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**INVESTIGATION OF INFORMATION EXCHANGE ALTERNATIVES
IN SUPPORT OF PLATOON TACTICS**

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Abstract

This trial investigated the utility of providing leaders with digital messaging for information exchange in dismounted infantry urban operations. A 20-day field trial was conducted at Fort Benning, Georgia over the period of 19 October to 9 November, 2003, which included nine missions (plus one pilot mission) during the day. Forty regular Canadian Forces (CF) infantry soldiers were required to undertake force-on-force tactical assault missions that moved through a wooded terrain to an objective in an urban environment. The assaulting force comprised a Company HQ, a Platoon HQ, three dismounted infantry sections, and a weapons detachment to assault one defending section.

Human factors measures included subjective utility and usability assessments of the different information exchange alternatives. Data collection methods included questionnaires, focus groups, and HF observer assessments.

Participants thought that more information via digital format was positive for leadership elements of a platoon, provided the amount of information in the digital system is manageable. This suggests that a system has to be customized/filtered to the individual or leadership level in order to maximize information exchange and minimize cognitive impact to the soldier's ongoing tasks.

Based on observations and results of this study, improvements to the digital prototype and recommendations for future investigations are discussed.



Résumé

L'essai en cause consistait à étudier l'utilité de fournir aux dirigeants la messagerie numérique aux fins de l'échange d'information en opérations d'infanterie débarquée. Un essai sur le terrain de 20 jours, allant du 19 octobre au 9 novembre, et mené à Fort Benning, en Géorgie, comprenait neuf missions de jour (en plus d'une mission pilote). Quarante fantassins des Forces canadiennes (FC) régulières avaient été chargés d'entreprendre des missions d'attaque tactique de force contre force passant par un terrain boisé vers un objectif dans un environnement urbain. La force d'attaque comprenait un QG de compagnie, un QG de peloton, trois sections d'infanterie débarquée et un détachement d'armes devant attaquer une section défensive.

Les facteurs humains mesurés comprenaient des évaluations subjectives de l'utilité et de l'utilisabilité de diverses solutions pour l'échange d'information. Les méthodes de collecte de données comprenaient des questionnaires, des groupes de discussion et des évaluations par des observateurs des facteurs humains.

Les participants étaient d'avis qu'une plus grande quantité d'information en format numérique était un facteur positif pour les éléments dirigeants d'un peloton, à condition que la quantité d'information dans un système numérique soit gérable. Cela laisse entendre qu'un système doit être personnalisé/filtré pour qu'il soit adapté au niveau des individus ou des dirigeants afin de maximiser l'échange d'information et de minimaliser l'incidence cognitive sur les tâches en cours des soldats.

Compte tenu des observations et des résultats de cette étude, des améliorations au prototype numérique et des recommandations pour des recherches futures sont discutées.



Executive Summary

A 20-day field trial was undertaken at Fort Benning, Georgia over the period of 19 October to 9 November, 2003, which included nine missions (plus one pilot mission) during the day. Forty regular Canadian Forces (CF) infantry soldiers were required to undertake force-on-force tactical assault missions in both urban and wooded terrain. The assaulting force comprised a Company HQ, a Platoon HQ, three dismounted infantry sections, and a weapons detachment to assault one defending Section.

Fifteen regular infantry NCOs and Officers completed these missions using both in-service methods (e.g. paper map, compass, TCCCS radio, hand-signals, etc.), and digitally enhanced information capabilities (e.g. laser designation, digital messaging, digital imagery, digital map, etc.). Platoon TTPs (tactics, techniques, and procedures) and organizational structure followed Battalion SOP (standard operating procedures) for both the in-service and digitally enhanced capabilities. While all members of the Platoon participated in the missions, data collection efforts focused on the leadership positions including the Comds and 2ICs of the platoon, sections, and the Weapons Det.

Human factors measures included assessments of subjective utility and usability assessments of the different information exchange alternatives. Data collection methods included questionnaires, focus groups, and HF observer assessments.

Results suggested that both radio only and radio / digital combinations were considered similar to each other. The daily questionnaire results suggest that participants thought digital options impacted attention to ongoing tasks. This indicates that increasing information exchange can have a negative impact on situation awareness for ongoing tasks.

The exit questionnaire results suggest that the digital options were more burdensome to the soldier during concurrent activities than a radio only option. This indicates that effort and time pressures were important for soldiers in order to use the information in the field. This also indicates that too much information will overburden the soldier's. Furthermore, participants thought digital options increased message detail and improved association of message to map. This indicates that increased information exchange can be achieved with digital format combined with radio. The results also suggest that digital options are more important during night manoeuvring and situation awareness of friendly forces than during the day.

The focus group results suggest that the disadvantages of digital messages are that they are time consuming to use and attention resources are reduced as you use the digital systems. Soldiers also stated that the biggest benefits of digital messages are having a copy of all of the information available for future reference and the reduced airtime required for transmitting the information. This indicates that digital systems can have a balance between volume of information / effort to use and attention demands to ongoing tasks. Currently, too little information makes digital system less useful, whereas, too much information will overburden the soldier. This indicates that the system needs to be customized / filtered to the individual or leadership level in order to maximize information exchange and minimize cognitive impact on the soldier.

Based on observations and results of this study, improvements to the digital prototype and recommendations for future investigations are discussed.



Sommaire

Un essai sur le terrain de 20 jours, allant du 19 octobre au 9 novembre, et mené à Fort Benning, en Géorgie, comprenait neuf missions de jour (en plus d'une mission pilote). Quarante fantassins des Forces canadiennes (FC) régulières avaient été chargés d'entreprendre des missions d'attaque tactique de force contre force tant en zone urbaine qu'en terrain boisé. La force d'attaque comprenait un QG de compagnie, un QG de peloton, trois sections d'infanterie débarquée et un détachement d'armes devant attaquer une section défensive.

Quinze sous-officiers et officiers de l'infanterie régulière ont effectué ces missions tant à l'aide de méthodes en service (p. ex. carte papier, boussole, radio STCCC et signaux manuels) qu'à l'aide de méthodes de transmission d'information améliorées par numérisation (p. ex. désignation laser, messagerie numérique, imagerie numérique, carte numérique). Les TTP (tactique, techniques et procédures) de peloton et la structure organisationnelle étaient conformes aux IPO (instructions permanentes d'opération) de bataillon tant pour les méthodes en service que pour les méthodes améliorées par numérisation. Bien que tous les membres du peloton aient participé aux missions, les efforts de collecte de données se sont concentrés sur les postes de dirigeant, y compris les cmdt et les cmdtA du peloton, des sections et du détachement d'armes.

Les facteurs humains mesurés comprenaient des évaluations subjectives de l'utilité et de l'utilisabilité de diverses solutions pour l'échange d'information. Les méthodes de collecte de données comprenaient des questionnaires, des groupes de discussion et des évaluations par des observateurs des facteurs humains.

Les résultats semblent indiquer que les communications par radio seulement et les communications combinées radio/numériques étaient considérées comparables. Les résultats des questionnaires quotidiens semblent indiquer que les participants étaient d'avis que les moyens numériques nuisaient à l'attention accordée aux tâches en cours. Cela indique que l'augmentation de l'échange d'information peut avoir un effet négatif sur la connaissance de la situation aux fins des tâches en cours.

Les résultats du questionnaire de départ semblent indiquer que les communications numériques étaient plus fastidieuses pour les soldats pendant des activités simultanées que la communication par radio seulement. Cela indique que les contraintes d'effort et de temps étaient importantes pour les soldats en vue de l'utilisation de l'information en campagne. Cela indique aussi qu'un excédent d'information surcharge les soldats. En outre, les participants étaient d'avis que les communications numériques augmentaient les détails des messages et amélioraient la mise en corrélation du message avec la carte. Cela indique qu'un échange d'information accru peut être atteint par la combinaison du format numérique et de la radio. De plus, les résultats semblent indiquer que les communications numériques sont plus importantes pendant les manœuvres de nuit et pour la connaissance des forces amies en présence que pendant le jour.

Les résultats du groupe de discussion semblent indiquer les inconvénients suivants des messages numériques : l'utilisation de ceux-ci est laborieuse et les ressources attentionnelles sont réduites lorsqu'on utilise des systèmes numériques. De plus, les soldats ont affirmé que les plus grands avantages des messages numériques sont : une copie de toute l'information en vue d'une utilisation ultérieure et le temps en ondes réduit pour la transmission de l'information. Cela indique que les systèmes numériques permettent d'atteindre un équilibre entre le volume



d'information/l'effort à déployer et les exigences d'attention aux tâches en cours. À l'heure actuelle, un manque d'information rend le système numérique moins utile, alors qu'un excédent d'information surcharge le soldat. Cela laisse entendre qu'un système doit être personnalisé/filtré pour qu'il soit adapté au niveau des individus ou des dirigeants afin de maximiser l'échange d'information et de minimaliser l'incidence cognitive sur les soldats.

Compte tenu des observations et des résultats de cette étude, des améliorations au prototype numérique et des recommandations pour des recherches futures sont discutées.



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1. Background

Information technology has fundamentally changed battlefield visualization. Battlefield visualization can be defined as:

The process whereby the commander develops a clear understanding of the current state with relation to the enemy and environment, envisions a desired end state which represents mission accomplishment, and then subsequently visualizes the sequence of activity that moves the commander's force from its current state to the end.

TRADOC Pam 525-70 (1997)

The formulation of battlefield visualization is a complex and difficult task where information is analyzed and processed, then fused with the commander's knowledge, experience and feel for the enemy to create a mental model of the battlefield. Battlefield visualization has been greatly facilitated by the use of digital tools. These operational tools are designed to assist commanders at each level in the decision making process by placing more information in the hands of the leaders as fast as possible, potentially leading to enhanced situational awareness (Bellesfield & Campbell (2002), Markus (1997), Matthews, Brooks & Webb (1998), TRADOC (1997), TRADOC (1998), ONR (2002), and ONR, 2003).

Technology support is currently focused on mission awareness, mission planning, rehearsal, and execution; future technology concepts; and technology integration.

