ Quiet and walking at less than 5 km/hr over soft ground = 10 m ρ Using voice comms and walking at less than 5 km/hr over soft ground = 20 m	Integrated protective clothing and equipment performance baseline 970481A p 27

	7.6 Light Non-detection	The IHS shall minimize unintentional light emissions.	Minimum non-detection ranges for the following conditions at night: ρ Light in visible band with unaided eye or image intensifier device with unity magnification = 10 m ρ Light in the near infrared band with Near IR device with unity magnification = 10 m	Integrated protective clothing and equipment performance baseline 970481A p 27
7.3 Detection hazard	4.3.1 Sound 4.3.2 Light and near IR 4.3.3 Reflection 4.3.4 Thermal 4.3.5 EM	4.3 Emission must be reduced to become detectable only at typical intragroup distances, after taking camouflage and concealment measures.	ρ 4.3.1 Voice will be attenuated while speaking over the radio, or digital messages used. ρ 4.3.2 The usual disrupted pattern and IR reflection characteristics will be applied, cut to the climate/area ρ 4.3.3 Specular reflection only from transparent surfaces. Reflection from sun directed towards the ground in upright position. ρ 4.3.4 Reduction of far IR emission by coverage of hot spots (face, antennas). Breaking of thermal signature to hide in the environmental noise. ρ 4.3.5 Use of shielded cables	
	4.4.1 Anti-jamming	4.4.1 Directed EM energy does not cause permanent damage to the systems.	4.4.1 Shield and ground electronics	
	4.4.2 Interference	4.4.2 Systems do not disturb each other.	4.4.2 Cancel crossover	

B: USABILITY CONSIDERATIONS

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
1. THERMAL COMFORT				
	2.1 Heat Loss Mgmt. (i.e. cold) (head)	The IHS shall minimize heat loss from the head in climates C1 to C3 (arctic) and C0 to A3 (Temperate). 1.8.3 The head is protected from frostbite, in particular the eyes, nose, ears and lips.	ρ maximum heat loss shall not exceed 100W/m2 ρ 1.8.3 At all conditions the WCI in the interior will not exceed **1600 W/m2**.	Integrated protective clothing and equipment performance baseline 970481A p 9 and 16
	11.7 Heat Loss (face and eyes)	The IHS shall minimize heat loss from the face and eyes in climates A1 to A3 and B1 to B3.	ρ maximum heat loss shall not exceed 300 W/m2	Integrated protective clothing and equipment performance baseline 970481A p 16
	2.2 Heat Gain Mgmt. (i.e. hot)	The IHS shall minimize heat gain to the head in climates A1 to A2 (Hot-dry) and B1 to B3 (Hot-Humid). .	ρ remain thermally neutral at sustained heat gain rate of up to 600W ρ 1.8.2 Evaporative cooling keeps the head skin **.5 C cooler** than the body skin.	Integrated protective clothing and equipment performance baseline 970481A p 9 and 17
		The insulation characteristics of the IHS shall limit heat gain.	ρ No greater than 1.10 clo in still air and 0.39 clo with an ambient airflow of 3.0 m/s.	Canadian Helmet p8

	Perceived Thermal Comfort	The IHS shall perceive their head thermal comfort as acceptable in climates A1 to A3 and B1 to B3.	ρ Rating of 4 or higher on a 7-point termal comfort scale. ρ Score of –1 to +1 (i.e. slightly cool to slightly warm) on an ASHRAE Predictive Mean Vote scale.	Integrated protective clothing and equipment performance baseline 970481A p 16
2. PHYSICAL COMFORT				
	3.1 Pressure Point Comfort	The IHS shall have no internal protrusions, abrupt profile discontinuities, or unprotected hard elements that may contact the wearer's head at high contact loads.		Canadian Helmet p7
		The IHS shall be constructed to enable an even distribution of load forces per unit surface area of the head.		Canadian Helmet p7
	3.2 Skin Contact Comfort	The IHS shall not irritate wet or dry skin after *24 hour beard growth and camouflage cream, or normal scalp after* 24 hours of strenuous wear, while in contact with next-to-skin materials.		Canadian Helmet p7
3. PHYSICAL LIMITS				
	4.1 Total Weight	Helmet weight shall be minimized wherever possible to limit load forces on the head and neck.	ρ Not to exceed 2.5 kg (maximum), 2.05 kg (ideal) ρ 3.1.2 Less than the total weight of current replaced items and preferrably not more than 2.5 kg **excluding II and TI)** ρ *2.5 kg maximum from longitudinal distance of +16 mm to –20mm from Head and Neck C of M (tragion notch)* ρ *2.5 kg maximum from vertical distance of 0mm to –10mm from Head and neck C of M (tragion notch). 2.3 kg max from vertical distance of 10mm from Head and Neck C of M (tragion notch)*	A. Integrated protective clothing and equipment performance baseline 970481A p 49 *A. p 195 and 196*

