STRATEGY RESEARCH PROJECT

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THE NATIONAL TRAINING CENTER (NTC) INSTRUMENTATION SYSTEM – A CAUSE OF DEGRADED TRAINING AT THE NATIONAL TRAINING CENTER

BY

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ABSTRACT

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This paper will examine the instrumentation system at the National Training Center (NTC) and review its ability to support current and future Army training requirements. The NTC instrumentation system is key to providing the training audience (rotational military unit) a high fidelity, realistic training experience and is critical to the overall success enjoyed by the NTC. The instrumentation system tracks the players on the battlefield, records "ground truth", complements the use of training aids, devices, simulators and simulations that present realistic events, and provides critical feedback to the rotational military unit. The instrumentation system, which has been in place since the early 1980's is now degrading the training experience of the rotational unit and if not addressed will seriously affect the ability of the U.S. Army to field combat ready units.

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Finally, I would like to thank Dr. Larry Meliza of the U.S. Army Research Institute He spent an inordinate amount of time on the phone discussing the project with me, suggesting references to consult, and also, critically reviewing this paper.

Thanks again to all of these folks.

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THE NATIONAL TRAINING CENTER (NTC)-A CAUSE OF DEGRADED TRAINING AT THE NATIONAL TRAINING CENTER

In war while everything is simple, even the simplest thing is difficult.

—Clausewitz

BACKGROUND OF THE NATIONAL TRAINING CENTER

The establishment of the United States Army National Training Center (NTC) at Fort Irwin, California in 1980 was the capstone achievement of the revolution in training that had taken place in the United States Army since 1973. With the end of American involvement in Vietnam, and spurred on by the lessons learned from the 1973 Arab-Israeli War, a group of senior leaders in the Army realized that one of the Army's major wartime shortcomings had been the inability to train as the Army intended to fight. Historically, the United States had entered wars unprepared, a situation that often resulted in high casualties and costly campaigns. Senior leaders postulated that through realistic battlefield training, the Army might gain better insight into the readiness of its units and ways to improve its training program. Realistic training would also provide a laboratory for the fielding of many new weapon systems. These visionary ideas set in motion the birth of the NTC, a 1000 square-mile installation in California's Mojave Desert.[1]

The NTC's purpose then and now, is to provide the most realistic battlefield training short of actual combat. It would be difficult to overstate the impact of the NTC on Army training. This successful training center stands as a tribute to the systems-based, hands-on approach that has dominated Army training since the mid-1970s. The NTC is a one-of-a-kind training and evaluation system found nowhere else in the world. The system is designed to provide both subjective and objective observations and a degree of insight into unit performance never available previously in the history of military training. The NTC has also been the model for the establishment of two more, but somewhat different, maneuver Combat Training Centers (CTCs): the Joint Readiness Training Center (JRTC) for light forces and the Combat Maneuver Training Center (CMTC) for forces assigned in Europe. [2]

Without question, the CTCs have been instrumental in improving the combat readiness of our Army. Former Army Chief of Staff, General Dennis J. Reimer, has referred to them as "the crown jewels of our training program." General Carl E. Vuono, also a former Army Chief of Staff, said, "The value of the Combat Training Centers cannot be overstated, and the payoff is measured in the performance of our units in battle."[3] Perhaps the most convincing testimony to the contribution of the NTC to Army training was the fact a majority of the combat troops that

deployed to Operations Desert Shield and Storm in 1990-1991, had already experienced "war" in the desert and learned its harsh lessons.[4]

THE BASIS OF NTC TRAINING

NTC training is based on three "pillars": an opposing force (OPFOR); a group of experienced trainers serving as exercise observer/controllers (O/Cs); and the instrumentation system. The OPFOR is represented by the 11th Armored Cavalry Regiment (ACR), which is permanently stationed at the NTC. The 11th ACR task organizes into a motorized rifle regiment to serve as the NTC OPFOR, which provides a realistic and challenging opponent to the rotational military unit. Their battle doctrine and tactics are modeled on that used by former Warsaw Pact forces. [5]

The O/C is a tactically and technically competent officer or non-commissioned officer who serves as trainer, observer, and exercise controller.[6] Working together with a Training Analysis Facility (TAF) analyst, the O/C controls the exercise, observes player activity, and identifies cause and effects that lead to tactical outcomes.[7]

