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Title: Emerging Staff Roles: Robotics NCO Task Analysis

Organizational Issues Track

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Abstract

The position of a new platoon asset, the Robotics NCO (RNCO), is introduced in the Objective Force Operational and Organizational (O&O) Plan (Unit of Action Maneuver Battle Lab, 2003). The RNCO is expected to assist the Platoon Leader in employing unmanned systems, to be a subject matter expert in platoon robotics systems, and to coordinate unmanned assets in support of reconnaissance and surveillance tasks (Unit of Action Maneuver Battle Lab, p 3-18). The task analysis conducted in this experiment was designed to improve the fidelity of task descriptions and understand interactions with robotic systems operators. The task analysis identified major coordinating responsibilities for this role. Continuation of this effort will examine RNCO tasks in the context of the battle command interface to determine how best to visualize information for major functions. We will also focus on the RNCO responsibilities from a system of systems perspective and identify key staff interdependencies within the platoon and with higher echelons.

Introduction

The position of a Robotics Non Commissioned Officer (RNCO) is introduced in the Objective Force Operational and Organizational (O&O) Plan (Unit of Action Maneuver Battle Lab, 2003). The RNCO will be a platoon asset and will assist the platoon leader in employing unmanned systems, act as a subject matter expert in platoon robotics systems, and support reconnaissance and surveillance tasks (Unit of Action Maneuver Battle Lab, p 3-18).   The task analysis conducted in this experiment was designed to provide more detail to the functions identified in the O&O.

A hierarchical task analysis method was used in this effort.   This approach (Kirwin & Ainsworth, 1992) uses task decomposition to structure higher level tasks into supporting activities. The starting point for this decomposition was a set of clear task descriptions that were decomposed according to relevant categories. Miller (1953) suggested the following categories for decomposition of tasks: description, subtask, cues, initiating action, controls used, decisions, typical errors, response, criterion of acceptable performance, and feedback. We used these categories to structure observations during the experiment.

The setting for this analysis was the C4ISR On-The-Move (C4ISR OTM) 2006 Experiment. This experiment was designed to evaluate the impact of Future Combat System (FCS) force structure and technologies on the effectiveness of an 18-man Reconnaissance Platoon.   The platoon was patterned in accordance with TRADOC Pamphlet 525-3-90, The United States Army Operations and Organization Plan for the Future Combat Systems Brigade Combat Team, dated 16 December 2005. Consistent with this document, the platoon was provided three Small Unmanned Ground Vehicle (SUGV) surrogates, one Class I Unmanned Aerial Vehicle (UAV) surrogate , three Unattended Ground Sensor (UGS) fields, and one Armed Reconnaissance Vehicle – Reconnaissance, Surveillance, and Target Acquisition (ARV-RSTA) surrogate. The platoon operated within a network centric information environment, with battle command systems provided in Command and Control (C2) vehicles (C2Vs) and on personal computer tablets. The battle command system used in this experiment was an integrated Force XXI Battle Command Brigade and Below (FBCB2). The experiment team modified the original FBCB2 system to support the sharing of sensor images and instant messaging chat capability.

The experiment was conducted over nine days, with one mission completed on each day. The same procedures were executed on each mission. The Soldiers exited the assembly area in a vehicle convoy and proceeded to the designated forward observation post (OP). The platoon leader, three team leaders and their assigned SUGVs, three scouts, and three data collectors were placed in hide spots. The Platoon Sergeant (PSG), two Vehicle Commanders, two data collectors and drivers then retired to a rear vehicle rally point (VRP), where the drivers emplaced the unattended ground sensors in a perimeter security formation. At the same time, the Class I UAV operator and the RNCO drove to a separate launch site, accompanied by two data collectors. The RNCO had to be co-located with the Class I UAV operators because the air vehicle was not integrated into the experiment's network architecture. This deficiency meant that the RNCO had to monitor the UAV operator control unit (OCU) for important information, which he then could transmit to the platoon over his FBCB2 tablet. In contrast, the SUGV and UGS OCUs were integrated in the network; their operators could directly transmit images via FBCB2.