	4.2 Range of Motion	The IHS shall not restrict or limit the natural range of motion of the head and neck. The mobility of the head will not essentially be restricted**, in particular when looking up** (3.3 Mobility)	ρ Sagittal flexion and extension of 60° (average) front and back ρ Lateral flexion of 41° (average) left and right ρ Head rotation of 80° (average) left and right ρ *Head/neck flexion 54° – 72°* ρ *Head/neck Extension 39° – 93°* ρ *Head/neck Lateral bending avg. of 59° (Right to Left)* ρ *Head/neck Axial Rotation avg. of 128° (Right to Left)* ρ Unrestricted yaw, roll. Pitch down better than **40**, pitch up better than **35** degrees, if bare head allows. (3.3 Mobility)	*C. p 152*
	4.3 Load Balance	The center of gravity of the head system shall produce minimum inertial effects on the head in relation to the c of g of the head.	ρ IHS c of g shall be within 25 mm of the head c of g (ideal), 35 mm acceptable, in the y and z axes, positioned directly over the sagittal midline. ρ *2.5 kg maximum from longitudinal distance of +16 mm to –20mm from Head and Neck C of M (tragion notch)* ρ *2.5 kg maximum from vertical distance of 0mm to –10mm from Head and neck C of M (tragion notch). 2.3 kg max from vertical distance of 10mm from Head and Neck C of M (tragion notch)*	**Canadian Helmet p9 (only for 25mm)** *A. p 195 and 196*
		Minimize asymmetrical load placement on the head.	ρ Limit headborne load asymmetry to 4.0 oz.	
	22.1 Breathing Demands	The IHS design, including the "masked" state, shall not impose undue airway resistance during all operational activity levels.	ρ Airway resistance shall not exceed 400 Pa/L at all flow rates, based on the ventilatory demands of a resting to a high physical exertion state. ρ Inhalation resistance of the mask shall not exceed 30 mm of H2O when tested using a flow rate of 85 L/min. ρ Exhalation resistance of the mask shall not exceed 20 mm of H2O when tested using a flow rate of 85 L/min.	JSCESM p7-8 and NIOSH Respiratory protective Devices
	21.5 Physical Forces (respirator)	The weight and balance of the IHS respiratory protection system shall not exceed static and dynamic load limits.	ρ The integration design of all IHS detectors shall conform to the IHS load force requirements (see Requirement 4.).	

	21.6 Snagging (respirator)	The IHS respiratory protection system (i.e. mask, canister) design could be integrated into the IHS or it could be distributed between the head and torso, requiring some form of ventilator hose or airway between the head and torso. Such hoses shall ensure, by their design, that hazards to the system and the wearer are minimized.	ρ Any ventilator hoses, between the head and torso, shall ensure that the risk of any snagging, which could lead to neck injury or system damage, is minimized. ρ Any ventilator hoses shall not restrict the range of head and neck movement.	
4. FIT / ADJUSTABILITY				
	5.1 Anthropometric Head sizing	The IHS shall accommodate the range of head dimensions of male and female Land Force personnel.	The IHS shall accommodate the following dimensions: ρ Head length (17.1 – 21.5 cm) ρ Head breadth (13.3 – 17.0 cm) ρ Head circumference (51.3 – 61.6 cm)	Canadian Helmet p6 and 33
	5.2 Stable Securement	The IHS shall resist helmet movement on the head during sudden high activity movements, such that unacceptable inertial forces are created, field of view is reduced, or comfort is compromised.	3.1.2 Fit individually adjustable and provided with slow foam padding. Contact surface at least 400 cm2.	Canadian Helmet p6-7
	5.4 Retention System Securement	The retention system will not detach or excessively elongate during a dynamic impact.	ρ Maximum elongation of the retention system will not exceed 25 mm and, immediately following a dynamic impact (?J), the elongation shall not exceed 12 mm.	Canadian Helmet p8 and 12
		The retention system shall be capable of being released when under tensile load by one handed operation.	ρ Release mechanisms shall be capable of being operated by applying 15 N of force or less when the retention system is loaded by a downward force of 500 +/- 10 N.	Canadian Helmet p12
		Following adjustment, the retention system shall remain secure.		Canadian Helmet p12