The instrumentation system is an electronic data collector that monitors position location and the Tactical Engagement Simulation (TES) devices on soldiers and vehicles that captures the activity of each player. The instrumentation system feeds the Training Analysis Facility with data that is converted into computer-generated graphics providing a top-down view of player location, status (alive or dead), movement, and firing activity. The instrumentation system also records player tactical voice communications, supports control of communications, and displays video from mobile video crews in the exercise area.[8]

The Tactical Engagement Simulation system is an integral part of the instrumentation system which simulates the employment of a combat system during force-on-force training between a live training unit (BLUFOR) and live OPFOR. For example, to simulate direct fire engagements, weapons are equipped with a tactical engagement simulation system called the Multiple Integrated Laser Engagement System (MILES). MILES emits an eye-safe laser when the soldier fires the weapon. MILES sensors on soldiers and equipment detect engagement by the laser and produce an audio and/or visual signal for a kill, hit, or near miss.[9]

NTC INSTRUMENTATION SYSTEM'S EFFECT ON TRAINING AT THE NTC

This analysis will examine the current NTC, and specifically the NTC instrumentation system, and review its ability to support current and future Army training requirements. The NTC instrumentation system is key to providing the training audience (the rotational military unit)

a high fidelity, realistic training experience and is critical to the overall success enjoyed by the NTC. The sophisticated instrumentation system is an electronic data collector that tracks the players on the battlefield and monitors players' status and captures their activities. The instrumentation system's function is essentially to gather data and provide raw material for assessing unit performance. There is evidence the instrumentation system, which has been in place since the inception of the NTC is now degrading the training experience of the rotational unit and if not addressed will seriously affect the ability of the U.S. Army to field combat ready units.

Deficiencies in the Tactical Engagement Simulation significantly affect the realism of the training. Shortcomings and limitations of other segments of the instrumentation system further degrade the rotational units' training experience. Human intervention by the O/Cs to augment the outdated instrumentation system keeps the training experience at an acceptable level. Programmed force modernization and the digitization of the force, will load additional requirements on the antiquated instrumentation system. If these issues are not addressed now a "train wreck" of gigantic proportions will occur. This "train wreck" will affect the readiness of the U.S. Army and impinge on the success of our National Military Strategy.

DEFICIENCIES OF THE NTC INSTRUMENTATION SYSTEM

The NTC instrumentation system has been in place since the inception of the NTC in 1980. Over the years modifications have been made, subsystems have been added because of increasing requirements and new weapon platforms and what has resulted is a "kluge of stove-piped systems". Quality training still occurs at the NTC but it is only at the expense of numerous workarounds and a huge investment of time by the O/Cs, Training Analysis Facility analysts, and other exercise controllers to supplement the instrumentation functions.

The Tactical Engagement Simulation portion of the instrumentation system was developed separately from the remainder of the NTC system. One of the problems with the current instrumentation system is that stovepipe subsystems have been developed separately and never fully integrated into the instrumentation system. There are two types of feedback provided to the rotational military unit: intrinsic and extrinsic feedback. Intrinsic feedback is "downrange" feedback provided to the training unit during the exercise as they interact with their tactical systems and other players. Intrinsic feedback consists of those real or simulated entities or activities that stimulate the senses of the training unit (sight, sound, smell, feel, and taste) and cause them to react to a condition or combination of conditions. Extrinsic feedback is feedback provided in the form of AARs, O/C coaching and mentoring, and unit Take Home

Packages (THPs). Data produced by the Tactical Engagement Simulation system is needed by the remainder of the instrumentation system to support extrinsic feedback in the form of AARs so the rotational military unit can understand "what happened," "why it happened," and "how to improve performance." Instrumentation system data is needed by the Tactical Engagement Simulation system to support exercise control requirements, produce battlefield effects (flash and bang) and assess equipment damage and casualties, i.e.; intrinsic feedback.[10] Intrinsic feedback to the training unit provides battle realism and provides "positive training" stimuli to improve training readiness. There needs to be a synergy between the Tactical Engagement Simulation systems and the remainder of the NTC instrumentation system to meet intrinsic and extrinsic feedback requirements.

DEFICIENCIES OF THE TACTICAL ENGAGEMENT SIMULATION SYSTEM

The simulation of both line of sight (LOS) and non-line of sight (NLOS) weapons by the Tactical Engagement Simulation (TES) system is not realistic in many respects. The Simulated Area Weapons Effects/Multiple Integrated Laser Engagement System II (SAWE/MILES II) is the primary TES system that provides battlefield effects for live force-on-force training. MILES simulates the effects of direct fire engagement (tank on tank) using eye-safe laser transmitters. SAWE simulates indirect fire, nuclear, chemical and mine effects using exercise controller actions and the instrumentation system to assess area weapon effects.

