PACERS: Platoon Aid for Collective Employment of Robotic Systems

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ABSTRACT

In the future, Army platoons will be equipped with small aerial and ground robotic systems, which will provide the unit with real time information about the immediate surroundings; what's over the next hill, around the next corner, or on the roof of a building. The Army currently is supplying platoons with both prototype and commercially available unmanned systems to evaluate military utility. The training provided prior to these "experiments" focuses almost entirely on individual operator training; but, training on how to integrate the system into unit operations is also required if the system is going to be properly exploited. While operators need training on the details of each system, the rest of the unit needs training on more general aspects involving coordination and communication. In addition, the employment of robotic systems puts new responsibilities on the platoon leader in terms of planning, delegation, resource allocation, coordination and workload, which he or she must learn to handle. Many of these unit level training objectives are common across different systems, both aerial and ground. The purpose of this paper is to (1) lay out these system-general aspects and (2) suggest a list of activities that trainers and leaders could focus on in order to help train unmanned system employment at the unit level. For each activity, associated observations and after-action review questions are suggested. Trainers could use these to help assess proficiency and coach the unit in system employment. One benefit of this system-general approach is that trainers don't need to stay conversant with the details of every system a unit may bring to a training event. The benefits that this kind of training could provide will be illustrated with examples from the Micro Aerial Vehicle Advanced Concept Technology Demonstration 2006 Soldier Experiment.

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INTRODUCTION

Unmanned or robotic systems (RSs) are envisioned to be a key part of the Army's future force. One motivation for the addition of RSs is to provide greater reconnaissance, surveillance, and target acquisition (RSTA) information, with lesser risk to manned elements. Research and development with RSs has tended to neglect employment training, however. When putting RSs in the hands of Soldiers, individuals or operator teams receive operator training, and then units are expected to employ the system in a mission context in order to evaluate military utility or explore tactics. Without some explicit guidance or feedback on techniques and procedures, however, the unit may never properly examine tactical utility (Alberts & Hayes, 2002; Durlach, 2005). This particularly may be the case when operators are designated, rather than dedicated, as is envisioned for operators of small RSs organic to the platoon level (Office of the Secretary of Defense, 2002). There is a need to get units functioning efficiently on techniques and procedures prior to evaluating the tactical utility of a prototype or prior to training on tactics with an operational system (Meshesha, et al.,2007).

The term "small" above refers to RSs where all system components (i.e. – platform or vehicle, control and communication equipment, and payload) are transportable by dismounted troops. Such systems have relatively low logistics requirements, which allow them to be used without an established base of operations (such as required by large fixed wing aircraft). Ideally, they provide the commander with real time information about the immediate surroundings; what's over the next hill, in the next alleyway, or on the roof of a building. It is these small systems that are most likely to be deployed organically at the platoon level.

Although different current-day systems differ in their details, they all share several common employment aspects, and making these common aspects explicit may aid leaders and trainers in understanding employment considerations. There is a need for system-generic guidance, because the Army is currently in an exploratory phase testing different prototype or commercially available systems, and trainers at places like the Joint Readiness Training Center or the National Training Centers will need to provide guidance without detailed knowledge of the specific systems they may encounter. It is anticipated that trainers will have the same problems coaching robotic employment as they currently have with coaching the use of digital battle command systems. With digital battle command systems, each rotation comes to training with a unique collection of digital command and control systems. Moreover, individual systems are continually evolving and up-to-date technical manuals are not necessarily available. For example, the "Digital TOC Integration Guide" (Leibrecht, Lockaby, Perrault, and Meliza, 2006) is already considered outdated. The rapidly changing technology of digital command and control and of unmanned systems makes it difficult for trainers to provide guidance on how to apply these technologies unless they can address their employment in a generic way.