CRITERIA	FUNCTION	FUNCTIONAL REQUIREMENT	TECHNICAL REQUIREMENT	REFERENCES
5. COMPATIBILITY				
	6.1 Weapons	The IHS shall be compatible with in-service weapons, with no associated degradation in weapon task performance, no interference with weapon operation, and no loss of helmet stability or comfort. 4.2.4 Shouldering and aiming weapons must be feasible while using face protection.	The IHS shall be compatible with the following weapons: ρ C7A1, C9A1, GPMG ρ M72A5, Carl Gustav ρ Eryx, ρ 4.2.4 Helmet may occupy **4 cm** of space at the cheek. Eye must approach ocular or iron sight to less than **5 cm**	41 Canadian Helmet p 6, 34-36
	6.2 Equipment 4.2.2 Pack 4.2.3 Soldier system 4.2.5 Handset	The IHS shall be compatible with in-service equipment, with no associated degradation in equipment task performance, no interference with equipment operation, and no loss of helmet stability or comfort. 4.2.2 Helmet conflict with pack must be minimized 4.2.3 IHP is fully compatible with soldier system, in particular power source, connectors, data formats, control box, radio and Body Area Network 4.2.5 Telephone handsets must be functional during full protection.	The IHS shall be compatible with the following equipment: ρ AVGP Grizzly DLIR Turret Sight ρ Integrated rucksack and small pack system ρ Tactical assault vest ρ TCCCS radio systems ρ 4.2.2 Helmet may occupy **3 cm** of space on the back of the head. Helmet does not shift when colliding with pack. ρ 4.2.3 IHP is fully compatible with soldier system, in particular power source, connectors, data formats, control box, radio and Body Area Network ρ 4.2.5 Speech membrane and microphone separated **10-15** cm.	41 Canadian Helmet p 6, 34-36
	6.3 Clothing	The IHS shall be compatible with in-service clothing, with no associated degradation in clothing use, no interference with range of motion, and no loss of helmet stability or comfort. 4.2.1 Collars will not be in the way. Compatibility between IHP, NBC and ballistic clothing.	The IHS shall be compatible with the following clothing: ρ fragmentation vest ρ NBC IPE ρ IECS clothing ensemble ρ 4.2.1 Interface between NBC/ballistic garment and helmet must be chemical/ballistic proof, with unrestricted head rotation.	

	6.4 *Parachuting*	*The helmet system shall be suitable with minor modifications, which can be performed by the user, without special tools in less than 30 minutes to serve in all respects as the parachutist's helmet. It shall not interfere with equipment in flight including risers and shroud lines*		Canadian Helmet p6
	Corrective Lenses	The IHS shall provide or enable the use of corrective lenses.	ρ Any IHS obstructions in front of the eyes (e.g. displays, visor, etc.) shall provide a minimum of 25 mm of eye relief to accommodate corrective eyewear. ρ 2.1.1 Exit pupil more than **35 mm** from the eye. ρ 2.5. Eye correction: Optics no closer than **25 mm** from the eye. Front of frame no wider than **120 mm**.	32, C p72 and 89
6. ENCAPSULATION				
	10.1 Encapsulation Stress	The IHS design should limit encapsulation stress by minimizing any loss of local perceptual capability.	Minimize any reduction in: ρ Local visual awareness ρ Local auditory awareness ρ Face-to-face speech communication	32
	3.7.3 Usability	3.7.3 Must not create feelings of isolation, deprivation or other detrimental effects.		
7. DRINKING AND FOOD INTAKE				
	Food and Drink	Consuming food and drinks shall be possible when face protection is not in place. Drinking of liquid (food) shall be possible under NBC conditions	Liquid flow of no less than 200 ml/min without breaking the seal of the IHS during drinking. Liquid flow of 200 ml/min by normal sucking.	JSCESM p7
8. EASE OF USE				
	3.7.1 Speed	3.7.1 Can be put on and off with a single action. Quick transition to NBC protection.	3.7.1 NBC ready in 9 sec	
	21.2 Transition	The IHS shall enable the wearer to achieve respiratory protection in 9 seconds.		