LINE OF SIGHT (LOS) DEFICIENCIES

For line of sight (LOS) engagements, the visual and audio cues produced by pyrotechnics on the firing vehicle create a signature for acquisition by the targeted vehicle. When killed, the target vehicle's MILES actuates a continuous, blinking amber light informing the crew that their vehicle is out of action and notifying the firing crew they destroyed the target vehicle.

The fidelity of direct fire, LOS simulation is limited by laser technology, which causes the O/Cs to have to perform extensive exercise control actions. MILES lasers will not penetrate minor obstructions. Tree leaves (tree-leaf defilade) will obstruct the laser. Firing positions with berms (MILES berms) that are inadequate to stop penetration by real ordnance will stop a MILES laser beam. Smoke and dust degrades the effectiveness of the laser and may preclude engagements at maximum range. For safety, rules of engagement (ROE) preclude the use of MILES by dismounted soldiers for close-in engagements at less than 10 meters. O/Cs have to manually kill players using laser pistols (control guns) in those instances where MILES fidelity limitations or safety preclude automatic casualty and battle damage assessments.

Although the shooter receives feedback when he hits a vehicle (continuous, blinking amber light on the target vehicle), the feedback he receives when he misses the target is inadequate. If he "near misses" the target, the amber light will blink two or three times. If he misses the target by a considerable distance, the amber light on the target vehicle does not blink at all. For misses, the shooter receives no feedback to sense whether the ordnance fell

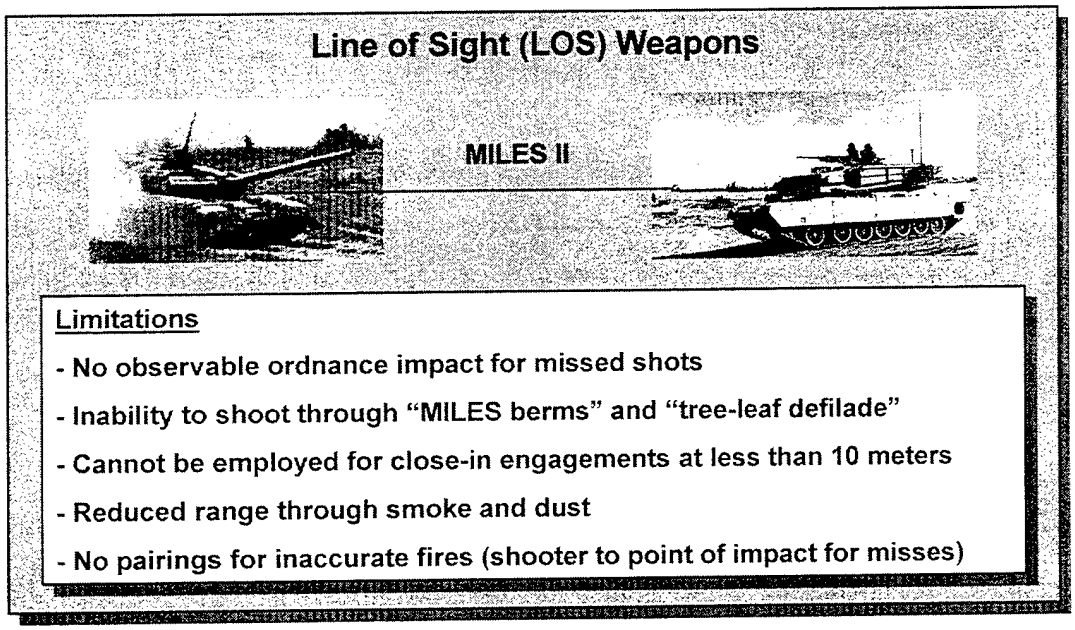

FIGURE 1

short, long, left or right of the target. Data collection does not pair the impact location of missing rounds to the firer for purposes of feedback.