Method

In the conduct of this task analysis, one data collector accompanied the RNCO during each mission to document observed tasks, observed workload, communication events, and key collaboration activities.[1] Additionally, platoon sergeants were interviewed to obtain their perspective of the RNCO and the integration of unmanned assets into the platoon structure. The PSGs were chosen for this interview because they had the most experience in the military and were senior Non Commissioned Officers (NCOs).

We relied upon two sources of data for the task analysis. First, we reviewed FCS documents that describe the RNCO role and the general use of robotics platforms. Second, we observed and interviewed the Soldiers who performed the RNCO and PSG duties in the experiment. A content analysis process was used to categorize observations and interview results.

A situational awareness survey was administered to key Soldiers at several points during each mission. This survey was based on the Situational Awareness Global Assessment Technique (Endsley, 2000). At several points in each mission we asked Soldiers to report on critical information related to the Opposition Force. For more details on this survey, see Bowman and Thomas (2006). The survey results for the RNCO are presented here as an illustration of how well the RNCO was able to demonstrate Situational Awareness (SA) over the mission.

39 Soldiers from the New Jersey Army National Guard (NJ ARNG) participated in this experiment. Their average age was 28 (SD = 8). This was an Infantry company; all Soldiers were male. About half (N=20, 51%) of the Soldiers reported less than five years of military service. Fourteen (36%) reported between 5 and 15 years of military service and five (13%) reported 16 or more years of military service. The majority of Soldiers (N=23, 60%) were in the lower enlisted ranks of E2, E3, and E4. Thirteen (34%) were NCOs (E5, E6, E7) and three (18%) were officers in the rank of lieutenant first class. Twenty-two (56%) of the Soldiers reported having a high school diploma. Seven (18%) had an undergraduate college degree, six (15%) had taken some graduate courses and one (3%) had a graduate degree. Three (8%) reported other degrees. Two of these Soldiers were selected to play the role of the RNCO on alternating days. These selections were made by the NJ ARNG leadership based on rank and not by the researchers. The Soldiers who were chosen for this role were E-5 and an E-4 Corporal.

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[1] Two platoons alternated as the Experiment Force each day. As a result of this design, two individuals served in each role on alternating days. Thus, though only one RNCO was active each day, over the course of the experiment, two individuals filled this role allowing the data collector to observe greater variability in how the RNCO approached this job. In this report, we consolidated the observations and refer to the position in the singular context.

Results

In this analysis, the main function performed by the RNCO was coordinating the unmanned assets. This function included the tasks of planning, sensor emplacement, and building individual SA.

Planning Observations

Coordination of the unmanned assets first required the planning of assigned assets for the mission. This coordination began with the receipt of the Operations Order (OPORD) followed by detailed Mission Planning. As a component of mission planning, the RNCO was responsible for suggesting how the unmanned assets would be used in the mission. Planning was generally accomplished in this experiment by the platoon leader (PL) and PSG, assisted by the RNCO.

Once the planning phase was complete, the RNCO briefed the operators of the unmanned systems and gave precise details of emplacement locations. He also had to attend to some unique details, some of which were an artifact of this experiment. An example of this was the supervision of loading SUGVs and UGSs into vehicles. The unmanned technologies were each identified with one of three team leaders in the network architecture, such that Team Leader A could only communicate with SUGV-A and UGS-A. The RNCO had to ensure that the unmanned systems associated with each team were actually loaded into the correct respective vehicle. This added approximately 15 minutes to the equipment loading time each day.

Once the forward teams were unloaded at the forward observation posts, the RNCO supervised the camouflaging of the SUGVs. In this experiment, the SUGVs were used as stationary sensors. Due to their loud auditory signature these vehicles were not appropriate for reconnaissance and surveillance missions. The camouflage effort required approximately 30 minutes each day. Figure 1 shows a SUGV that is in camouflage position in a forested environment.