Heretofore, collective training with respect to small RSs has received scant training time. According to one observer, the collective training that is given to operational units tends to take the form of (poorly attended) briefings, rather than live or simulated training exercises; and the first opportunity for collective employment may not occur until the equipped unit reaches the National Training Center. With respect to experimentation, it is the same story. Typically individuals or operator teams receive hands-on operator training. Then their units are expected to employ the system in a mission context in order to evaluate military utility. It is not typical for the unit to be given any prior training on tactics, techniques, and procedures (TTPs) before the evaluation phase, except perhaps via briefing (e.g., Kennedy, Williams, Robertson, Pettitt, & Swiecicki, 2005). However, hands-on unit level training that is not part of formal experimentation could greatly enhance the benefits of exploratory experiments, as well as subsequent operational efficiency. TTPs and lessons learned from previous experiments must be included in the technology train-up in follow-on experimentation, to avoid reinventing the wheel in each experiment (Meshesha, et al., 2007).

Collective training concerns the integration of system employment into the organization of responsibilities of the unit as a whole. This is not covered in operator training. Unit commanders and squad leaders require training on system capabilities and requirements, as well as the practicalities of integrating system use into their operations. Consider a platoon with a mission to enter an urban neighborhood and secure a building. During the actual assault will the platoon leader (PL) have personnel to spare for RS operation? If he chooses to employ the RS, how will he coordinate its actions with those of his other assets? If the PL is remote from the operator, how will they maintain common situation awareness? Will the PL have time to keep abreast of the information provided by the RS and use it to make mid-mission adjustments? The actionable use of real-time sensor data by a small unit, such as a platoon, may be limited to pre-mission reconnaissance, unless the coordination and integration demands of system employment can be made efficient. The aim of this paper is to help facilitate this process.

PACERS GUIDANCE

From readings, discussions, and interviews with people involved in research and development concerning small RSs, and from actual observation of training and experimentation with small RSs, several activities and goals involved in RS employment techniques and procedures were found to be common across systems. These common aspects were grouped into seven general categories or activities. These activities and the associated goals of these activities are listed in Table 1. In order to help units successfully achieve these goals, trainers need to focus unit coaching on the required underlying behaviors. In order to assist leaders and trainers in this task, a set of observations and after- or during-training questions was compiled for each of the rows in Table 1. The complete set of information is referred to as PACERS: Platoon Aid for Collective Employment of Robotic Systems. A more detailed discussion of background and rationale can be found in the U.S. Army Research Institute report by the same name (Durlach, submitted for publication).

The remainder of this paper will discuss the activities, goals, observations and questions of PACERS, using examples from the Micro Air Vehicle (MAV) Advanced Concept Technology Demonstration (ACTD) 2006 Soldier Experiment, conducted by the Defense Analysis Research Projects Agency. Because of space limitations, the discussion will focus on the first three rows of Table 1. See Durlach (submitted for publication) for more complete discussion. Examples presented highlight some unit deficiencies and errors; but, this should not be taken as an evaluation of the platoon or the ACTD. The author participated in this experiment as an observer only. The platoon did not have the benefit of the coaching being suggested in this paper. The platoon leader (PL), platoon sergeants, three privates, and a corporal had operator training prior to the beginning of the experiment. The privates and the corporal acted as the operators during the experiment. Participants were members of a Stryker reconnaissance platoon of the 25th Infantry Division. They conducted several missions (urban reconnaissance and building seizure, area reconnaissance, and route reconnaissance) using a prototype Class I MAV (see Crane, 2005 for more information on the Class I). The MAV had a ducted fan, permitting vertical take-off, landing, and hover capabilities. For each mission, a varying number of people (6 – 12) were available to play the role of local civilians or hostiles. Rules of engagement instructed platoon members not to fire unless an unknown displayed clear hostile intent.