	21.3 Contamination	It shall be possible to remove the IHS respiratory protection, once contaminated, with minimal risk of contacting the skin of the head, face and neck.		
	3.7.2 Operation	3.7.2 IHS items must be easily operated with and without gloves, also in the dark.	3.7.2 Remote switches for functions, default status if not available	
	5.3Adjustability	The IHS shall be capable of being donned, doffed, and adjusted while worn with a single gloved hand or *single bare hand*.		Canadian Helmet p8
	3.9 Vomiting and cold	No major malfunction after vomiting or saliva wetting and clearing.	Easy cleaning of inner mask, in particular valves, materials acid resistant.	
	Modularity	IHS components shall be capable of being added, removed, and adjusted quickly in the field with a gloved hand. No special tools will be required to add or remove modular components.		
9. PERCEPTION				
9.1 UNAIDED VISUAL PERFORMANCE				
	12.1 Field of View	The IHS shall not obstruct the natural ambinocular field of horizontal view.	ρ 94^{o} right and left of the visual centerline. ρ *150^{o} horizontally and 120^{o} vertically, each eye. Both eyes together have approximated 200^{o} horizontally and 120^{o} vertically* ρ *200^{o} horizontally and 130^{o} vertically. Only approximately 120^{o} can be seen by both eyes. Blind spots are approximately 5^{o} in diameter and occur between 13^{o} to 18^{o} in the periphery* ρ 3.6.1 Both eyes together: **180^{o} horizontal**, -45 to +35^{o} vertical, nose cover no wider than 10 mm. Distortion less than 1/8th diopter, transmission better than 90%.	1 *A. p134* *B.p50*

		The IHS shall not obstruct the natural field of vertical view.	ρ 50° above and 70° below the standard sight line. ρ 150 horizontally and 120 vertically, each eye Both eyes together have approximated 200° horizontally and 120° vertically ρ 200° horizontally and 130° vertically. Only approximately 120° can be seen by both eyes. Blind spots are approximately 5° in diameter and occur between 13° to 18° in the periphery ρ 3.6.1 Both eyes together: 180° horizontal, **-45 to +35° vertical**, nose cover no wider than 10 mm. Distortion less than 1/8th diopter, transmission better than 90%.	1,29 A. p134 B. p 50
	12.2 Resolution	The visual acuity of the wearer shall be optimized to 1 minute of arc while wearing the IHS (i.e. discriminating 1 minute of arc at a distance of 20 feet or 20/20 vision).	2.1.1 Image is located central in the visual field at 1:1 scale.	1,7
	12.3 Eyewear /Visor Equipment	Eyewear and visor devices shall minimize any interference effects on normal visual performance.		
		Luminous transmittance for clear lenses	ρ 85% photopic, scotopic, P43 ρ 3.6.1 Both eyes together: 180° horizontal, -45 to +35° vertical, nose cover no wider than 10 mm. Distortion less than 1/8th diopter, transmission better than **90%.**	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2, 13, 14and 15
		Eyewear and visors shall maintain visual efficiency indices (quotients of the field of vision with and without a vision device).	**Visual efficiency indices for three field of vision (e.g. right eye):** ρ lateral (70 – 135°) = minimum of 80% ρ downward (135 – 180°) = minimum of 50% ρ binocular (250 – 315°) = minimum of 20%	32
		Luminous transmittance for sunglass tint	ρ 10 – 20% +- 0.1 density units for uniformity within a lens and between lens pairs	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 13

		Neutrality of sunglass tint	ρ Average deviation from D65 is no greater than +- 15% measured in 2 nm intervals. Red light visibility factor should be between 0.9 and 1.1.	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2, 13, 14 and 15
		Luminous transmittance for laser protective tints	ρ 40% for scotopic, photopic, and P43. 4.0 optical density at 694 nm and 1064 nm ρ 40% for scotopic, photopic, and P43. 4.0 optical density at 532 nm and 694 nm ρ 9% for scotopic, photopic, and P43. 4.0 optical density at 532 nm, 694 nm and 1064 nm	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2, 13, 14 and 15
		Optical power	ρ +0.06 to –0.125 diopter for plano lenses in any meridian (eyewear) ρ +-0.06 D sphere (flat visor) ρ +0.06 to –0.125 D in any meridian (cylindrical low impact visor and aspheric visor)) ρ +0.06 to –0.25 D in any meridian (cylindrical medium and high impact visors)	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 6
		Definition	ρ 0.79 cycles/mm using the 1951 USAF test pattern	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2
		Prismatic imbalance	ρ 0.125 prism diopter in any direction of any individual lens. 0.25 prism diopter imbalance between lens pairs (eyewear) ρ 0.25 change in any direction (flat visor) ρ 1.0 change horizontal or 0.25 change vertical (cylindrical, low impact visor) ρ 1.5 change horizontal or 0.25 change vertical (cylindrical, medium impact visor) ρ 2.0 change horizontal or 0.25 change vertical (cylindrical, high impact visor) ρ 0.25 change in any direction (aspheric visor)	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 10 and 11