To summarize, for LOS weapons, MILES has the following limitations, which impacts the fidelity and realism of the NTC experience:

- There is no observable ordnance impact for missed shots. The firer has no immediate intrinsic feedback on where missed shots impacted.
- The inability of MILES to shoot through "MILES berms" and "tree-leaf defilade" is not realistic.
- MILES cannot be employed for close-in engagements at less than 10 meters.
- MILES has a reduced range through smoke and dust.
- There are no pairings for inaccurate fires (shooter to point of impact for misses) in the computer display for feedback purposes.

NON-LINE OF SIGHT (NLOS) DEFICIENCIES

The Simulated Area Weapons Effects simulation (SAWE) produces visual and audio cues and assesses battle damage and casualties for non-line of sight (NLOS) area effects weapons. For indirect fire resulting in a near miss, hit, or kill, SAWE sets off pyrotechnics in vehicle-mounted Audio-Visual Devices (AVDs) creating flash, bang, and smoke signatures. The blinking amber light indicates a "near miss" or kill just as in a LOS engagement. For indirect fires against dismounted soldiers, a firemarker (human exercise controller) provides the visual and audio cues to simulate impacting ordnance. SAWE assesses personnel casualties by activating the audio alarm on the soldier's Man Worn Laser Detector (MWLD).

Unlike LOS engagements, NLOS engagements require intensive manning and control actions to produce realistic effects. After extensive O/C and Training Analysis Facility analyst coordination and considerable manual input into the instrumentation system, SAWE performs battle damage assessment (BDA). For inaccurate indirect fires impacting well beyond OPFOR vehicles that SAWE cannot mark using vehicle AVDs, a firemarker marks the impacting ordnance. Firemarkers also mark fires against dismounted soldiers. Firemarkers equipped with smoke generators or smoke pots produce the smoke for artillery and mortar smoke missions. Firemarkers use flares to simulate illumination produced by indirect fire units. Firemarkers may not be timely in marking fires because of the distance to the target, terrain, and visibility conditions (day or night).

Unless the O/C detects obvious gunnery errors by the mortar or artillery fire direction center (FDC) or by the mortar or howitzer crews, the grid in the call for fire is the location marked and assessed for casualties and BDA. For undetected gunnery errors, the errors are not projected down range during force-on-force training.

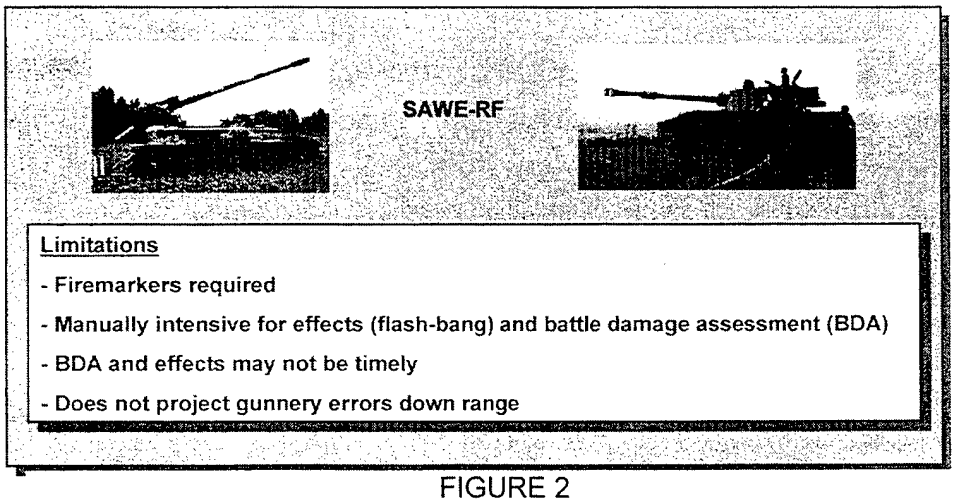

FIGURE 2

To summarize, SAWE has the following limitations which impacts on the realism of the training and requires labor-intensive human intervention:

- Firemarkers (human exercise controllers) are required to simulate audio and visual cues for battlefield effects.
- The creation of effects (flash-bang) and BDA are manually intensive.
- BDA and effects may not be timely.
- Gunnery errors are not projected downrange (cause-effect).[11]

OTHER INSTRUMENTATION DEFICIENCIES

The deficiencies of the remainder of the instrumentation system other than the Tactical Engagement Simulation portion of the system are significant. Many times there is no pairing of shooter to victim by the instrumentation system. The instrumentation system detects only 30 percent of the pairings that actually occur. Consequently, O/Cs must check the kill code for each disabled vehicle to determine what type of combat system killed the vehicle. OPFOR does the same for their vehicles. This pairing information is needed to prepare killer/victim statistical charts for the After Action Review (AAR).[12]

False positives (instrumentation kills) are a problem, as are crashes and jamming of the instrumentation system. Many times units experience their combat systems being killed by the instrumentation system and there is no OPFOR weapon system in range to have killed them. To resurrect these vehicles and get them back in the fight requires time and an O/C's approval. Paging and phone companies are infringing on the frequencies used at the NTC and affect the instrumentation system's functioning.