To appreciate the examples to follow, it is important to be familiar with the essential elements of current-day small RSs. The Soldier operator interacts with the Ground Control Station (GCS) to control the maneuver of the RS. This can be done either in manual mode, or by programming pre-planned routes, or both. The GCS consists of an operator control unit (OCU) plus any additional equipment required for the GCS to communicate with the RS. This is done using line-of-sight (LOS) uplink (GCS to platform) and downlink (platform to GCS) radio frequencies. The platform can send streaming video to the OCU via a downlink frequency, which is critical for maneuver, because current systems have no sense and avoid capabilities. If equipped with Global Positioning Satellite (GPS) receivers (as was the MAV system), the GCS can display the location of both the GCS and the robotic platform on a situation awareness display. The primary means of communication between the operator and a remote commander would be by voice radio, perhaps through one or more intermediaries. A remote commander (or intermediary) might or might not have a second video terminal (RVT) for observing the incoming video from the RS. To capture video, the MAV could be equipped with either two fixed daylight cameras (forward and down) or two fixed infrared (IR) cameras. Potentially, but rarely, is information from the GCS or RS directly networked with any other Army systems. In the 2006 MAV Soldier Experiment, multiple GCSs and MAVs were available for use, allowing the platoon to operate more

Table 1. Activity and Goals common across small reconnaissance, surveillance, and target acquisition robotic systems (RSs).

Activity	Goals
Decide whether/how to employ the RS	▪ Potential benefits vs. risks of employing the RS are considered in light of overall mission objectives and METT-TC[3]
Select RS **team*** and plan RS missions within the overall mission context ***RS team**—any personnel involved in - Operation of the RS - Interpretation and/or communication of information gained from the RS - Security for above	▪ Provide adequate number of personnel to conduct RS operations and provide security ▪ Ensure RS team members understand their mission ▪ Ensure RS employment is integrated into the overall mission
Define roles of unit personnel in tracking the RS mission, interpretation of RS sensor imagery, and reporting on CCIRs[2].	▪ Intel acquired by the RS gets to the people who need it in a timely manner. ▪ RS mission can be dynamically re-planned based on new intelligence
Pre-deployment checks	▪ Necessary RS-related equipment and supplies are present and in fully working order ▪ Communication frequencies for operator use have been cleared with higher and specified to operator ▪ Radio nets for voice communications specified and checked ▪ Coordination with higher on A2C2[1] (for air platforms)
Develop or refine unit SOPs[4] and TTPs[5]	▪ Improve efficiency and effectiveness of RS employment
Record keeping	▪ Safety incidents recorded and reported ▪ Use and Maintenance logs kept up to date ▪ Operator training currency and logbooks kept up to date
Preparation for launch and recovery at a remote site	▪ RS team safety ▪ Timely RS launch
1. A2C2 = Army Aviation Command and Control 2. CCIR = Commander's Critical Information Requirements 3. METT-TC = Mission, Enemy, Time, Troops, Terrain (and Weather), and Civilians 4. SOPs = Standard Operating Procedures 5. TTPs = Tactics, Techniques, and Procedures	

than one MAV at a time, or singly in very rapid succession; or for the PL to use one of the spare GCSs as a RVT.

Decide whether/how to employ the RS

Table 2 lists the observations and questions associated with the activity, "Decide whether/how to employ the RS." The associated goal is to ensure that potential constraints, benefits and risks of employing the RS are considered in light of overall mission objectives, and prevailing conditions (Mission, Enemy, Time, Troops, Terrain, and Civilians, or METT-TC). Consideration must be given as to whether employment of the RS will contribute positively to attaining mission objectives. This includes consideration of what potential enemy response to it might be (e.g., if it makes a lot of noise or gives clues to mission objectives). Most RSs will have constraints on their employment according to weather, terrain, personnel requirements, available radio frequencies, and air space privileges (for aerial vehicles). It is important that these factors be taken into account. Dedicated radio frequencies are essential to ensure no interference in operator control. If an adjacent unit were to use the same frequencies, there is a potential for loss of control.