		Distortion	ρ No visible distortions of a grid when eyewear is worn in normal position (eyewear). ρ Distortion only within 5.0 mm of the edges (visor). ρ 3.6.1 Both eyes together: 180^{o} horizontal, -45 to $+35^{o}$ vertical, nose cover no wider than 10 mm. Distortion less than **1/8th diopter**, transmission better than 90%.	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 12
		Warpage	ρ +- 0.50 D between the principal meridians	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 13
		Narrow angle scatter (i.e. Haze)	ρ a luminance reduction factor no greater than 0.5 cd/m^2 lux	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 16
		Field of view	ρ Eyewear device shall not restrict the field of view by more than 10^{o} in any meridian. ρ Visor device shall not restrict the field of view. ρ *60° – 70° Field of view for tasks involving special orientation, navigation through the environment and manipulating objects (3600 – 4200 pixels resolution)* ρ *55° field of view can see opponents head, shoulders, arms in hand to hand combat (3300 pixels resolution)*	Non-Ballistic Standards For Ballistic Protection Eyewear (1998) p2 and 17-18 *C. p225* *D. p107*
		Anti-fogging 3.5.2 No misting of eye glass in the cold	ρ Eyewear and visor devices shall provide good visual clarity when worn for prolonged periods (8 - 16 hours) at ambient temperatures between $-32^{o}C$ and $39^{o}C$. ρ 3.5.2 No leakage of moist exhaled air to eye glass. Sufficient ventilation over eye glass to remove condensation.	32 as modified by DLR 5

		Head Vibration / image stabilization	ρ *Eyewear and visor device shall provide protection against head vibration in the frequency of 1to 5 Hz* ρ *head experience accelerations in the frequency range 2 – 5 hz* ρ *head eye pursuit reflex can handle 1 – 3 Hz* ρ *Above 1Hz marked decline in aiming* ρ *3 to 5 Hz reading performance is degraded most significantly* ρ *1 – 5 Hz significantly degradation of visual performance / visual acuity*	C. p 203-235
		Abrasion resistance	ρ *Lens(es)shall be tested for abration in accordance with ASTM 1044*	JSCESM p18
		3.5.1 During heavy work no sweat dripping in eyes. During light work no sweat discomfort. (3.5.1 Heat and humidity)	ρ 3.5.1 Sufficient ventilation over face to remove liquid. (3.5.1 Heat and humidity)	
9.2 UNAIDED AUDITORY PERFORMANCE				
	16.1 Unaided Hearing	The IHS shall not reduce or limit the wearer's natural hearing ability.	ρ *Unaided hearing can pick up the following natural sound levels :* ρ *Resting leaves 20 dB* ρ *Quiet whisper 30 dB* ρ *Quite home 40 dB* ρ *Quite street 50 dB* ρ *Normal conversation 60 dB* ρ *In side a car 70 dB* ρ *Load singing 75 dB* ρ *Automobile 80 dB* ρ *12-gauge shotgun 165 dB*	S.F.U. http://www.sfu.ca/sonic-studio/handbook/Noise.html *NIOSH http://www.cdc.gov/niosh/hp110.html*
	16.2 Sound Localization	The IHS shall not interfere with natural sound localization in all dimensions.	ρ The wearer of the IHS shall maintain sound localization in the frequency range of 250 – 8000 Hz. ρ The mean error of sound localization shall be less than 15 degrees.	34
	16.3 Sensitivity to Ambient Sounds	The IHS shall not prevent detection of low-level sounds, particularly in the 3 to 8 kHz range.		13

		While wearing the IHS, sensitivity to ambient sounds shall be sufficient to enable CHABA allowable temporary threshold shift to detect low-level sound pressure.	**Sound pressure detection levels:** **500 Hz = 10 dB, 1000 Hz = 10 dB, 2000 Hz = 15 dB, 3000 Hz = 20 dB, 4000 Hz = 20 dB, 6000 Hz = 20 dB, 8000 Hz = 20 dB.**	13
		The IHS shall attenuate sound level by less than 10 dB in the frequency range of 250 – 8000 Hz.		32, 34
		The IHS shall amplify sounds by less than 5 dB, as measured at a distance of 5 m from the sound source, in the frequency range of 250 – 8000 Hz.		34
	16.4 Local Speech Intelligibility	The IHS shall not reduce or limit speech intelligibility for listening to local voice communications (i.e. face to face).		