As BG Webster, former NTC commander puts it, "We must eliminate crashes and jamming of this nature. When the real time part of our Solaris system (the instrumentation system) goes down, the screen picture is fixed, no longer updating, and situational awareness for our O/Cs is lost. Real time is going down once or twice per rotation at present. The system must show something close to reality, otherwise our training will not accomplish what we want it to. We will not be able to demonstrate the ground truth of what happened to training units."[13]

The play of "fast movers" or Air Force fighter aircraft is deficient, lacks realism and requires extensive human intervention. The history of Air Force involvement in NTC exercises explains the reason two semi-independent systems are in place. In general, the Air Force supported the concept of the NTC, which is based heavily on its own Red Flag exercises.[14] In 1984, the Army and Air Force signed a Memorandum of Agreement (MOA) known as the "31 Initiatives"[15]. Initiative 24 of the agreement, "Close Air Support, " reaffirmed the Air Force's

responsibility to provide fixed wing close air support to the Army and implicitly confirmed the Air Force commitment to take part in the training exercises at the NTC.[16] After much negotiation, it was decided to establish a link between the instrumentation system at the NTC and the Air Warrior system at Nellis AFB. What has resulted is the Air Warrior Measurement and Debriefing System (AWMDS). It is a semi-independent Air Force system that allows close air support (CAS) engagements with bomb damage assessment and the ability to shoot down the aircraft. The Air Force has just upgraded this system and refers to it now as the Air Warrior Advanced Display and Debriefing System (AWADDS).[17]

The Air Warrior system employs pods on the aircraft capable of intercepting and downlinking signals from the NTC instrumentation system. The pods register engagements and pass the information to the Air Warrior mainframe at Nellis AFB, where the computer matches the data to the NTC data to identify the target and assess damage. The data is then routed back to Fort Irwin to the NTC instrumentation system. There, Army officials convert the classified data produced by the Air Force system into a form that can be readily shared with Army combat units. That information is then passed to the NTC Operations Center where training analysts implement target kills through the NTC instrumentation system. The Air Force instrumentation system's "no-drop" weapons scoring capability show where ordnance would have hit the ground, while the NTC data show what (tanks, Bradley Fighting Vehicles, etc.) is in the strike zone. Visual cues known as "smoky SAMS" (simulated surface-to-air missiles) allow the pilot to initiate evasive action in the time that it would take a real missile to reach his aircraft.[18]

From the description of the integration of the Air Warrior and NTC instrumentation systems, it is evident that an optimum training experience cannot result. Training deficiencies are present. There are 2 independent systems marginally interoperating with each other. A "sneaker network" is required at the NTC to complete the interoperability loop. Data is passed from Nellis AFB to the NTC several times and latency is a problem at times with the CAS missions. Significant human intervention by exercise controllers is required to supplement the Air Force play and even with this assistance, the airplay is still somewhat artificial.

The instrumentation system also has deficiencies in the Engineer, Air Defense Artillery (ADA), and Combat Service Support (CSS) areas. The amount of human intervention required to provide realistic training in the area of mines and minefields is significant because of instrumentation limitations. There are numerous shortcomings with the laying of minefields, the breaching of minefields and the realism involved with Mine Effects Simulators (MES). O/Cs perform intensive control actions to simulate battlefield effects and casualties/battle damage for

conventional minefields. The instrumentation system cannot simulate a breach/lane in a minefield and will kill all players encroaching on a minefield. The minefield is either on or off; NTC O/Cs cannot designate a lane in the minefield that BLUFOR or OPFOR has effectively breached so that vehicles/personnel can move through the breach unharmed. To rectify this problem, O/Cs manually adjudicate most minefields rather than use the instrumentation system.[19]