Table 2. Decide whether/how to employ the RS

Activity & Goals	Observe	Ask/AAR Questions
Activity: Decide whether/how to employ the RS **Goals:** Potential benefits vs. risks of employing the RS are considered in light of overall mission objectives, METT-TC, and weather.	▪ Was airspace clearance checked (air systems)? ▪ Was there any coordination with adjacent units wrt RS employment? Specifically on communications frequencies? ▪ If indirect fires are available, was there any consideration of how this might impact RS employment?	**<u>Ask Platoon Leader</u>** ▪ What factors did you consider in deciding to employ (or not employ) the RS? ▪ What did you view as the potential advantages of using the RS? ▪ What did you view as the potential disadvantages of using the RS? ▪ Is there a process for coordinating with adjacent units?

METT-TC = Mission, Enemy, Time, Troops, Terrain, and Civilians

All RSs will also have operating characteristics that could affect appropriateness of employment. For example, the communication range of the system, its stealth (or lack thereof), and its battery/fuel supply must be factors contributing to determining whether and how to employ the RS in the context of a particular mission. During training, it is important to establish that consideration of these factors becomes a routine step before employing the system. Durlach (submitted for publication) contains a more detailed discussion of METT-TC considerations.

In the MAV ACTD 2006 Soldier Experiment, if conditions were suitable and the MAV was available the unit was expected to use it (as the purpose of the experiment was to give them as much opportunity to try it out as possible). Therefore, in the context of the experiment, the issues listed in Table 2 came more into play in planning how the MAV would be used rather than whether it would be used. One of the prime considerations by the PL was workload and manpower. He preferred to use the MAV primarily for leader's reconnaissance, prior to maneuver on his main mission. His Stryker vehicles were equipped with the Long-Range Advance Scout Surveillance System (LRAS3), providing pretty good sensor coverage even without the MAV. Employing the MAV during maneuver involved removing personnel from the actual operation, and also complicated use of the radio nets (as a net was needed between PL and remote RS team). It also added new synchronization responsibilities to his workload; not only did he have to synchronize squads, he also had to synchronize

MAV maneuver with squad maneuver. This was particularly complicated if the operator was not stationary and remote, but instead mounted on one of the Strykers. In this case, issues of terrain (blocking LOS) and landing (recovery) sites for the MAV became additional factors for consideration. It is important that the PL think through and synchronize all activities if the RS is going to be used during the maneuver part of a mission, as opposed to only for pre-mission reconnaissance. Indeed, it has been suggested by some subject matter experts that, at least given the current state of the art, RSs should be used by small units only for pre-mission reconnaissance, unless the team operating the RS is a specialized dedicated attachment to the unit.

Select RS Team and Plan RS Missions Within the Overall Mission Context

Table 3 lists the observations and questions associated with the activity, "Select RS team and plan RS missions within the overall mission context." RS team refers to any personnel involved in the RS operation, interpretation and/or communication of information gained from the RS, and security for these personnel. The associated goals involve delegating tasks, assigning responsibilities, integrating the use of the RS into the larger mission plan, and making sure the plans are understood. One issue that arises when the RS team is designated, not dedicated, is that a different set of people may constitute the RS team from one mission to another. As a consequence, people may not have established