C: OPERATION

1. Power / Data	8.1 Power and Data Conduit	The power and data conduits for various devices mounted on or integrated into the IHS shall limit detection and hazards to the system and the wearer.	ρ The IHS will comply with electromagnetic interference / compatibility requirements for emission and susceptibility to electromagnetic radiation in accordance with MIL-STD-461D and MIL-E-6051E. ρ The IHS shall not allow electrostatic buildup to occur to the extent that a discharge could damage IHS components or harm the wearer. ρ Power and data conduits shall be suitably integrated into the IHS to ensure no risk of snagging, which could lead to neck injury or system damage.	Integrated protective clothing and equipment performance baseline 970481A p 54
	8.2 Cabling to Torso	Although power storage and data processing could be distributed within each device mounted or integrated into the IHS, it is more likely that these functions will reside on the torso, requiring power and data linkages between the head and torso. Such linkages shall ensure by their design that hazards to the system and the wearer are minimized.	ρ Power and data linkages between the head and torso shall ensure that the risk of any snagging, which could lead to neck injury or system damage, is minimized. ρ In the event of a snag, the power and data linkages shall include a quick-release feature (maximum break-away force ?N). ρ The IHS power and data linkages shall not restrict the range of head and neck movement.	
2. Environment requirements		The IHS shall be capable of worldwide operations and deployment without degradation under different climatic conditions	* Operating temperature 2., 11.7 * Humidity 2.2 High altitude High altitude Electromagnetic pulse (HAEMP) * NBC 1.11 * Electromagnetic Interference (EMI) 8.1 Wind Packaging * Submerging 1.13 Rough handling Salt * Sunlight 1.10, 11.5 * Fungus 1.12 * Rain 1.13 * Dust 11.2	JSCESM P 10-11

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(U) Development of future infantry soldier systems with portable computing systems, advanced sensors, intra−section communications, head−mounted displays, and so on, has been ongoing among NATO nations for over a decade. Key to the success of any future soldier system will be the effective integration of capabilities and technologies on the head. Defence Research and Development Canada is undertaking a technology demonstration programme to investigate various designs and means of integrating headwear components and sub−systems: the Soldier's Integrated Headwear System (SIHS) programme. This programme will be faced with many design and capability trade−off decisions. To ensure that these decisions consider the aims and intent of the Canadian Army, and reflect the operational context for employment of such a future headwear system, an Infantry Subject Matter Workshop was held to acquire insight into operator priorities and the associated importance of various capabilities and technologies for a future infantry headwear system. The priorities and importance assigned to select system capabilities and usability criteria during this workshop provide the SIHS programme with the necessary guidance and direction for future headborne system design efforts.

(U) Depuis plus de dix ans, les pays membres de l'OTAN s'occupent de mettre au point des systèmes destinés au fantassin qui sont munis de systèmes informatiques portatifs, de capteurs évolués, de dispositifs de communications de section, d'affichages sur casque et d'autres dispositifs. Le succès des systèmes destinés au soldat dépend de l'efficacité de l'intégration des techniques et des capacités au casque. R & D pour la défense Canada lance un programme de démonstration de technologies pour étudier diverses conceptions et divers moyens d'intégration d'éléments et de sous−systèmes au casque : le programme du casque intégré du soldat (SIHS). De nombreuses décisions devront être prises dans le cadre du programme au sujet des compromis à faire en ce qui concerne la conception et les capacités du casque. Pour s'assurer de tenir compte des objectifs et des visées de l'armée canadienne dans la prise de ces décisions, de même que du contexte opérationnel dans lequel le futur casque du soldat sera employé, on a tenu un atelier à ce sujet à l'intention de l'infanterie pour mieux comprendre les priorités de l'opérateur et l'importance connexe de diverses techniques et capacités du futur casque intégré du fantassin. Les priorités et l'importance données à des capacités choisies du casque et aux critères servant à en déterminer l'utilisabilité, durant l'atelier, ont permis de donner l'orientation dont les responsables du SIHS ont besoin pour guider les efforts de conception du futur casque du soldat.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) Soldier Integrated Headwear System Technology Demonstration; SIHS TD; headwear integration; infantry headwear; headwear system