There are individual Mine Effects Simulators (MES) that engineers use to employ mines in some instances. Engineer O/Cs state that BLUFOR use of MES to simulate minefields still requires manual adjudication, since MES does not accurately simulate BLUFOR mines. Pressure or contact with a tilt-rod detonates BLUFOR conventional mines. In other words, to activate the mine the vehicle must pass directly over the mine. Consequently, O/Cs must manually resurrect OPFOR vehicles, which were killed in close proximity to the BLUFOR-emplaced MES, but that did not pass directly over the mine. NTC has 19,000 MES mines.[20]

Wide Area Munitions (WAM) simulation requires exercise control intervention and is not realistic. O/Cs stated the probability of kill is not sufficient to realistically represent the mine's capability. Also, the signature (flash and bang) of exploding mines is nonexistent in some cases and artificial in others.[21]

ADA engagements have many of the same problems. Battalion Task Force O/Cs manually adjudicate air-to-ground, fixed-wing engagements. For ground-to-air, fixed-wing engagements, NTC and Air Force O/Cs manually adjudicate engagement results. An ADA engagement should produce a pairing (shooter to victim). An instrumentation system–reported pairing may or may not occur, because the instrumentation system currently pairs shooter to victim for only 30 percent of the engagements. Range for the Stinger is 5 kilometers (KM). Maximum range for the Stinger Tactical Engagement Simulation (TES) is 3.7 to 4 KM. There are no TES sensors on the lower portion of a helicopter's nose, rear or belly of the fuselage. O/Cs say the location of the sensors on the aircraft combined with the reduced range for the Stinger Tactical Engagement Simulation does not provide a good simulation of ADA systems.[22] Because of the large amount of manual adjudication and human intervention required by the ADA O/Cs, the O/Cs can view only about 50 percent of the BLUFOR ADA assets at any given time. ADA analysts, therefore, cannot adequately support ADA data collection and AAR requirements.[23]

CSS O/Cs also report that they must perform numerous control duties to supplement an inadequate instrumentation system so that data can be collected for feedback to the CSS community during AARs. CSS O/Cs report they are too busy counting, controlling, and

collecting data over widely dispersed locations to perform coaching and mentoring, even during the planning and preparation phases.[24]

CONTROL AND FEEDBACK FUNCTIONS PERFORMED BY O/CS IN SUPPORT OF THE INSTRUMENTATION SYSTEM

As has been demonstrated, human intervention is needed to overcome the shortcomings of the instrumentation system to achieve a good training experience for the rotational military unit. Humans in the loop, like the O/Cs, the Training Analysis Facility analysts, the Firemarkers and other exercise controllers prop up the instrumentation system and continue to make the NTC experience the culmination of a unit's training. An O/C is a tactically and technically competent officer or NCO who serves as a trainer and observer of the exercise and if needed as an exercise controller. The O/C's primary duties should be to coach and mentor his counterparts in the training unit. Coaching and mentoring are key O/C contributions to the improved training readiness achieved by the rotating unit.[25] The amount of work O/Cs and analysts must do to insure units get the proper feedback is dependent to a large extent upon the performance of the NTC instrumentation system. At the present time, the analysis clearly shows that O/Cs are too involved in many data collection tasks, which divert them from their primary tasks of player behavioral observations, coaching, and mentoring.[26]

The control and feedback (CAF) functions performed by the O/Cs, especially the manual adjudication, have far-reaching effects on the NTC training experience. In the eyes of the BLUFOR player, the credibility of the exercise is diminished when they see the "00" MILES kill code generated by the O/C control gun (i.e., "OPFOR didn't kill me—the O/C did!.") There are further credibility problems when manually intensive control procedures result in the assessment of casualties several minutes after a successful engagement. Control procedures to simulate weapons effects for certain weapons often interfere with player actions. For example, the time required for an O/C to move around on the ground and assess casualties after an attack helicopter engagement may prevent the O/C from assessing a subsequent engagement by the same helicopter at a different location. In some cases, the need for O/Cs to approach targets for exercise control purposes has the effect of compromising player locations.[27]

The O/Cs are involved in supporting the instrumentation system in the determination of situational awareness and the pairing of who shot whom, when and with what. In addition, they aid in the realistic play of artillery, engineer tasks, ADA activities and LOS and NLOS engagements. Also, O/Cs are involved in manually adjudicating the above listed engagements, and preparing the data collected for feedback to the training audience during the AAR sessions.