Table 3. Planning RS missions

Activity & Goals	Observe	Ask/AAR Questions
Activity: Select RS team* and plan RS missions within the overall mission context **Goals:** ▪ Provide adequate number of personnel to conduct RS operations and provide security ▪ Ensure RS team members understand their mission and individual responsibilities ▪ Ensure RS team has adequate time to move to emplacement site and prepare RS for maneuver ▪ Ensure RS employment is integrated into the overall mission * **RS team**—any personnel involved in - Operation of the RS - Interpretation and/or communication of information gained from the RS - Security for above	▪ Did PL or PSgt ask questions to ensure RS team understood its mission? ▪ Was a rehearsal conducted? ▪ Did the rehearsal cover the entire RS mission? ▪ Were CCIRs/PIRs explicitly discussed? ▪ Did the PL prepare a written RS-OPORDER? ▪ Was all the information required for the RS team operations briefed? (SEE APPENDIX C) ▪ If the RS team would be remote from the rest of the unit was a trigger for reuniting specified? ▪ When entering autonomous missions in the RS OCU, does the user check this mission with respect to terrain/other factors ▪ Was there a discussion on how to program response to loss of UDL links?	**<u>Ask RS Team</u>** ▪ What was your mission? ▪ How did your mission relate to the overall mission? ▪ Were you briefed on all the information you needed to conduct your mission? ▪ Were problems encountered in preparing to launch that might have been addressed with additional personnel? ▪ Did you run into any situations that you were not sure how to respond to? ▪ Was time a problem in preparing for the launch? ▪ Were each individual's responsibilities clearly defined?

roles nor feel responsible for particular duties involved in RS operation, unless explicitly assigned the task. The PL should not assume that the RS team will systematically work out these responsibilities on their own. For example, during the MAV experiment, the RS team had several steps to conduct before the aerial vehicle could be launched. This included vehicle set up, fueling, engine tuning, setting the communications channels, and various pre-flight vehicle checks. One step that could have been conducted ahead of the final launch sequence, but typically was not, was pre-checking the functioning of the up- and downlinks between GCS and MAV. Despite the fact that the RS team usually had ample time to do so, they often neglected to check this until the planned launch time. They typically did vehicle set up, fueling, and tuning in advance, and then waited to continue the process until the designated launch time. Technical problems were often encountered at this stage (either due to user errors or omissions in previous steps or because of genuine hardware/software glitches). Consequently launch was

delayed until the nature of the problem could be established and corrected. Had the team checked the radio links prior to the scheduled launch time, these delays could have been averted. During operator training, all steps were conducted in immediate succession, so there was no discussion of sequencing the different steps to fit in with a mission plan. During experimentation, the problem was never addressed during an after action review (why hadn't the radio links been checked prior to scheduled launch?), even though it was a repeated cause of delayed MAV flights. Unless problems like this are explicitly addressed they will continue to plague operation.

It is important that all critical details of the RS mission be specified for the RS team. Especially when the RS team is ad hoc, there should be no assumptions made about what the team already understands or knows about their responsibilities and mission. All the information regarding employment of the RS should be briefed to the RS team, and ideally specified in a written form. Units may benefit by adopting a standard format for this to ensure that no details are omitted. Durlach (submitted for publication) includes a list of details to include. In addition, the RS team should be asked questions to make sure they understand their role in the mission in terms of RS operations and the means of communicating RS status and intelligence gathered. Ideally, a mission rehearsal would be conducted, including synchronization of RS operations with the rest of the unit. During the MAV experiment, the PL was pretty thorough in briefing the RS team; however, he did not provide the RS team with a standardized briefing and there were instances when critical pieces of information were omitted. These included how to program the "loss of link" response, where the landing site should be, which payload to use, and which up- and downlink channels to use (when the plan included two vehicles in the air at the same time). Operators typically asked for clarification at some later point, but sometimes not until the critical time when they realized they were lacking required information.

Defining roles of unit personnel during RS mission

Table 4 lists the observations and questions associated with the activity, "define roles of unit personnel in tracking the RS mission, interpretation of RS sensor imagery, and reporting on commander's critical information requirements (CCIRs)." The goals are to make sure that the intelligence acquired by the RS gets to the people who need it in a timely manner, and to make sure that RS operation is responsive to unfolding events and the advent of new intelligence. Currently fielded RSs tend to be stand alone systems, not networked with any other military digital displays. This may create some difficulties in terms of the PL keeping abreast of mission progress and fully utilizing the sensor information provided by a RS. The importance of assigning roles and communication procedures needs to be explicitly addressed in training.