Mission Awareness. Mission and situation awareness provides leaders at all levels with near real time information on the current situation. It is derived from sharing data at all levels, but data that is tailored for resolution and content by the level of formation using it. Data is exchanged on:

- Friendly forces
- Enemy forces
- Non-combatants
- Environment
- Terrain Visualization

Mission Planning, Rehearsal and Execution. A number of tools are available today to help commanders optimize plans, supports rehearsal training and monitors plan implementation. Simulation and visualization tools are currently available to help commanders plan. Terrain visualization systems help commanders plan troop movements, display lines of sight, etc. A number of tools are available to help commanders in rehearsals allowing them to build a cohesive collective mental model. Virtual tours, fly-through animations, etc. help commanders rehearse all aspects of proposed operations. Information technology now permits distribution of these simulations to dispersed units. A number of battlefield command and control tools are now available to support leaders once operations have begun. Commanders can now receive near real time information on the status of friendly and enemy forces and thus monitor the accomplishment of the commander's intent. A number of experiments have been conducted by the SIREQ-TD program on the use of tools to map near real time soldier positions, the use of augmented intra-section communications, off-bore surveillance systems etc.



Future Technology Concepts. A number of new technologies are being developed to help leaders visualize the battlefield. At the dismounted Section and Platoon level, digital terrain visualization tools, intra-section communications, digital communications, soldier GPS tracking, novel display devices, soldier computers, high resolution cameras, etc. are being investigated by SIREQ to see if they help commanders and soldiers in operations. Information technologies do not currently exist that permit the free flow of voice, data and video information.

Technology Integration. Key to future performance is the integration of the various systems currently being developed. Seamless transfer of data and information will permit soldiers at all levels to concentrate on war fighting rather than information management.

Information technology can create information management problems for commanders and staff. A large amount of information is now available such that information overload becomes a reality unless controls are implemented to control the quality and quantity of information. Quality is a subjective term for which each leader will have his or her own definition, it does however imply that it proves utility to the user and satisfies some stated or implied need. Providing leaders with volumes of data that do not impact current or foreseeable operations is not appropriate. Quantity of information implies that information can be measured for magnitude, size, amount, etc. Text messages are only dozens of kilobytes in size (if that) while streaming video is megabytes in size. There are physical limits to wireless network band widths so that large files impact image flow and thus situational awareness across the network. While it is fairly easy to quantify and characterize computer mediated information, it is more difficult to quantify information size in verbal communications. Throughout the mission planning and execution cycle commanders require information.

A number of experiments have been conducted by the SIREQ-TD program on terrain visualization. One experiment investigated the effectiveness of different conventional and virtual visualization capabilities for use in dismounted infantry missions in a high-density urban streets environment. The use of digital map information has proven to be useful and desirable at the Section Comd and riflemen levels, for situation awareness, navigation, and in-situ mission planning and briefing. The utility of exchanging these and other types of digital information on the battlefield, for use in coordinating small units' activities at the Platoon level, has not been investigated by SIREQ for dismounted infantry missions.

The opportunities afforded by digitization of the battlefield are many and varied. The common, dynamic visual reference of a digital map provides considerable opportunities for enhancing individual and collective situation awareness by displaying mission-critical location information, accurate in real time, of friendly and enemy forces, routes, objectives, etc. Large volumes of information can now be exchanged on the battlefield in a variety of digital forms (e.g. voice, text, imagery, schematic, etc.). A key focus for SIREQ is to determine the relative benefits of exchanging these information types on the battlefield, their impact on mission performance and outcome, and the usability issues associated with them.



2. Aim

The following aims were pursued in this experiment:

- Compare teamwork, coordination, and battlefield awareness between the in-service and digitally enhanced conditions.
- Investigate the differences in situation awareness, mental workload, and mission performance between in-service and digitally enhanced conditions.
- Assess the tactical feasibility and usability issues of the digital information exchange options.



3. Method

This report presents the findings of two of the studies conducted during the Fort Benning Experimental Series (FBES) VI. The main task for the FBES VI studies was a Platoon mission. The Platoon mission was the venue for the following studies:

- Digital Messaging Information Transfer
- Input Modality Investigation
- Recce Information Transfer
- Distributed Orders
- Commander's Recce

This report only discusses parts of the mission that pertained to the digital messaging information transfer experiment. The method provided below outlines how the digital messaging information transfer study was undertaken within the context of this much larger program.

3.1 Overview

The following section provides a general overview of the trial. Further details are provided in subsequent sections.

A 20-day field trial was undertaken at Fort Benning, Georgia over the period of 19 October to 9 November, 2003, which included nine missions (plus one pilot mission). All of the missions were conducted during the day. Forty regular Canadian Forces (CF) infantry soldiers were required to undertake force-on-force tactical assault missions in both urban and wooded terrain. The assaulting force comprised a Company HQ, a Platoon HQ, three dismounted infantry sections, and a weapons detachment (Weapons Det) to assault one defending section.

Fifteen regular force infantry NCOs and Officers completed these missions using both in-service methods (e.g. paper map, compass, TCCCS radio, hand-signals, etc.) and digitally enhanced information capabilities (e.g. laser designation, digital messaging, digital imagery, digital map, etc.). Platoon TTPs (tactics, techniques, and procedures) and organizational structure followed Battalion SOP (standard operating procedures) for both the in-service and digitally enhanced capabilities. While all members of the Platoon participated in the missions, data collection efforts focused on the leadership positions, including the Comds and 2ICs of the Platoon, sections, and the Weapons Det.

Human factors measures included subjective utility and usability assessments of the different information exchange alternatives. Data collection methods included questionnaires, focus groups, and HF observer assessments.



3.2 Equipment and Facilities

3.2.1 Sensor Systems

3.2.1.1 Personal Role Radio (PRR)

The Personal Role Radio (PRR) is a light, short range radio. PRRs (a.k.a. a Light Assault Radio) are the smallest radios in the Army’s communications inventory (see Figure 1).



Figure 1: Personal Role Radios (PRR)

The PRR is used for short-range communications between dismounted units, military police, and security forces. Its specifications are detailed in Table 1.

Table 1: PRR specifications

Features
Utilizes wireless LAN technology and incorporates spread spectrum techniques at 2.4GHz.
Operating range in rural terrain is more than 500 meters.
Transmission is capable through 3 floors of urban terrain.
Operates on 2 standard AA batteries providing typically 24 hour use (Ratio: 1:7:16 – Tx/Rx/Standby).
Fitted with a detachable Press To Talk (PTT) Switch Assembly, as standard. This incorporates a single PTT Switch and an ancillary’s socket (where the Lightweight Headset is connected).



3.2.2 Xybernaut MA-V (Digital Messaging)

Xybernaut Mobile Assistant V[®] (MA V[®]) has a range of display, input and wearability options. The MA V[®] allowed the experimenters to personalize configurations for the platoon mission attacks.

The MA V[®] is designed to be lightweight and rugged with core technologies that deliver the full functionality of a desktop PC (see Figure 2).



Figure 2: Xybernaut MA-V (top) and Larissa Daylight Readable Display (bottom)

The Intel Celeron, 500 MHz processor of the MA V[®] works with a range of displays, wireless LAN, USB, PCMCIA, Firewire and RS232 devices. Xybernaut's Larissa flat-panel displays are daylight readable, have touchpads for quick input and are built to handle rugged use. Head Mounted Displays (HMD), with integrated microphone and earphones, permit continuous hands-free use through speech recognition software. The specifications of the Xybernaut MAV are given in Table 2.



Table 2: Xybernaut MAV specifications

Processor	Celeron 500 MHz,
Memory and Storage	256 RAM 5 GB Internal HDD
OS	Windows 2000 Professional
Ports	2 USB, 2 Firewire
Weight (w/o holster)	455 g
Dimensions (w/o holster)	5.9 "x 3.5 "x 2 "

3.3 Trial Participants

Fifteen regular force NCO's and Officers were recruited from the 3rd Battalion Princess Patricia's Canadian Light Infantry Regiment (PPCLI Regiment), Edmonton, Alberta. The mean age of the participants was 32.7 years (SD = 5.1, max = 43, min = 23). The mean length of service in the regular forces was 130.3 months (SD = 75.4, max = 276, min = 48). All of the participants were righted handed, and 29 % of the participants wore glasses. None of the participants were colour blind. Ninety percent of the participants had one or more operational tours.

One human factors observer was assigned to work with each of the platoon leadership (platoon commanders, platoon second in command and section commanders) for data collection and trouble shooting the digital systems. Each data collector was responsible for one leader at any one time.

3.4 Experimental Conditions: Radio and Radio/Digital

For the main tasks in each mission, Table 3 outlines the in-service (Radio alone) and digitally enhanced (Radio/ Digital messaging) capabilities that were investigated.



Table 3: Condition plan

Mission Tasks	Radio alone		Radio/Digital	
	Method	Means	Method	Means
Reporting	TCCCS Radio	- verbal report	Radio	- verbal report
			Digital Messaging	- menu driven reporting on computer
Recce Reporting	TCCCS Radio	- verbal report	Digital Messaging	- menu driven reporting on computer
			Digital Imagery	- image messaging to other computers.
Intra-Section Coordination	Voice and Hand Signals	- yelled voice commands and hand signals	Personal Role Radio	- voice radio comms between all section members.
PI Command and Control	TCCCS Radio	- voice radio commands	Radio	- voice radio commands
			Digital Map and Drawing Tool	- digital map locations of sub-units, objective, and routes. - drawing tool used to create plan and send to all computers.
PI Assault Orders	Verbal	- centralized briefing in the PI ORV	Radio	- de-centralized sections with voice radio orders
			Digital Map and Radio	- de-centralized sections with voice radio orders - digital map drawing tool used to create plan and send to all computers.
Call for Fire	TCCCS Radio	- verbal request	Digital Messaging	- menu driven call for fire on computer

3.5 Trial Description

One Platoon assault was performed each day for a total of 9 missions. For any one mission, each Section was required to navigate to a separate recce objective, observe the objective, report back to the PI Comd, and await his orders.

The mission started with each of the three sections being deployed to separate initiation points about 1500 to 2000m from their respective recce objectives. Each section manoeuvred independently through wooded terrain to their objective while avoiding enemy contact. Section and PI Comds were required to provide reports and returns (as per SOP) throughout the mission.

While enroute, sections may have been engaged by enemy sniper teams. If engaged, these teams were eliminated. Where possible, enemy contact was avoided and any observed enemy activity was reported to the PI Comd.

At their respective objectives, sections were to recce the site and make any necessary records and observations. Following their recce, each section reported their findings back to the PI Comd. An assault objective was selected from these recce reports, and a PI ORV (objective rendez-vous)



was indicated to the Section Comd. Sections were required to navigate to this ORV where the PI Comd developed his assault plan, reported his plan back to the Coy HQ, and, if approved, briefed his plan to the platoon. The platoon then advanced to engage a section of enemy soldiers occupying a defensive position. The enemy force soldiers were not participants in the experiment. This approach is described in more detail below.