Figure 1 A camouflaged SUGV

Source: Dr. Pamela Savage-Knepshield

The planning task also included maintenance, storage, and packing tasks undertaken in the 12 hours prior to mission execution. The RNCO supervised the maintenance of the sensors (e.g. primarily that the batteries were charged and that extra batteries were packed).[2] The RNCO also supervised the packing of the unmanned systems into the trail vehicles. This was important for two reasons. First, as described above, each SUGV had a corresponding operator control unit (OCU); if OCUs were mismatched to the SUGVs they would not work. The SUGVs and OCUs had to be loaded into the trail vehicle that corresponded to their operator's assigned seat. On more than one occasion, SUGVs, OCUs, and operators became separated and the operator could not interact with the technology. When this separation occurred, mission time was increased to re-deploy the matching OCUs and SUGVs. This maintenance task can be expected to become more complicated on the actual battlefield when missions are not confined to a short window of time.

Once the platoon departed the assembly area, the RNCO was required to monitor the FBCB2 display and to interact with the platoon leader and platoon sergeant while on the move. The tasks associated with this function included reading and typing messages, downloading sensor images, and monitoring the FBCB2 icons to ensure that all vehicles were following their assigned routes. Any last minute deviations to the plan would be communicated over FBCB2 and would require distributed collaboration between the RNCO and his leaders.

Emplacement Observations

To emplace Soldiers and unmanned technologies, the platoon convoy would first stop at the forward OP location. The RNCO supervised this phase with PSG oversight. Each of the three dismounted team leaders operated a SUGV and used an FBCB2 tablet. Once the dismount teams were in place, the remaining members of the convoy departed for the rear vehicle rally point (VRP) and the RNCO vehicle departed for the UAV launch site. When the vehicles arrived at the VRP, the drivers unloaded and emplaced the Army Research Laboratory (ARL)-UGS in a perimeter security formation under the supervision of each vehicle's commander.

The RNCO was responsible for setting up the Class I UAV launch site. He supervised this operation and guided the UAV operators as necessary. In the role of robotics subject matter expert, he would be expected to troubleshoot problems with the air vehicles and OCUs. For this experiment however, civilian technology developers were always present to assist with problems. Once the launch site was in order, the RNCO was responsible for monitoring FBCB2 messages and sensor images to keep the VRP and dismounts informed of UAV system status.

Building situational awareness

During each mission, the RNCO built his SA by monitoring the status of the unmanned assets through FBCB2 and radio communications. Cues that alerted the RNCO to changes in the status of the assets included notifications in the battle command interface that a message was waiting or that an image had been updated. Alternately, he may have received a radio communication. The RNCO served as a human information filter for the platoon with respect to robotics entities. He monitored the incoming data (i.e. messages, images, icons on the map) and

[2] In this experiment, sensor technicians repaired and maintained the unmanned technologies. The RNCO observed this maintenance. In real operations, the RNCO would be responsible for this maintenance.

determined what was of primary importance, with whom to share the information, and in which format.

During a typical mission, the RNCO continually cycled through an Observation, Orientation, Decision, and Action (OODA) loop. In the observation phase, the RNCO monitored the unmanned assets. Specific cues alerted the RNCO to monitor or intervene with a system. These cues included FBCB2 messages, sensor images from SUGVs and UGSs, chat messages, and radio communications. In this experiment, the RNCO was not overloaded to the point where tasks were dropped or he became fatigued. This was partially due to the fact that the three SUGV operators were responsible for monitoring streaming video, snapping relevant images, and using the system software package to annotate the image prior to sharing with the platoon over FBCB2.