For now and several years to come, a human will be required to interpret sensor imagery. This includes understanding what they are seeing, and relating it to a geographic location. It is important to make sure that designated interpreters have the capability to do this. It can not be assumed that imagery interpretation or spatial orientation training will be covered in operator training. It might be necessary to designate an "interpreter" in addition to an operator, to glean relevant meaning from the sensor imagery. The interpreter may be right next to the operator or remote from the operator, depending on the ability of the system to transmit sensor data to a RVT. Multiple experiments have shown that a two person team is better at detecting targets than a single operator (Murphy, 2004; Rehfeld, Jentsch, & Curtis, 2005), with one person primarily responsible for control of the RS and the other for imagery interpretation.

In addition to sensor data interpretation, some degree of tactical judgment will be required to filter the information gained from the sensor imagery. This kind of tactical knowledge may be variable across operators—thus the potential need for an additional person to assist. In addition to understanding what they are seeing, the interpreter has to be able to communicate it clearly. Without some protocols for communication, there may be opportunity for confusion. In order to track MAV mission progress, PL introduced brevity codes. The operators were to radio in these codes at different stages. These specified fifteen points of a MAV mission including engine start, ready to launch, vehicle landed, vehicle retrieved, etc. This was abandoned after two missions. No one could remember the codes (letters from the phonetic alphabet: alpha, bravo, etc.), and they covered MAV mission progress in far more detail than the PL had time to be concerned with, or the operators cared to report. The original idea of using codes was a good one, however. The unit only needed to work out the essential elements to report; unfortunately they never really established a system. They could have done so if the issue had been discussed explicitly during after action review sessions. Because this did not occur, the operators were left uncertain regarding what they were supposed to report, or what actions required explicit authorization. For example, if the PL radioed to launch as quickly as possible, were they subsequently required to get an explicit authorization before launching? Observation of conversations at the launch site indicated that the RS team didn't know.

In terms of who looked at and interpreted sensory imagery during the MAV missions, several approaches were tried. Sometimes the PL stayed right by the operator and watched the OCU screen over his shoulder. When PL watched the raw sensor imagery, he often directed the operator how to control the MAV and camera zoom. He might as well have been flying it himself. This clearly was not good use of personnel and would not be possible if PL had other things going on requiring his attention. Sometimes the PL would have a RVT set up, so that he could watch the sensor imagery without having to be right next to the operator. He felt that this better allowed him to multi-task, and not get caught up in micro-managing MAV operation. Most frequently, communications concerning real-time imagery were radio-relayed to the PL through one or two intermediaries. When such a chain is used, it is

Table 4. Defining roles of unit personnel during RS mission

Activity & Goals	Observe	Ask/AAR Questions
Activity: **Define roles of unit personnel in tracking the RS mission, interpretation of RS sensor imagery, and reporting on CCIRs.** **Goals:** ▪ Intel acquired by the RS gets to the people who need it in a timely manner. ▪ RS mission can be dynamically re-planned based on new intelligence	▪ Who monitors and reports progress of the RS mission? Was responsibility for this clearly defined? ▪ Who interprets RS imagery and reports on CCIRs to the PL? Was responsibility for this clearly defined? Was the communication chain clearly defined? ▪ Did the PL look at real time streaming video or imagery selected/filtered through someone else first? ▪ If person(s) were designated to monitor RS mission progress and/or imagery were they involved in mission planning? ▪ What status reports does the RS operator provide? Are there SOPs on what to report and how to report? ▪ Are RS missions changed mid-mission? Who makes the decision for this dynamic re-planning? ▪ Did the intel acquired by the RS contribute to the platoon's performance? ▪ How was intel acquired by the RS acted upon ? ▪ Were other digital systems and/or higher echelons updated with intel provided by RS?	**Ask Platoon Leader** ▪ Were you able to keep track of the progress of the RS mission? ▪ How did you utilize the intelligence provided by the RS mission? If you did not, why not? ▪ Did RS functioning meet the expectations you had during planning? Why or why not? ▪ If there was a point you lost track of the RS mission status, when and why do you think that occurred? How might you avoid this in the future? **Ask Platoon Leader, RS operator(s), and designated Third Parties** ▪ Was it clear what the RS operator was responsible for reporting or recording? ▪ Was it clear who was responsible for interpretation of sensor imagery? **Ask person(s) who performed sensor imagery interpretation** ▪ Did you experience any time pressure while interpreting sensor imagery? ▪ Did you experience any conflict between sensory analysis and your other responsibilities? ▪ Were there times when you were unsure what you were seeing? ▪ Were there times when you were unsure how to relate the imagery to a place on a map or in the environment?