3.5.1 Procedure

Generally, and under controlled field conditions, participants were required to perform the mission activities and the measures for each investigation in a standardized, repeatable protocol. The following outlines the procedures common to all of the information exchange investigations.

Subjects were screened prior to commencement of the study. Screening was comprised of testing for visual acuity (20/20 corrected required), colour vision (must meet Colour Vision 1 CF Standard), and contrast sensitivity in an effort to characterize subjects. A qualified Human Factors Engineer using an Optec™ 3500 Vision Tester conducted all screening tests.

Selected Platoons were composed of some cohesive sub units that have trained extensively together and some sub-units that had not.

Phase 1: Initial Patrol Briefing: Participants were briefed on their assigned task, using the assigned information package.

Following the Initial Patrol Brief, but prior to the start of any testing, participants were provided with training on all the equipment and hardware to be used in the investigations. This comprised instruction on the use of the software interface for generating reports, returns, plans, routes, image capture, and sending/receiving data. Individual instruction and practice for NCOs and officers on digital equipment training was then moved to collective training with digital information and the platoon organizational structure. Extensive training time was allotted to ensure that the novel digital systems could be used to their maximum capability with the platoon organization.

After training, participants assessed the immediate usefulness of the information package. They then had up to 90 minutes to complete their plan using the assigned planning tools. Once the plan was completed, the usefulness of the supplied information was reassessed. Although both recce and fighting patrol plans were prepared, only fighting patrols were executed.

Once the mission planning and fighting patrol briefing phase was completed, the platoon moved to the Line of Departure and began the mission.

Phase 2: Pre-attack Briefing: After navigating to the ORV, the Platoon Orders Group conducted the normal pre-attack recce of the objective. At this point, recce teams would scout the objective and surrounding area.

Phase 3: Mission Execution: After pre-attack briefing, the platoon initialized an attack from ORV to the objective.

Phase 4: Post-mission Evaluation: At the completion of the mission, participants were issued the Mission Information Exchange Questionnaire.



3.6 Dependent Measures

Data collection utilized the following methods. Test content is described in more detail below. The order of test conditions was balanced.

- Subjective data
 - Mission Information Exchange Questionnaire
 - Exit Information Exchange Questionnaire
- Focus Group Discussion

3.6.1 Mission Information Exchange Questionnaire

Following the completion of each mission, NCOs and officers completed a Mission Information Exchange Questionnaire. The participants were required to rate their perception of information transfer acceptability for both condition used in this trial (see Annex A). Participants rated each condition for the following four areas:

- Information transfer
- Message types
- Receiving information
- Overall acceptance

3.6.2 Mission Organization Exit Questionnaire

Following the completion of all trial missions, NCOs and officers completed the Mission Organization Exit Questionnaire. The participants were required to rate their opinion of mission organizational acceptability for each platoon organization structure used in this study (see Annex B). Participants rated each structure for the following five areas:

- Information transfer
- Message types
- Receiving information
- Overall acceptance
- Mission phases importance

3.6.3 Focus Group

Following the completion of the trial serial, participants took part in a focus group. The participants discussed their responses to a series of questions regarding the various information transfer methods.



3.7 Questionnaire Rating Scale

Participants rated acceptability in all questionnaires using the following seven-point scale and rated importance using the following seven-point scale (see Figure 3).

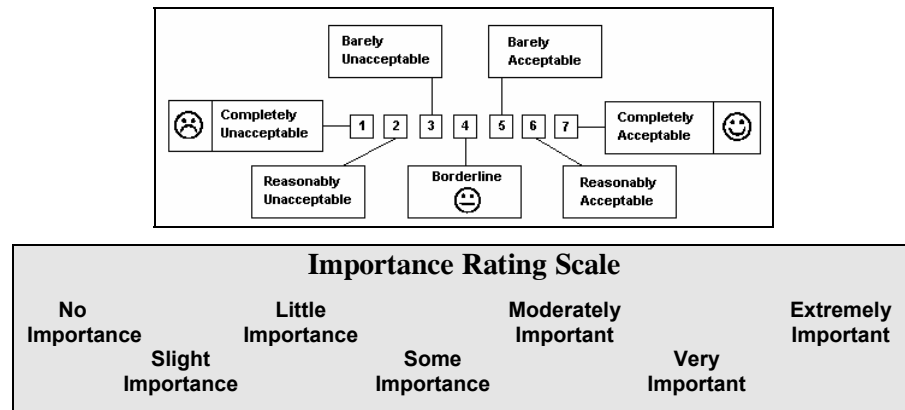


Figure 3: Standard Acceptability (top) and Importance (bottom) Rating Scales

3.8 Statistical Plan

A repeated measures analysis of variance between information exchange methods was conducted on acceptability ratings. Differences were identified at $p < 0.05$. Non-parametric analysis (Sign Test) was conducted on messaging importance ratings. The statistical plan for the target engagement experiment is shown in Table 4 below.

Table 4: Statistical plan

Measure	Method	Analysis
Comparing <u>individual</u> statement's ratings of different information exchange methods	Subjective assessment by participant	ANOVA between: <ul style="list-style-type: none"> Task and exit questionnaire Information exchange methods Conditions (2): <ul style="list-style-type: none"> Radio alone Radio/Digital messaging
Comparing <u>individual</u> statement's ratings of the importance of digital messaging during the day and at night	Subjective assessment by participant	Sign Test between: <ul style="list-style-type: none"> Digital messaging importance criteria (18) Conditions (2): <ul style="list-style-type: none"> Day Night



3.9 Testing Procedure

During each test day, platoons engaged one of nine missions. Each platoon mission included the following:

- Prior to experimentation, all platoon leaders were fitted with the Xybernaut computer systems, GPS and digital radios, and these systems were started and configured. All soldiers in the platoon changed out the batteries in all radios and in their SIMLAS (weapons effects simulator) systems. All SIMLAS weapons lasers were then bore-sighted, and all systems started and configured.
- The mission brief was provided by the assigned staff member, detailing mission goals, timings, insertion points, an outline plan of execution, and enemy status. The platoon sub-unit leaders then had half a day to review the mission map and for the sub-unit Commander to detail their plan and route details.
- The mission was started and continued until the objective was reached or until time limit was reached.
- Following the mission, NCOs and officers completed a series of questionnaires.

3.10 Limitations

Due to limitations in the number of suitable participants and time available, a full repeated measures design between all mediums of information transfer and all levels of information complexity was not feasible. Small sample sizes (as small as 4) limited the statistical analyses that could be carried out on the data.

This experiment investigated information transfer only during the day. Therefore, the full impact of information methods on platoon and section engagements and actions at night could not be collected during this study.

Due to time constraints, no testing of the systems in dense urban, dense woods and open terrain was possible. Furthermore, no testing was possible for the systems during Recce patrols, OP's and defensives. Therefore the full impact of systems on platoon and section engagements and actions could not be assessed with this study.

Most participants had limited experience with digital systems in section and platoon assaults. This limited their ability to quickly improvise the built up doctrines for platoon assaults when enemy and terrain information was added to platoon command staff. Therefore, the use of the old doctrines during assaults could have limited the benefits of the digital systems of information exchange methods, in minimizing casualties, and engaging the enemy.

The enemy force knew the platoon preferred attack methods and adapted their defensive postures. Therefore, reactions of the enemy force to platoon and section attacks adapted and the challenge level changed during the study.



Once soldiers had completed one run of the experiment, they gained additional navigation cues on the McKenna MOUT Site. As a result, they may not have needed the same level of terrain information during subsequent sessions as they required during the initial sessions. This would limit the ability to understand the full benefit that each information exchange enhancement had on a given mission.



4. Results

Fifteen participants were used in an evaluation of information exchange methods. The results of the trial are organized as following:

- Subjective Results
 - Mission Information Exchange Questionnaire
 - Exit Information Exchange Questionnaire
- Focus Group Discussion

4.1 Task Questionnaire Results

Task questionnaires were divided into three blocks, assessment of information transfer, suitability for use in operational messaging and suitability for receiving information.

4.1.1 Mission Information Exchange Questionnaire- Information Transfer

At the end of each run, participants completed a Mission Information Exchange Questionnaire. Using the standard seven-point scale of acceptance, participants rated the acceptability of each statement.

The impact on method of communications was assessed for a variety of information transfer criteria. Overall the radio alone or the radio/digital methods were judged to be “Barely to Reasonable Acceptable” for the 10 information transfer assessment criteria – see Figure 4.

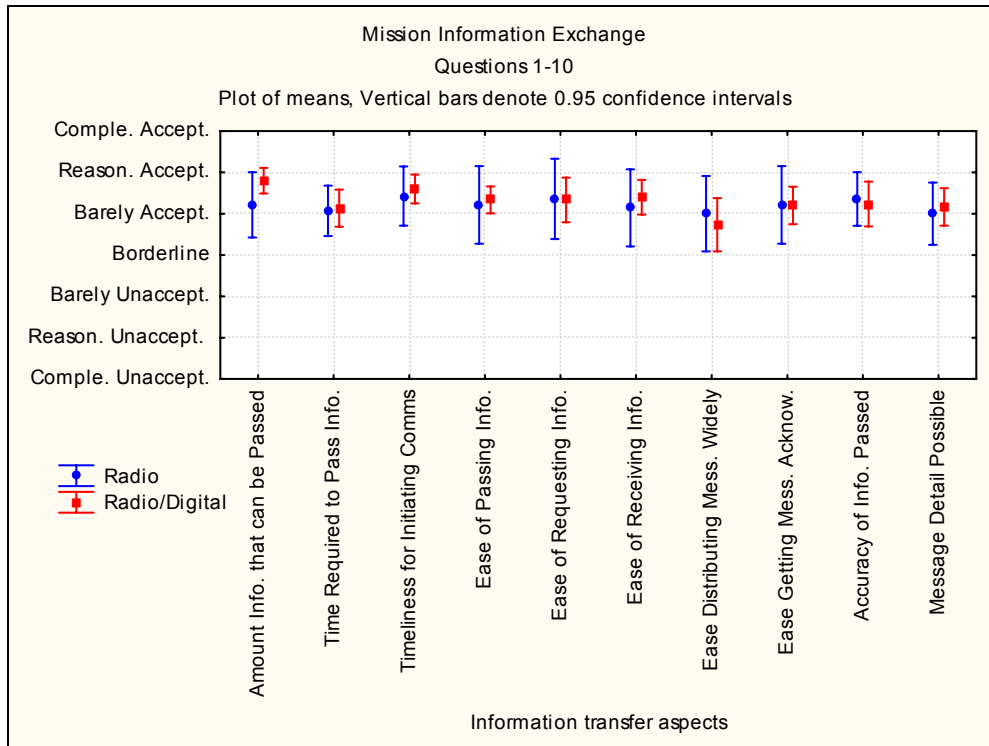


Figure 4: Mission information exchange statement results (Q 1-10)

A repeated measures analysis of variance for the amount of information transferred indicates that the radio/digital means was considered significantly more acceptable than the radio alone method, but only at the $p = .089$ level. A repeated measures analysis of variance for each of the other criterion indicated that there were no significant differences between either information transfer methods for the 10 areas of investigation. ANOVA results are detailed in Annex C

Except for the amount of information that could be passed there were no discernable differences between the two means of passing information.