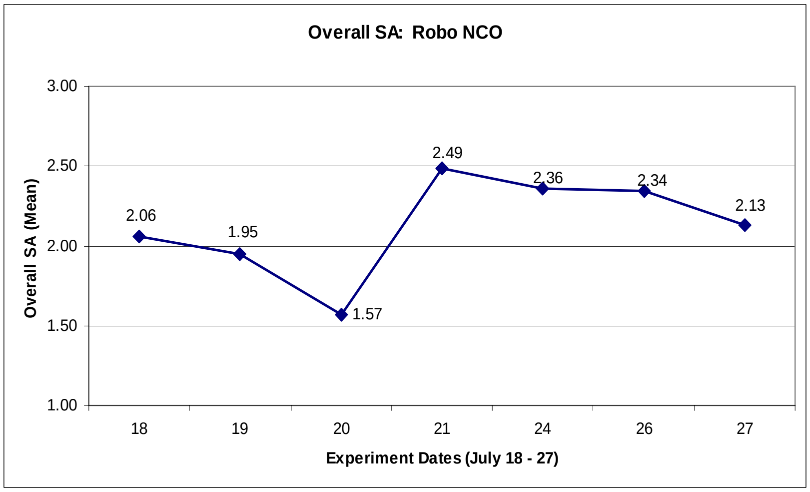
The RNCO acquired battlefield information by fusing information from the unmanned systems and Soldier reports. As the RNCO collected information from FBCB2 images, messages, and radio reports, he consolidated this information into a coherent picture of the status of the contributions the unmanned systems were or were not making to the operation. This allowed him to advise the platoon appropriately and to redirect assets as needed. This decision to act was most often coordinated with his superiors but could be directed toward an unmanned system operator. This requires the RNCO to know the status and location of all unmanned assets.

Feedback is an important component of the OODA loop. The RNCO received feedback on system performance in two ways. First, the images from the sensors provided information on how well the systems were emplaced. In many cases, frequent images of foliage indicated that the sensors had been emplaced with a moving branch or weed directly in front of the sensor. This caused the camera to trip with each movement of the branch. Battery power was another important system component to be monitored. If the SUGVs ran out of batteries, this information would first be displayed on the SUGV OCU and then be shared by the operator to platoon members via FBCB2 text messaging or voice report.

Throughout the observations, the data collector monitored the RNCO for signs of cognitive and physical workload, though no survey instruments were administered. On each mission, the RNCO appeared to have a moderate, but not excessive, workload. If problems arose with the unmanned systems or the battle command interface, system developers were available for troubleshooting. This RNCO workload can be expected to increase on the battlefield without the support of technicians.

The SA survey results were examined for the RNCO. As shown in figure 2, the RNCO had moderate to high scores across the experiment. The data points shown below are daily averages. Answers to the SA survey were scored on a scale of 1 (low) to 3 (high). These scores could reflect a number of issues, but it is most likely that the lower scores reflect the RNCO's forced attention on the UAV operator control unit and his need to capture relevant information from that source to feed into the FBCB2 network. This requirement may have made it difficult for him to focus on the larger battle picture.

Figure 2: Overall SA of RNCO



Interviews

Platoon Sergeants were asked to comment on their view of how the RNCO should be integrated into a Recon platoon. These individuals were chosen due to their high enlisted rank and length of service. Both platoon sergeants stressed the need for additional platoon members to provide security for Soldiers responsible for operating the unmanned assets. The use of the software interfaces required the operators to focus on the display screen rather than behind their individual weapon observing the objective area. In this experimental configuration, it was clearly unrealistic to expect that a Soldier operator would be able to control an unmanned asset while remaining in control of his weapon. The picture in figure 3 clearly shows a Soldier looking at the SUGV OCU while his gun is beside him on the ground. The issue of security was mentioned frequently by the leaders, and as one Platoon Sergeant cautioned “The PackBot is not an extra man.”