important that participants understand what to communicate and how to communicate.

The final element of this activity is acting on the intelligence information gathered from the RS. There is no point in employing a RSTA system if the information it provides is not used. In order to make the most use of it, the PL may need to think through contingency plans ahead of time, so that he can quickly and efficiently re-task his squads based on unfolding events. He must also consider what information needs to be sent to his higher command, either through radio contact or the updating of his digital military systems. In some cases, PL may need to designate a person responsible for this activity. This will continue to be an issue until RSs are networked with digital command and control systems and some kind of automated target recognition is available.

CONCLUSIONS AND RECOMMENDATIONS

PACERS considers the application of RSs at platoon level -- a situation where the work involved in planning and executing employment strategy and analyzing sensor feeds will be performed without a dedicated staff. Although PACERS is based largely on the author's research and observations concerning small aerial RSs, it is intended to be applicable to any small RS, aerial or ground-based, or even littoral, where the RS is employed by a designated ad hoc team from within the unit (as opposed to a dedicated attached team). The extent to which PACERS is useful, independent of the RS system will need to be assessed by trial application to units equipped with RS systems other than the MAV.

In an attempt to remain generic, PACERS deliberately avoided addressing individual operator training. Nevertheless, there are aspects of operator training that are relevant to system employment, which will be mentioned here. Depending on who designs the training operators receive, and how much time is allotted for operator training, operators may not actually receive all the training truly required to operate the system. For example, a table of approved up- and downlink frequencies for the local area might be required, but the operator may have not been trained where to get this or how to load it into the GCS even if he/she had it. Or map imagery might be required for the operating area but the operator may have not have been trained how to integrate available imagery into the OCU. Or, the OCU may be capable of recording video or still photos, but the operator may not have been trained how to download these for export to other systems.

Even if operator training has covered these more technical aspects, there are potentially several other skills required for employment which may have been assumed rather than included in operator training. For example, an RS might be equipped with an IR camera; however, training on IR imagery interpretation may not be a part of operator training. Or, terrain analysis skills might be required to set routes, interpret maps, or interpret sensor images; but operator training may not address terrain analysis skills. The point is that to employ a RS beneficially, there are other skills required besides mere operator training. Leaders will have to include knowledge of how these other skills are distributed among their personnel when assigning RS teams.

Another variable element in operator training is trouble shooting. Training will likely vary in how much attention is given to what to do when something goes wrong. But things do inevitably go wrong (Meshesha, et al.,2007). Explicit practice on dealing with malfunctions or other problems is recommended, and leaders may need to arrange opportunities for this if it was not adequately dealt with during operator training. Knowledge of how different members of the unit deal with various dilemmas (both practically and emotionally) may need to be considered in assigning RS teams.

Finally, it is recommended that designers of RS systems give some consideration to incorporating the collection of data for after action review aids into their systems. Many small RS systems include a tablet computer, and could record data on how the RS was employed during a mission. This includes recording of platform routes, sensor coverage and sensor imagery, mission timings, and alerts and warnings sent to the operator by the system. Using the RS itself to collect and display these data in the form of visual aids could greatly facilitate the after action review process.

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