4.1.2 Mission Information Exchange Questionnaire- Messaging

The impact on method of communications was assessed for acceptability for sending a variety of combat messages. Overall the radio alone or the radio/digital methods were judged to be “Barely to Reasonable Acceptable” for sending the seven message types – see Figure 5.

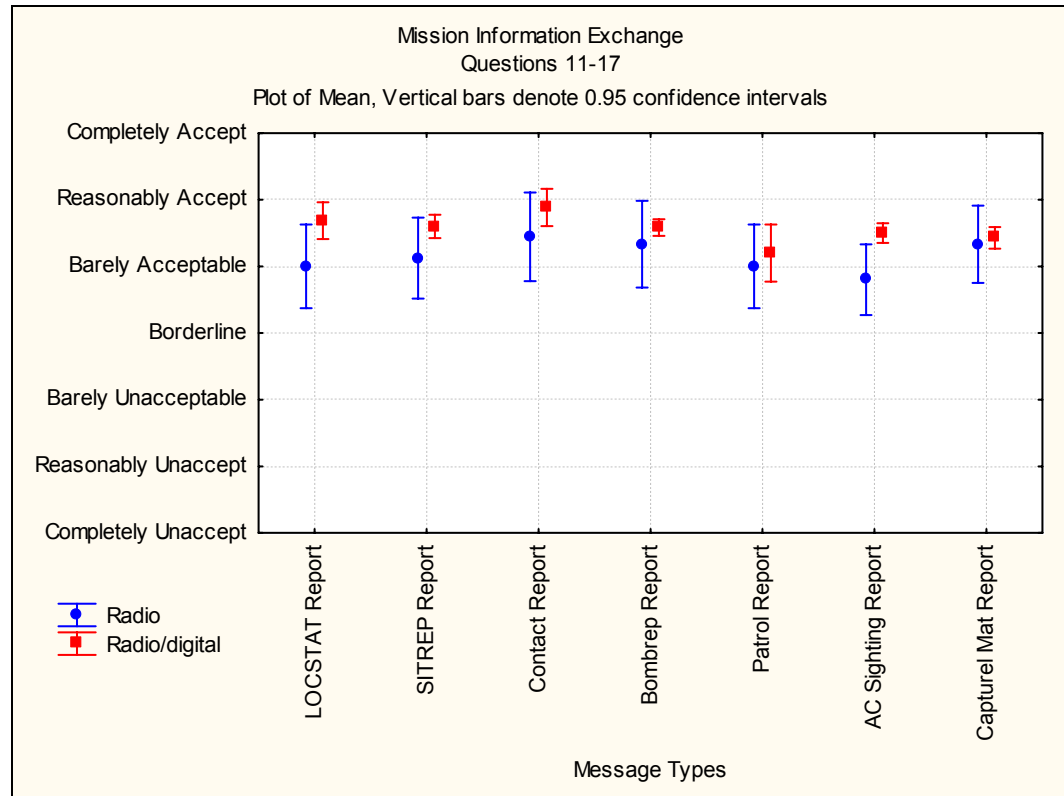


Figure 5: Mission information exchange statement results (Q 11-17)

A repeated measures analysis of variance for each of the message types indicated that there were significant differences between the two information transfer methods for sending LOCSTAT reports and enemy aircraft sighting reports. A repeated measures analysis of variance for each of the other criterion indicated that there were no significant differences between either information transfer methods for the other message types. ANOVA results are detailed in Annex C.

Differences in the variance between the radio and the digital means were a particular concern for the evaluation of questions 11-17. The variations in the results for the digital means were less than that of the radio approach. It is possible that the participants never actually sent these types of messages and thus were rating their perception of the digital system based on assumption and not experience; as a result the participants could have given the digital system higher ratings than what could be expected. The radio-only ratings were based on concrete operational/training experience, leading to higher variations in assessment. Given the lack of controlled assessment of the various reports and returns caution is recommended before inferring any significance.

The participants believed that sending LOCSTAT reports was faster and simpler digitally than using the traditional radio method. The integrated system meant the user did not have to spend time determining their own position with map and compass to estimate their own GR location, the systems GPS system provided accurate location information automatically.



4.1.3 Mission Information Exchange Questionnaire- Receiving Information

The impact on method of communications was assessed for a variety of information receiving criteria. Overall the radio alone or the radio/digital methods were judged to be “Barely to Reasonable Acceptable” for the eight information exchange assessment criteria – see Figure 6.

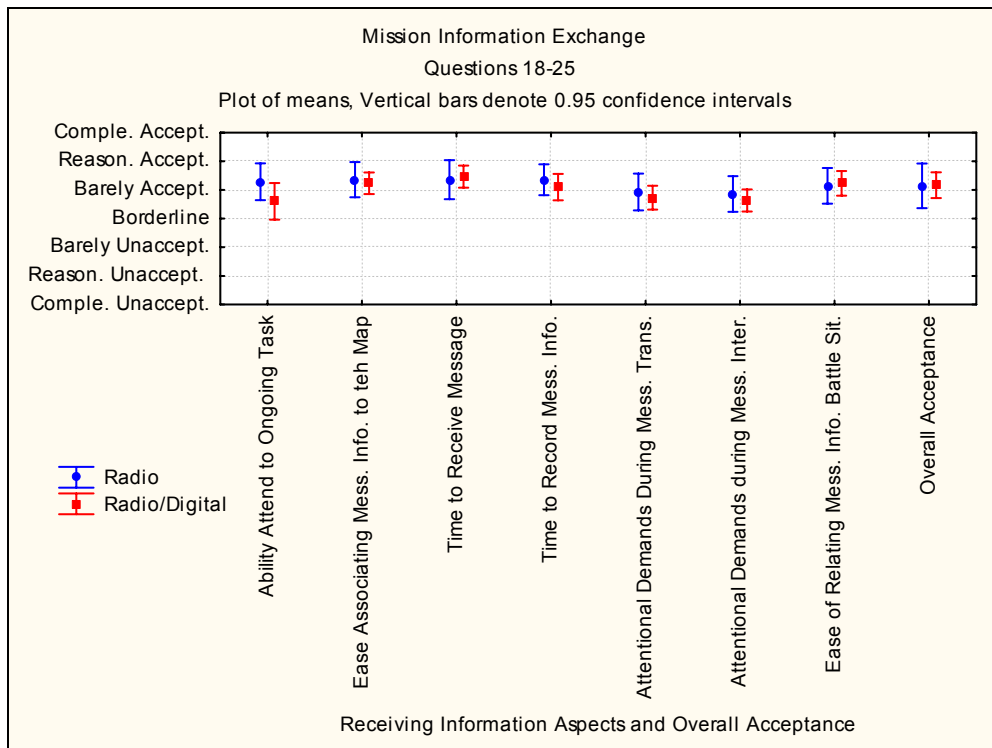


Figure 6: Mission information exchange statement results (Q 18-24)

A repeated measures analysis of variance for each of the receiving information criteria indicated that there were no significant differences between either information transfer methods for the eight areas of investigation. ANOVA results are detailed in Annex C.

There were no discernable differences between the two means of receiving information.

4.2 Exit Information Exchange Questionnaire

At the end of all testing, viz., after all systems were used, participants completed the Exit Information Exchange Questionnaire. Using the standard seven-point scale of acceptance, participants rated the acceptability of each statement.



4.2.1 Mission Information Exchange Exit Questionnaire- Ease of Use

The impact on method of communications was assessed for a variety of ease of use criteria. Overall the radio alone or the radio/digital methods were judged to be “Borderline to Reasonable Acceptable” for the 10 information transfer ease of use assessment criteria – see Figure 7.

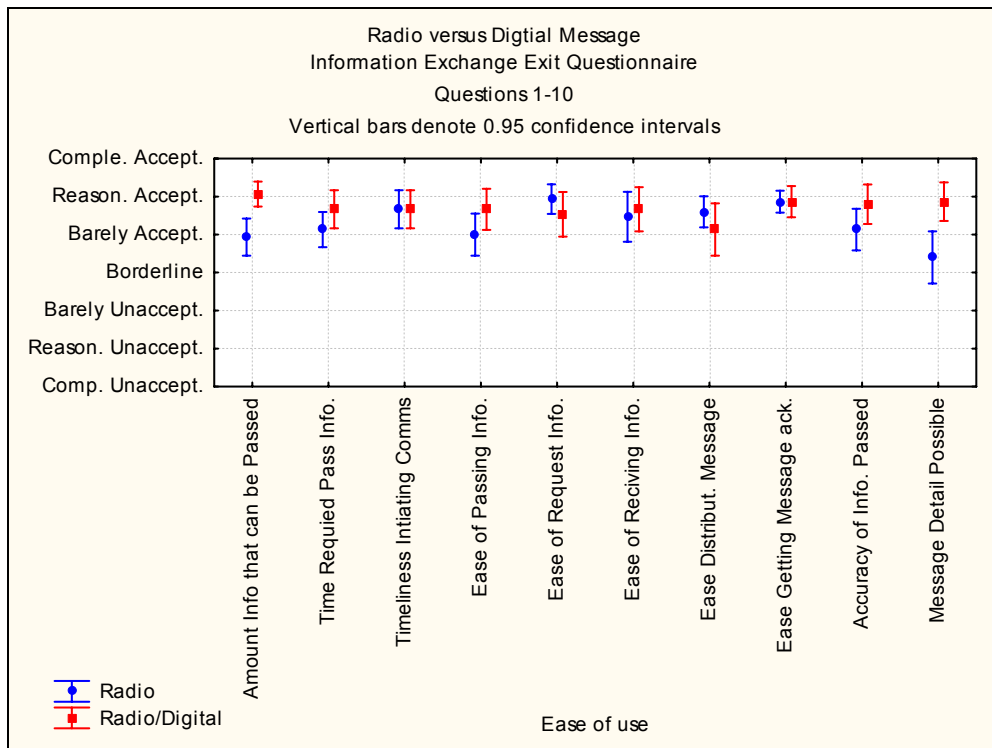


Figure 7: Mission information exchange exit statement results (Q 1-10)

A repeated measures analysis of variance for the amount of information transferred indicates that the radio/digital means was considered significantly more acceptable than the radio alone method, for the amount of information that can be passed (Question #1) and the message detail possible (question #10). A repeated measures analysis of variance for each of the other criterion indicated that there were no significant differences between either information transfer methods for the other eight areas of investigation. ANOVA results are detailed in Annex C.