NUMBERS OF PERSONNEL SUPPORTING THE INSTRUMENTATION SYSTEM

In April 1999, Raytheon Services Corporation was the NTC Support Service Contractor. Their Rotational Support Group, which supported the field instrumentation, the Tactical Engagement Simulation systems, and the battlefield effects, consisted of 102 personnel. Forty-one of these personnel acted as firemarkers.[28] 103 different Raytheon contractors were part of the NTC Training Analysis Division. They were comprised of the Training Analysis Facility analysts who supported the O/Cs and the faltering instrumentation system, and personnel who supported the Take Home Package production and Civilians on the Battlefield scenarios.[29] With our declining defense budget and other priorities for defense dollars such as the Army Transformation, the Army cannot continue supplementing deficiencies in the NTC instrumentation system with this amount of human intervention.

The number of people identified above to support the NTC instrumentation system is significant, but the O/Cs have not even been accounted for. BG Webster, former NTC Commander, addressed the number of O/Cs and the need to supplement the NTC instrumentation system. "At present we say the instrumentation will provide the ground truth and the O/Cs will know what happened and how to improve. This is not altogether true. We can show you where most people and equipment were, most of the artillery engagements, and who was there. We can show very little of the direct fire engagements (such as might occur with reconnaissance). ....That is why we have 625 O/Cs."[30]

This is a startling number of leaders acting as trainers at the NTC; maybe even more startling since a large part of their time is spent acting as part of the instrumentation system instead of training, coaching and mentoring. BG Webster states his concern on the number of O/Cs. "There is no guarantee that we can continue to staff 625 O/C positions. The O/Cs are a brigade's worth of leaders without the soldiers. They are the best brigade and battalion commanders on down to platoon leaders that we can find. Retired BG James P. (Pat) O'Neal dealt with this problem. How to reduce the number of O/Cs? He phrased the question in this way: 'Can we afford not to have 100% coverage?' Can we say that we are not going to train the smoke platoon- that an O/C is just going to be there for a couple of hours and this is it? I think the answer is, not if we can help it, but if at some point in the future, we can't help it, the instrumentation might help us make up for fewer O/Cs."[31]

THE INSTRUMENTATION SYSTEM IS DIVERTING O/CS FROM THEIR PRIMARY TASKS

BG Webster and BG O'Neal have hit upon a critical conclusion; we must get the most effective use of the O/Cs. The NTC mission is training. Less of the O/C's time involved in instrumentation events means more time for coaching and mentoring.

The downsizing of the Army, the increased deployments and missions resulting in higher and higher OPTEMPO and PERSTEMPO, and the scarcity of defense dollars necessitates that we leverage technology. The NTC instrumentation system must take the load off the human exercise controllers, not the other way around.

O/Cs for live force-on-force exercises have traditionally faced a heavy workload. These trainers must often spend substantial efforts during exercises helping to simulate the effects of weapon systems. They must also expend substantial effort collecting and analyzing data to provide units with feedback. [32] The NTC O/Cs not only spend a substantial amount of time supplying feedback downrange, but they also spend considerable time collecting and analyzing data for the conduct of AARs.

An extensive study (1998) of control and feedback functions at the NTC examined AAR tasks for O/Cs and Training Analysis Facility analysts. In the analysis, a total of 25 O/C and 86 Training Analysis Facility analyst AAR preparation tasks were identified based on a limited sample of one tactical task for each Battlefield Operating System (BOS). Undoubtedly, analysis of additional BOS tasks would yield many more AAR preparation tasks. However, the analysis clearly showed that O/Cs are involved in many data collection tasks, which divert them from player behavioral observations, coaching, and mentoring.[33]

Extrinsic feedback is that feedback provided to the BLUFOR in the form of AARs, coaching, and unit Take Home Packages. The AAR is a dynamic discussion among the BLUFOR exercise players following an exercise in which the key leadership of the unit strives to determine: "What happened," "Why it happened," and "How to improve performance." The BLUFOR players are guided in their discussion by an AAR facilitator, usually an O/C.[34] Teams of O/Cs and Training Analysis Facility analysts are involved in AAR preparations before the exercise, during the exercise and after the exercise.

An upgraded instrumentation system would take the data collection burden off the O/C. Also, Training Analysis Facility analyst tools built into the instrumentation and automated aids would automatically produce AAR products and perform a substantial portion of the analysis functions now performed by the O/Cs and analysts.