Figure 3 A dismounted Soldier uses the SUGV OCU

Source: Dr. Pam Savage-Knepshield

The PSGs also suggested that the mastery of robotics elements should develop in a progressive manner. Lower enlisted personnel (E-2) should be responsible for the unattended ground sensors due to the ease of use of these technologies. Junior enlisted (E-3 and E-4) should be responsible for the small unattended ground vehicles. Young NCOs (E-5) should operate platoon asset unmanned aerial vehicles. This progression of assignments would suggest that the RNCO would be a senior NCO (E-6) with sufficient rank and experience with robotics elements to function effectively as a platoon subject matter expert. Such a progression would allow for a group of robotics specialists with increasing expertise.

Discussion

Our observations suggest that the RNCO must be knowledgeable of both the unmanned systems and the terrain to make satisfactory contributions to this planning event. He must also be of sufficient experience and rank to participate in this discussion as an equal partner (e.g. he must feel free to disagree with superiors when appropriate).The RNCO we observed, possibly because of junior rank and lack of experience with the unmanned systems, generally let the PSG take the lead role in planning. This interaction should be expected to change once the RNCO position is fielded and the incumbents become experts in the fielded technologies.

The network architecture used in this experiment required certain dependencies between systems and users. This feature added workload to the RNCO because he had to ensure that each user had their assigned vehicle among many that appeared alike. Mistakes in assignment led to mission delays. As network architectures evolve, we should expect this deficiency to be resolved.

Coordinating the emplacement task did not appear to be difficult, but did require pre-planning, oversight, and the ability to re-plan on site. Sensors emplaced improperly will not yield the necessary information and will be rendered useless. It was helpful for the operators to check the images once sensors were emplaced, but this will not always be possible on the battlefield due to time constraints and the risk of exposure. Experienced operators will learn how to safely emplace unmanned systems over time. The RNCO will be responsible for this training and monitoring.

Communication and developing SA was a vital and consuming task for the RNCO. This required the RNCO to monitor the FBCB2 and UAV OCU screens to maintain his awareness of actions, becoming a relay point between the UAV operator and the rest of the platoon. However, because the SUGV and UGS OCUs were integrated into the FBCB2 network, these operators did not have to channel their inputs through the RNCO prior to populating the battle command interface. This appeared to reduce the RNCO workload significantly.

The observed workload of the RNCO, confirmed by periodic queries, was in the moderate range. This should be interpreted with caution, as the PSG performed many of the duties of the RNCO as outlined in the FCS O&O.

Conclusions

In conclusion, the RNCO appears to be an integral asset to the platoon leader for managing the logistical and operational tradeoffs necessary for employing unmanned assets. The RNCO should be capable of monitoring system statuses and locations of unmanned assets and disseminating pertinent information as to system health to the platoon leader. The RNCO will need to be well versed with each systems capability and be knowledgeable of the tactics, techniques, and procedures (TTPs) for its intended use. This could be accomplished with a progressive track as described above for the eventual position of RNCO. The RNCO also will need to carry an appropriate rank to allow decision making and tasking of platoon assets as necessary.

References

Bowman, E. & Thomas, J.A. (2006). SALUTE- AP: A Method for Evaluating Situation Awareness in Tactical Field Experiments. Presented to DoD Human Factors Technical Advisory Group, Monterey, CA November 8, 2006.

Endsley, M. (2000). Direct measurement of situation awareness: Validity and use of SAGAT. In Mica R. Endsley & Daniel J. Garland, (Eds.), *Situation Awareness Analysis and Measurement.*_p. 147-173

Kirwan, B. & Ainsworth, L. (1992). A guide to task analysis. Great Britain: Burgess Science Press.

Unit of Action Maneuver Battle Lab. (2003). The United States Army Objective Force Operational & Organizational Plan Maneuver Unit of Action. Fort Knox, KY: Author.

Miller, R. B. (1953). A method for man-machine task analysis. Wright-Paterson Air Force Base, Ohio, USA: WADC Tech Report No. 53, 137.