Except for the amount of information that could be passed and the detail possible for inclusion, there were no discernable differences between the two means of passing information.

4.2.2 Mission Information Exchange Exit Questionnaire- Messaging

The impact on method of communications was assessed for acceptability for sending a variety of combat messages. Overall the radio alone or the radio/digital methods were judged to be “Barely to Reasonable Acceptable” for sending the seven message types – see Figure 8.

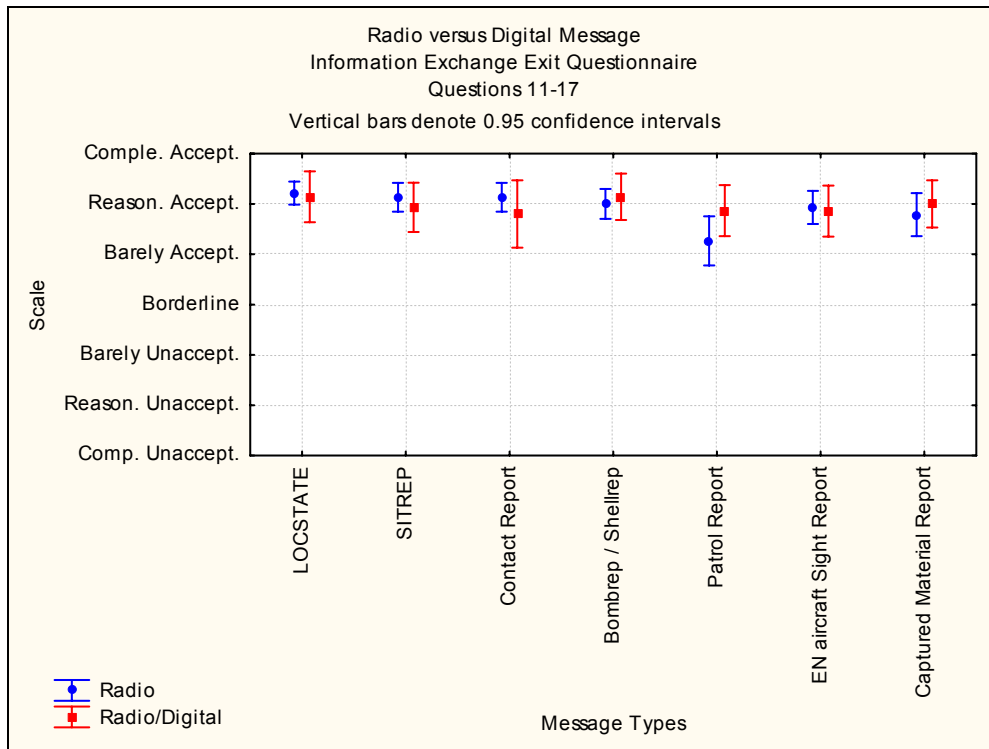


Figure 8: Mission information exchange exit statement results (Q 11-17)

A repeated measures analysis of variance for each of the message types indicated that there were no significant differences between either information transfer methods for the different message types. ANOVA results are detailed in Annex C.

4.2.3 Mission Information Exchange Exit Questionnaire- Receiving Information

The impact on method of communications was assessed for a variety of information receiving criteria. Overall the radio alone or the radio/digital methods were judged to be “Borderline to Reasonable Acceptable” for the eight information exchange assessment criteria – see Figure 9.

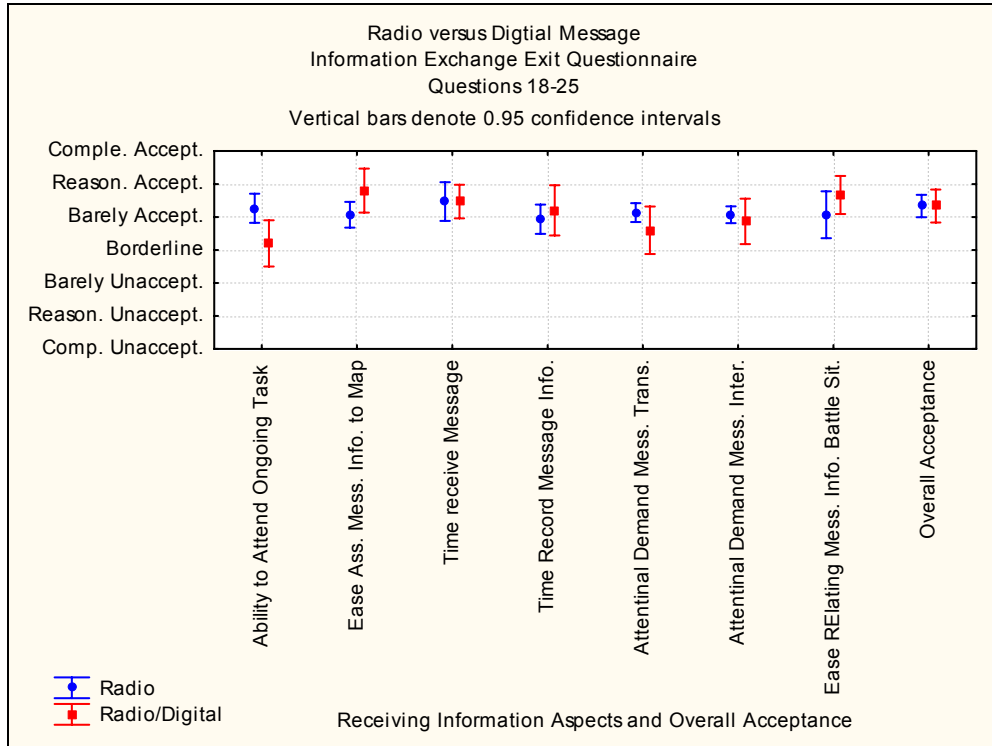


Figure 9: Degree of participant acceptability of exit information exchange

A repeated measures analysis of variance for the amount of information transferred indicates that the radio means was considered significantly more acceptable than the radio/digital method, for their ability to attend ongoing tasks (Question #18). A repeated measures analysis of variance for each of the other receiving information criteria indicated that there were no significant differences between either information transfer methods for the remaining seven areas of investigation. ANOVA results are detailed in Annex C.

There were no discernable differences between participants' acceptance for the two means of receiving information.

4.3 Exit Questionnaire: Importance of Digital Messaging

At the end of all testing, viz., after all systems were used, participants assessed the importance of digital messaging for a variety of criteria. Using the standard seven-point scale of acceptance, participants rated the acceptability of digital messaging during the day and at night.

The participants considered most of the night digital information statements 'moderately important', with seven exceptions. Participants considered the following four statements as having 'some importance': Advance to RV; Assault Objective; Consolidation; and Tempo of mission. Furthermore, participants rated the following three statements 'very important': Awareness of friendly forces; Awareness of battle situation; and Issuing / receiving orders– see Figure 10 and Figure 11.

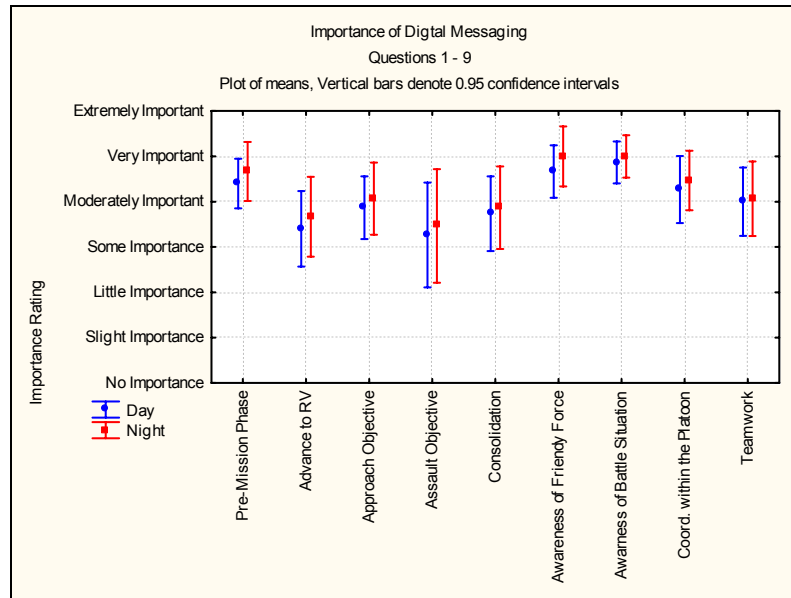


Figure 10: Importance of digital messaging (Q 1-9)

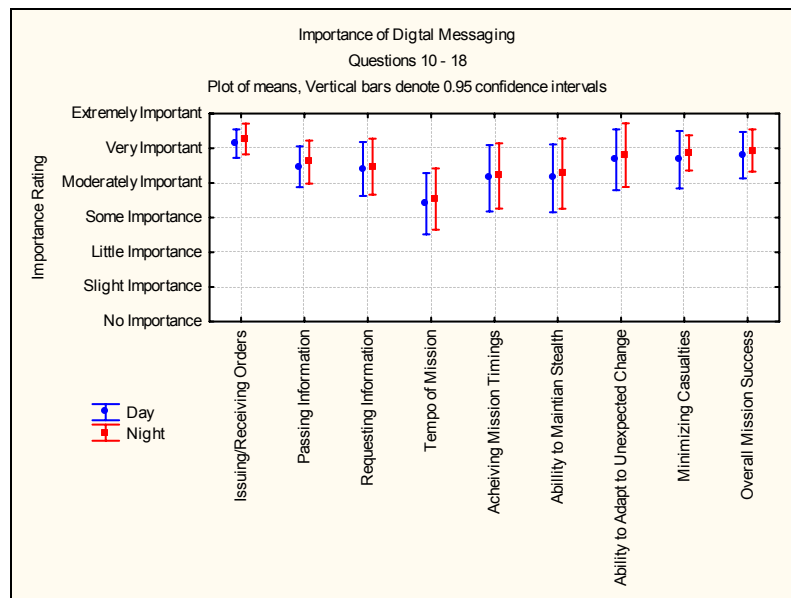


Figure 11: Importance of digital messaging (Q10-18)

The participants considered most day digital information statements ‘moderately important’, with six exceptions. Participants thought that the following had ‘some importance’: Advance to RV; Approach objective; Assault Objective; Consolidation; and Tempo of mission. On the other hand, participants thought that Issuing / receiving orders was ‘very important’ for the day.



In summary, participants rated digital systems ‘moderately important’ overall during both night and day activities. However, digital systems appeared more important to movement and coordination of the platoon during night activities. Furthermore, participants did not seem to consider digital systems as important for effectiveness of manoeuvring platoon, assaulting the objective, consolidation and tempo of mission.

Non-parametric analyses were conducted on the day and night importance ratings for each of the digital messaging questions. Dependent analysis (Chi-square or sign test) results indicated that there were no significant differences between the importance of digital messaging during the day or at night. Sign test results are detailed in Annex C.

4.4 Focus Group Discussion

At the end of the trial, all participants attended a focus group regarding information exchange to the platoon leadership. The exit focus group occurred at the completion of the trial at the site, on November 9 2003. Therefore, the discussion took place after the participants had exposure to the different information exchange systems. A summary of the comments made by the participants is presented below.

Some of the soldiers were slightly in favour of digital messaging and others were slightly against it. They stated that the biggest benefits of digital messages were having a copy of all of the information available for future reference and the reduced airtime required transmitting the information. Further advantages included having all of the information on one system (Xybernaut) with prompts to remember everything to send (i.e., more info about convoy). The soldiers desired, however, a message alerting system (audible, vibration, or overlay) to notify them when a message has been sent or received with the ability to restart everything, if needed. Soldiers also wanted the ability to customize the way information is sent and to whom it is sent. Security was also identified. Soldiers, therefore, wanted the ability to quickly destroy the information stored on the computers.

Participants stated that the disadvantages of digital messages were it was time consuming to use and attentional resources are reduced as individuals use the digital systems. The soldiers were concerned about digital messaging being time consuming, decreasing their situational awareness while viewing the information and unsure of the comprehension of written orders sent digitally. Soldiers would like the digital orders to look the same as written orders (so that it is easy to switch if necessary). They require both radio and digital options, in case the comprehension of what was written is questionable – radio allows you to ask for confirmation back.

Soldiers considered the Xybernaut too large and would prefer a palm pilot design with capabilities to transcribe writing into type. The soldiers stated that the TCCCs radio are not reliable and do not have enough range.

Participants also believed that computer skills and training was required in order to use the digital systems to their fullest. Digital systems, however, should not replace map and compass skills because if digital systems go down, the ability to navigate by compass will be required.

The soldiers realize that their tactics would have to evolve with the technology. There could possibly be more benefits than known right now, based on new tactics with the digital systems. The soldiers would like the system to be viable during the worst possible situations. For



example, if a soldier is injured or dies, the information being sent across his system should skip him and jump to the next soldier. The system should also be a basic and simple network based on radio transmission.



5. Discussion

A battery of scientific human factors performance tests were conducted at Fort Benning as part of an information transfer evaluation. This human factors study investigated issues related to mission information exchange, exit information exchange and focus group discussion.

Mission information exchange questionnaire results suggest that both options were considered equally effective. The daily questionnaire results suggest that the digital options impact on attention to ongoing tasks. This indicates that increasing information exchange can have a negative impact on situation awareness to ongoing tasks.

The exit questionnaires results suggest that the digital options over burdened the soldier during concurrent activities more than radio only option. Effort and time pressures were important for soldiers in order to use the information in the field. This indicates that too much information may consequently over burden the soldiers. Furthermore, participants believed that digital options increased message detail and improved the association of the message to the map. This indicates that increased information exchange can be achieved with digital format combined with radio. The exit questionnaire result also suggests that digital options are more important during night manoeuvring and situation awareness of friendly forces than during the day.

The focus group results suggest that the disadvantages of digital messages are that they are time consuming to use and attention resources are reduced as you use the digital systems. Soldiers also stated that the biggest benefits of digital messages are having a copy of all of the information available for future reference and the reduced airtime required transmitting the information. This indicates that digital systems have a balance between volume of information and effort to use as well as attentional demands of ongoing tasks. Currently, too little information makes digital system less useful whereas too much information will overburden the soldier. This suggests that a system has to be customized / filtered to the individual or leadership level in order to maximize information exchange and minimize cognitive impact to the soldier.

Participants suggested computer skills and training is required in order to use the digital systems to their fullest. Training doctrine may have to change in order to incorporate digital systems into the platoon structure.

The soldiers realized that their tactics would have to evolve with the new technology. There could possibly be benefits that are currently unknown, based on new tactics with the digital systems. Digital information exchange systems impact on platoon activities may require a change in doctrine to platoon organization and manoeuvring in order to use the digital systems to their full advantage during future engagements.



6. Recommendations

A future study should be conducted in a wooded environment to investigate the effects of limited information transfer methods on manoeuvring elements and covering greater area. Wooded environments limit visual contact to the different platoon elements and force the platoon to manoeuvre with elements closer together. The ability to spread the platoon out at day and night may have advantages to light infantry to out manoeuvring enemy positions and enemy engagements.

Further studies in urban engagements should be conducted to determine the effects of different information transfer methods on planning and manoeuvring different elements around an urban environment. Since limited situational awareness of the leadership elements of a platoon limits the manoeuvring of each element to visual contact and radio contact, the ability to improve situational awareness in an urban area could improve elements manoeuvring to support each other and minimize friendly casualties.

The number of participants used in future studies should be increased to improve the possible statistical analyses of the data. The small sample size of this study limited the analyses to inferences from descriptive statistics.

Design issues of the prototype digital messaging system were identified by the soldiers. The areas for improvement include:

- Message alerting system (audible, vibration, or overlay) to notify them that a message has been sent or received
- Customise the way information is sent and to whom it is sent
- Ability to quickly reset everything if needed and the reinitialize quickly
- Ability to quickly destroy the information stored on the computers (for security purposes)
- Digital orders to look the same as written orders
- Require both radio and digital options
- Basic and simple network based on radio transmission.

The ability to improve the prototype in next phases of experiments could help better define system specifications required by the soldiers that balance volume of information exchange with effort required to use the information.



7. Reference

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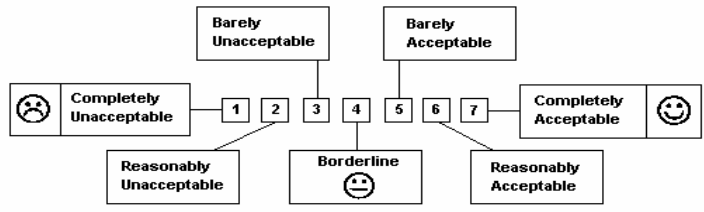
Annex A – Mission Info Exchange Questionnaire



PARTICIPANT NUMBER : _____ MISSION NUMBER : _____
SECTION NUMBER : _____

CONDITION:	RADIO ALONE		RADIO / DIGITAL MESSAGING	
	<input type="radio"/>		<input type="radio"/>	
ROLE: WEAPONS DET	COMD	SECTION COMD	PLATOON COMD	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

USING THE SCALE PROVIDED,
INDICATE THE ACCEPTABILITY OF
THE FOLLOWING ASPECTS OF
YOUR MISSION.



Information Transfer	☹						☺
	1	2	3	4	5	6	7
Amount of information that can be passed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time required to pass information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Timeliness for initiating comms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of passing information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of requesting information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of receiving information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of distributing message widely within Platoon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of getting message acknowledgement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accuracy of information passed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Message detail possible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

MESSAGE TYPES	☹		☺		☺		
	1	2	3	4	5	6	7
LOCSTATE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SITREP	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contact Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bombrep / Shellrep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patrol Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enemy Aircraft Sighting Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Captured Material Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RECEIVING INFORMATION	☹		☺		☺		
	1	2	3	4	5	6	7
Ability to attend to ongoing tasks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of associating message information to the map	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time to receive message	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time to record the message information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attentional demands during message transmission	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attentional demands during message interpretation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of relating message information to battle situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
OVERALL ACCEPTANCE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Comments

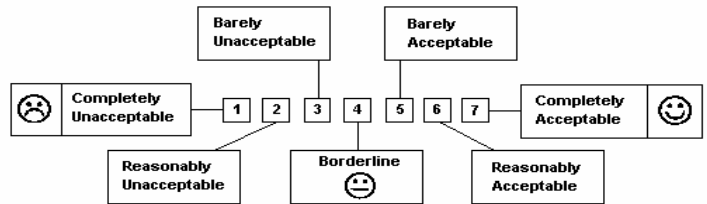


Annex B – Exit Info Exchange Questionnaire

PARTICIPANT NUMBER : _____ **Date:** _____

SECTION : _____

USING THE SCALE PROVIDED, INDICATE THE ACCEPTABILITY OF THE FOLLOWING FEATURES FOR THE NO RADIO AND RADIO/DIGITAL MESSAGING COMMUNICATION METHODS.



	Radio Alone	Radio and Digital Messages
INFORMATION TRANSFER	☹️ ☺️ 1 2 3 4 5 6 7	☹️ ☺️ 1 2 3 4 5 6 7
Amount of information that can be passed	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Time required to pass information	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Timeliness for initiating comms	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Ease of passing information	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Ease of requesting information	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Ease of receiving information	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Ease of distributing message widely within Platoon	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Ease of getting message acknowledgement	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Accuracy of information passed	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
Message detail possible	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○

	Radio Alone							Radio and Digital Messages						
MESSAGE TYPES	☹		☺			☺		☹		☺			☺	
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
LOCSTATE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SITREP	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contact Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bombrep / Shellrep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patrol Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enemy Aircraft Sighting Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Captured Material Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Radio Alone							Radio and Digital Messages						
RECEIVING INFORMATION	☹		☺			☺		☹		☺			☺	
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to attend to ongoing tasks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of associating message information to the map	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time to receive message	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time to record the message information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attentional demands during message transmission	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attentional demands during message interpretation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of relating message information to battle situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
OVERALL ACCEPTANCE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Likes	Dislikes
Indicate the features you liked the most about the digital messaging.	Indicate the features you liked the least about the digital messaging.
Improvements	
How would you improve the digital messaging system?	

Mission Phases		Importance Rating Scale						
		No Importance	Slight Importance	Little Importance	Some Importance	Moderately Important	Very Important	Extremely Important
Pre-Mission Briefing	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Advance to RV	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approach Objective	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assault Objective	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Consolidation	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

RATE THE IMPORTANCE OF DIGITAL MESSAGING FOR THESE FEATURES.

Mission Phases		Importance Rating Scale						
		No Importance	Slight Importance	Little Importance	Some Importance	Moderately Important	Very Important	Extremely Important
Awareness of Friendly Forces	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Awareness of the Battle Situation	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Coordination within the Platoon	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Teamwork	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Issuing / Receiving Orders	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Passing Information	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Requesting Information	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tempo of mission	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Achieving mission timings	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to maintain 4stealth	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to adapt to unexpected changes in mission	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Minimizing casualties	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overall Mission Success	Day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments

Annex C: Significant Difference, Means and Post-Hoc Tests for Information Exchange Questionnaires

C.1. Task Questionnaire Results

Task questionnaires were divided into three blocks, assessment of information transfer, suitability for use in operational messaging and suitability for receiving information. The descriptive results are detailed below in Table 5. ANOVA results for each question are also described (significant differences ($p < .05$) are highlighted).

Table 5: Mean and Standard Deviation for Mission Information Exchange

	Radio Alone		Radio and Digital Messages	
	Mean	SD	Mean	SD
INFORMATION TRANSFER				
Amount of information that can be passed	5.2	1.5	5.8	0.6
Time required to pass information	5.1	1.1	5.1	0.8
Timeliness for initiating comms	5.4	1.3	5.6	0.6
Ease of passing information	5.2	1.8	5.3	0.6
Ease of requesting information	5.4	1.8	5.3	1.0
Ease of receiving information	5.1	1.7	5.4	0.8
Ease of distributing message widely within Platoon	5.0	1.7	4.7	1.2
Ease of getting message acknowledgement	5.2	1.8	5.2	0.8
Accuracy of information passed	5.4	1.2	5.2	1.0
Message detail possible	5.0	1.4	5.2	0.8
MESSAGE TYPES				
LOCSTATE (n=6)	5.0	1.7	5.7	0.7
SITREP (n=8)	5.1	1.6	5.6	0.4
Contact Report (n=9)	5.4	1.6	5.9	0.5
Bombrep / Shellrep (n=6)	5.3	2.0	5.6	0.4
Patrol Report (n=9)	5.0	1.5	5.2	0.8
Enemy Aircraft Sighting Report (n=5)	4.8	1.8	5.5	0.4
Captured Material Report (n=6)	5.3	1.8	5.4	0.4

	Radio Alone		Radio and Digital Messages	
RECEIVING INFORMATION				
Ability to attend to ongoing tasks	5.3	1.2	4.6	1.2
Ease of associating message information to the map	5.4	1.2	5.2	0.7
Time to receive message	5.4	1.3	5.5	0.7
Time to record the message information	5.4	1.0	5.1	0.8
Attentional demands during message transmission	4.9	1.2	4.7	0.8
Attentional demands during message interpretation	4.9	1.2	4.6	0.7

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Amount of info passed					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	909.8587	1	909.8587	578.4376	0.000000
Error	22.0214	14	1.5730		
R1	2.5730	1	2.5730	3.3553	0.088347
Error	10.7357	14	0.7668		

Repeated Measures Analysis of Variance (Task Questionnaire version) Sigma-restricted parameterization Effective hypothesis decomposition Time required to pass info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	781.0287	1	781.0287	813.6869	0.000000
Error	13.4381	14	0.9599		
R1	0.0287	1	0.0287	0.0316	0.861402
Error	12.7238	14	0.9088		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Timeliness for initiating comms					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	912.2204	1	912.2204	902.0949	0.000000
Error	14.1571	14	1.0112		
R1	0.2204	1	0.2204	0.2075	0.655724
Error	14.8714	14	1.0622		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of passing info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	834.3920	1	834.3920	424.4139	0.000000
Error	27.5238	14	1.9660		
R1	0.1063	1	0.1063	0.0842	0.775897
Error	17.6667	14	1.2619		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of requesting info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	857.1471	1	857.1471	365.7493	0.000000
Error	32.8095	14	2.3435		
R1	0.0043	1	0.0043	0.0025	0.960770
Error	23.7381	14	1.6956		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of receiving info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	833.6388	1	833.6388	431.4581	0.000000
Error	27.0500	14	1.9321		
R1	0.4959	1	0.4959	0.3344	0.572285
Error	20.7643	14	1.4832		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition ease of distributing message in platoon					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	710.5333	1	710.5333	362.1650	0.000000
Error	27.4667	14	1.9619		
R1	0.5333	1	0.5333	0.2534	0.622523
Error	29.4667	14	2.1048		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of getting acknowledgement					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	813.4301	1	813.4301	469.8859	0.000000
Error	24.2357	14	1.7311		
R1	0.0015	1	0.0015	0.0008	0.977292
Error	25.5214	14	1.8230		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Accuracy of information passed					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	841.1864	1	841.1864	1148.671	0.000000
Error	10.2524	14	0.7323		
R1	0.1150	1	0.1150	0.072	0.792544
Error	22.3952	14	1.5997		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Message detail possible					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	775.2083	1	775.2083	671.3144	0.000000
Error	16.1667	14	1.1548		
R1	0.2083	1	0.2083	0.1522	0.702337
Error	19.1667	14	1.3690		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition LOCSTAT Report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	856.6699	1	856.6699	906.2293	0.000000
Error	13.2344	14	0.9453		
R1	3.5449	1	3.5449	6.0270	0.027775
Error	8.2344	14	0.5882		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition SITREP					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	862.6922	1	862.6922	1481.925	0.000000
Error	8.1500	14	0.5821		
R1	1.6922	1	1.6922	2.340	0.148382
Error	10.1250	14	0.7232		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Contact Report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	962.6070	1	962.6070	958.6565	0.000000
Error	14.0577	14	1.0041		
R1	1.4531	1	1.4531	2.0884	0.170434
Error	9.7415	14	0.6958		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition BOMBREP and Shell Report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	893.8021	1	893.8021	1080.927	0.000000
Error	11.5764	14	0.8269		
R1	0.4687	1	0.4687	0.775	0.393469
Error	8.4653	14	0.6047		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Patrol Report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	780.3000	1	780.3000	975.3750	0.000000
Error	11.2000	14	0.8000		
R1	0.3000	1	0.3000	0.2763	0.607352
Error	15.2000	14	1.0857		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Enemy aircraft sighting report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	795.6750	1	795.6750	1410.057	0.000000
Error	7.9000	14	0.5643		
R1	3.6750	1	3.6750	8.720	0.010483
Error	5.9000	14	0.4214		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Captured material report					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	868.6395	1	868.6395	1448.965	0.000000
Error	8.3929	14	0.5995		
R1	0.0680	1	0.0680	0.117	0.737620
Error	8.1548	14	0.5825		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ability to attend ongoing tasks					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	732.9551	1	732.9551	605.6459	0.000000
Error	16.9429	14	1.2102		
R1	3.5265	1	3.5265	2.4067	0.143125
Error	20.5143	14	1.4653		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of associating message info with map					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	841.1864	1	841.1864	1046.588	0.000000
Error	11.2524	14	0.8037		
R1	0.1150	1	0.1150	0.130	0.723966
Error	12.3952	14	0.8854		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Time to receive message					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	878.6614	1	878.6614	761.5756	0.000000
Error	16.1524	14	1.1537		
R1	0.0900	1	0.0900	0.1068	0.748672
Error	11.7952	14	0.8425		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Time to record message info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	820.1388	1	820.1388	1025.828	0.000000
Error	11.1929	14	0.7995		
R1	0.4959	1	0.4959	0.597	0.452418
Error	11.6214	14	0.8301		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Attentional demands during message transmission					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	700.1430	1	700.1430	667.6680	0.000000
Error	14.6810	14	1.0486		
R1	0.2859	1	0.2859	0.3286	0.575590
Error	12.1810	14	0.8701		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Attentional demands during message interpretation					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	675.5185	1	675.5185	700.0439	0.000000
Error	13.5095	14	0.9650		
R1	0.3757	1	0.3757	0.4808	0.499384
Error	10.9381	14	0.7813		

Repeated Measures Analysis of Variance (Task Questionnaire) Sigma-restricted parameterization Effective hypothesis decomposition Ease of relating message info to battle situation					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	807.4900	1	807.4900	1020.865	0.000000
Error	11.0738	14	0.7910		
R1	0.0614	1	0.0614	0.057	0.814728
Error	15.0738	14	1.0767		

C.2. Exit Questionnaire Results

The exit questionnaire was divided into three blocks, assessment of information transfer, suitability for use in operational messaging and suitability for receiving information. The descriptive results are detailed below in Table 6. ANOVA results for each question are also described (significant result differences ($p < .05$) are highlighted).

Table 6: Mean and Standard Deviation for Exit Information Exchange Feature Criteria

	Radio Alone		Radio and Digital Messages	
	Mean	SD	Mean	SD
INFORMATION TRANSFER				
Amount of information that can be passed	4.9	0.9	6.1	0.6
Time required to pass information	5.1	0.8	5.7	0.9
Timeliness for initiating comms	5.7	0.9	5.7	0.9
Ease of passing information	5.0	1.0	5.7	1.0
Ease of requesting information	5.9	0.7	5.5	1.1
Ease of receiving information	5.5	1.2	5.7	1.0
Ease of distributing message widely within Platoon	5.6	0.7	5.1	1.2
Ease of getting message acknowledgement	5.9	0.5	5.9	0.7
Accuracy of information passed	5.1	1.0	5.8	0.9
Message detail possible	4.4	1.2	5.9	0.9
MESSAGE TYPES				
LOCSTATE	6.2	0.4	6.1	0.9
SITREP	6.1	0.5	5.9	0.9
Contact Report	6.1	0.5	5.8	1.2
Bombrep / Shellrep	6.0	0.6	6.1	0.9
Patrol Report	5.3	0.9	5.9	0.9
Enemy Aircraft Sighting Report	5.9	0.6	5.9	0.9
Captured Material Report	5.8	0.8	6.0	0.9

RECEIVING INFORMATION				
Ability to attend to ongoing tasks	5.3	0.8	4.2	1.3
Ease of associating message information to the map	5.1	0.7	5.8	1.2
Time to receive message	5.5	1.1	5.5	0.9
Time to record the message information	4.9	0.8	5.2	1.4
Attentional demands during message transmission	5.1	0.5	4.6	1.3
Attentional demands during message interpretation	5.1	0.5	4.9	1.2
Ease of relating message information to battle situation	5.1	1.3	5.7	1.0
OVERALL ACCEPTANCE	5.3	0.6	5.3	0.9

Repeated Measures Analysis of Variance (Exit Info Exchange) Amount info passed: Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	907.5000	1	907.5000	1588.125	0.000000
Error	8.0000	14	0.5714		
R1	9.6333	1	9.6333	17.144	0.001000
Error	7.8667	14	0.5619		

Repeated Measures Analysis of Variance (Exit Info Exchange) Time pass info. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	874.8000	1	874.8000	1093.500	0.000000
Error	11.2000	14	0.8000		
R1	2.1333	1	2.1333	3.027	0.103814
Error	9.8667	14	0.7048		

Repeated Measures Analysis of Variance (Exit Info Exchange) Timeliness comms Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	963.3333	1	963.3333	860.8511	0.000000
Error	15.6667	14	1.1190		
R1	0.0000	1	0.0000	0.0000	1.000000
Error	7.0000	14	0.5000		

Repeated Measures Analysis of Variance (Exit Info Exchange) Ease of passing info. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	853.3333	1	853.3333	1378.462	0.000000
Error	8.6667	14	0.6190		
R1	3.3333	1	3.3333	2.500	0.136169
Error	18.6667	14	1.3333		

Repeated Measures Analysis of Variance (Exit Info Exchange) Ease request info. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	986.1333	1	986.1333	995.6154	0.000000
Error	13.8667	14	0.9905		
R1	1.2000	1	1.2000	1.9091	0.188716
Error	8.8000	14	0.6286		

Repeated Measures Analysis of Variance (Exit Info Exchange) Ease of receive info. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	929.6333	1	929.6333	938.5721	0.000000
Error	13.8667	14	0.9905		
R1	0.3000	1	0.3000	0.1981	0.663053
Error	21.2000	14	1.5143		

Repeated Measures Analysis of Variance (Exit Info Exchange) Ease of distribute message. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	864.0333	1	864.0333	655.0433	0.000000
Error	18.4667	14	1.3190		
R1	1.6333	1	1.6333	2.1043	0.168921
Error	10.8667	14	0.7762		

Repeated Measures Analysis of Variance (Exit Info Exchange) Ease of getting message ack. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1032.533	1	1032.533	2235.381	0.000000
Error	6.467	14	0.462		
R1	0.000	1	0.000	0.000	1.000000
Error	5.000	14	0.357		

Repeated Measures Analysis of Variance (Exit Info Exchange) Accuracy of info passed. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	896.5333	1	896.5333	1325.859	0.000000
Error	9.4667	14	0.6762		
R1	3.3333	1	3.3333	2.800	0.116452
Error	16.6667	14	1.1905		

Repeated Measures Analysis of Variance (Exit Info Exchange) Message detail. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	790.5333	1	790.5333	1057.401	0.000000
Error	10.4667	14	0.7476		
R1	16.1333	1	16.1333	9.878	0.007193
Error	22.8667	14	1.6333		

Repeated Measures Analysis of Variance (Exit Info Exchange) LOCSTATE. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1145.242	1	1145.242	1668.903	0.000000
Error	9.607	14	0.686		
R1	0.038	1	0.038	0.120	0.734186
Error	4.464	14	0.319		

Repeated Measures Analysis of Variance (Exit Info Exchange) SITREP. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1092.033	1	1092.033	1805.724	0.000000
Error	8.467	14	0.605		
R1	0.300	1	0.300	0.677	0.424275
Error	6.200	14	0.443		

Repeated Measures Analysis of Variance (Exit Info Exchange) Contact report. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1068.033	1	1068.033	1766.039	0.000000
Error	8.467	14	0.605		
R1	0.833	1	0.833	0.745	0.402707
Error	15.667	14	1.119		

Repeated Measures Analysis of Variance (Exit Info Exchange) Bombrep/shell report. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1105.867	1	1105.867	1970.455	0.000000
Error	7.857	14	0.561		
R1	0.153	1	0.153	0.366	0.554951
Error	5.857	14	0.418		

Repeated Measures Analysis of Variance (Exit Info Exchange) Patrol report. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	929.6333	1	929.6333	1319.074	0.000000
Error	9.8667	14	0.7048		
R1	2.7000	1	2.7000	2.953	0.107736
Error	12.8000	14	0.9143		

Repeated Measures Analysis of Variance (Exit Info Exchange) Enemy aircraft sighting report. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1041.773	1	1041.773	1304.712	0.000000
Error	11.179	14	0.798		
R1	0.038	1	0.038	0.098	0.758811
Error	5.464	14	0.390		

Repeated Measures Analysis of Variance (Exit Info Exchange) Captured material report. Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1041.773	1	1041.773	1106.707	0.000000
Error	13.179	14	0.941		
R1	0.344	1	0.344	0.931	0.350967
Error	5.179	14	0.370		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Attend ongoing task					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	672.1333	1	672.1333	498.7562	0.000000
Error	18.8667	14	1.3476		
R1	8.5333	1	8.5333	9.5829	0.007901
Error	12.4667	14	0.8905		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Ease associate msg info to map					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	885.6333	1	885.6333	1805.660	0.000000
Error	6.8667	14	0.4905		
R1	4.0333	1	4.0333	2.759	0.118932
Error	20.4667	14	1.4619		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Time to receive msg					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	896.5333	1	896.5333	811.5172	0.000000
Error	15.4667	14	1.1048		
R1	0.0000	1	0.0000	0.0000	1.000000
Error	12.0000	14	0.8571		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Time to record msg info					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	770.1333	1	770.1333	603.4627	0.000000
Error	17.8667	14	1.2762		
R1	0.5333	1	0.5333	0.4275	0.523822
Error	17.4667	14	1.2476		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Attentional demands during msg trans					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	710.5333	1	710.5333	687.6129	0.000000
Error	14.4667	14	1.0333		
R1	2.1333	1	2.1333	2.3212	0.149884
Error	12.8667	14	0.9190		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Attentional demands during msg interpretation					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	740.0333	1	740.0333	769.3416	0.000000
Error	13.4667	14	0.9619		
R1	0.3000	1	0.3000	0.3750	0.550109
Error	11.2000	14	0.8000		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Ease of relating msg info to battle situation					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	864.0333	1	864.0333	898.2525	0.000000
Error	13.4667	14	0.9619		
R1	2.7000	1	2.7000	1.5242	0.237307
Error	24.8000	14	1.7714		

Repeated Measures Analysis of Variance (Exit Info Exchange) Sigma-restricted parameterization Effective hypothesis decomposition Overall acceptance					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	853.3333	1	853.3333	3258.182	0.000000
Error	3.6667	14	0.2619		
R1	0.0000	1	0.0000	0.000	1.000000
Error	13.0000	14	0.9286		

C.3. Digital Messaging Importance Results

At the end of all testing, viz., after all systems were used, participants assessed the importance of digital messaging for a variety of criteria. The descriptive results are detailed below in Table 7. Non-parametric Sign Test results for each question are also described.

Table 7: Mean and Standard Deviation for Importance of Digital Messaging Criteria

Mission Phase	Day Digital Messaging		Night Digital Messages	
	Mean	SD	Mean	SD
Pre-mission phase	5.4	1.0	5.7	1.2
Advance to RV	4.4	1.5	4.7	1.6
Approach objective	4.9	1.2	5.1	1.4
Assault Objective	4.3	2.1	4.5	2.3
Consolidation	4.7	1.5	4.9	1.6
Features				
Awareness of friendly forces	5.7	1.0	6.0	1.2
Awareness of the battle situation	5.9	0.8	6.0	0.8
Coordination within the platoon	5.3	1.3	5.5	1.2
Teamwork	5.0	1.4	5.1	1.5
Issuing / receiving orders	6.1	0.7	6.3	0.8
Passing information	5.5	1.1	5.6	1.1
Request information	5.4	1.4	5.5	1.5
Tempo of mission	4.4	1.6	4.5	1.6
Achieving mission timings	5.1	1.7	5.2	1.7
Ability to maintain stealth	5.1	1.8	5.3	1.8
Ability to adapt to unexpected changes in mission	5.7	1.6	5.8	1.7
Minimizing casualties	5.7	1.5	5.9	0.9
Overall mission success	5.8	1.2	5.9	1.1

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
aware friendly force day & night	5	100.0000	1.788854	0.073638

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
aware battle sit day & night	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
coord within pl day & night	3	100.0000	1.154701	0.248213

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
Teamwork day and night	3	66.66667	-0.000000	1.00000

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
issuing/receive orders day and r	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
pass info day and night	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
request info day and night	1			

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
tempo of mission day and	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
mission timings day and night	1			

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
stealth day and night	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
adapt to change day and night	2	100.0000	0.707107	0.479500

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
min casualties day and night	1			

Pair of Variables	Sign Test (Exit Info Exchange) Marked tests are significant at p <.05000			
	No. of Non-ties	Percent v < V	Z	p-level
overall success day and ni	1			

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(U) This trial investigated the utility of providing leaders with digital messaging for information exchange in dismounted infantry urban operations. A 20-day field trial was conducted at Fort Benning, Georgia over the period of 19 October to 9 November, 2003, which included nine missions (plus one pilot mission) during the day. Forty regular Canadian Forces (CF) infantry soldiers were required to undertake force-on-force tactical assault missions that moved through a wooded terrain to an objective in an urban environment. The assaulting force comprised a Company HQ, a Platoon HQ, three dismounted infantry sections, and a weapons detachment to assault one defending section. Human factors measures included subjective utility and usability assessments of the different information exchange alternatives. Data collection methods included questionnaires, focus groups, and HF observer assessments. Participants thought that more information via digital format was positive for leadership elements of a platoon, provided the amount of information in the digital system is manageable. This suggests that a system has to be customized/filtered to the individual or leadership level in order to maximize information exchange and minimize cognitive impact to the soldier's ongoing tasks. Based on observations and results of this study, improvements to the digital prototype and recommendations for future investigations are discussed.

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(U) Soldier Information Requirements Technology Demonstration Project; SIREQ TD; Information Exchange; Platoon Tactics; digital information; dismounted infantry; urban operations; mission planning

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