Although analysts create numerous aids during the planning, preparation, and execution phases of the battle, the AAR products may or may not be useful for the AAR. The factor

driving the selection of which aids will be presented is battle outcome. However, since neither the O/C nor the analyst can positively predict battle outcome and the primary causes and effects that led to that outcome, the analyst must generate AAR aids during the exercise for any eventuality. The state of the art will allow an upgraded instrumentation system to have an AAR tool set to assist the O/C or analyst to select which AAR aids are pertinent based on the battle outcome. Standard sets of AAR products linked to battle outcome by BOS could be developed automatically by the instrumentation system which use the best medium or combination of media to stimulate AAR audience discussion, self-assessment, and fixes. Consequently, much time that is presently wasted reviewing numerous AAR aids that are not pertinent for the AAR might be avoided.

It is also apparent that AAR preparations are manually intensive. The analyst must be highly skilled in the operation of a complex AAR subsystem and tactically and technically competent in the mission executed by the exercise players. The analyst builds each AAR aid from scratch, one aid at a time. With the advent of battlefield digitization, the AAR subsystem will become even more complex, demand additional skills and result in the generation of a greater number of AAR products to review for pertinence. This will be extremely difficult even for the trained NTC analyst to cope with.[35] Automated tool sets to perform the analysis and produce standard products from collected data, and an instrumentation system that contains an AAR subsystem that is more user friendly will make the analyst's job less intensive.

O/Cs must transport a large library of references to perform the many tasks required of them. Ensuring all O/Cs have a current reference library requires a considerable effort by the O/C team's senior leadership. Manual searches for information in paper-based references is terribly time-consuming and often results in an incomplete search. O/Cs need a capability to rapidly locate information under adverse field conditions (cold and dark) to perform their duties. The state of the art would allow this capability to be integrated into an upgraded NTC instrumentation system.

There are also numerous recurring, pre-formatted reports that O/Cs submit to their senior O/C or a TAF analyst. The O/C hand-writes the report and/or submits the report orally over a control net. On occasions, the nature of the report may require the O/C to travel to the addressee's location to deliver the report. In any case, preparation and submission of reports is a manually intensive activity, which detracts from the O/C's ability to observe, coach, and mentor his BLUFOR counterpart.[36] An instrumentation tool set could make this reporting task more efficient and less labor intensive.

A final example illustrates how the O/C is torn between performing exercise control functions to aid the instrumentation system and the primary functions of observation, coaching, and mentoring. Observations of human behavior and coaching may require the O/C to separate himself from his vehicle and controller communications. This presents a dilemma for the O/C. If the O/C is unable to hear others calling him on the radio, his absence from the control net may impact adversely on the control of a critical exercise activity. If he stays with his vehicle to respond to radio calls, he may miss an observation or coaching opportunity; i.e., generation of courses of action by the Battalion Task Force staff with the BLUFOR tactical operations center (TOC). When the O/C judges that exercise control is the dominant factor, he remains with his vehicle.[37] The next instrumentation system must relieve the O/Cs from exercise control responsibilities, thereby, freeing him to perform his primary responsibilities. If the O/C cannot be completely freed from these exercise control tasks, then tools need to be developed, such as a palm top or some form of "hands free" communication device, to keep him connected with other exercise controllers to aid in the performance of his duties.

DIGITIZATION OF THE BATTLESPACE AND FORCE MODERNIZATION ISSUES- MORE PRESSURE ON THE INSTRUMENTATION SYSTEM

Lack of battle realism resulting in degraded training of the rotational military unit is the result of instrumentation deficiencies. Portions of the NTC experience are artificial and thereby, U.S. soldiers are receiving negative training. The need for human intervention (O/Cs, Training Analysis Facility analysts, firemarkers, etc.) to supplement the instrumentation system has been illustrated. In the near future, when digitization of the battlespace and force modernization issues arise, even more pressure will be placed on the NTC instrumentation system to provide a credible training experience to the rotating military units.

DIGITIZATION OF THE BATTLESPACE

Digitization of the battlespace increases the amount of work required to support feedback for C4I activities. The advent of digitization makes it especially difficult for platoon and company level O/Cs to track the flow of information within the unit they are observing and between the observed unit and higher, adjacent and supporting units.[38] While O/Cs in the current voice communications environment can track the flow of information within and across units by listening to multiple radio nets, tracking the flow of visually-based digital communications often requires interacting with a separate computer for each net. This creates a situation where O/Cs at platoon and company level may be entirely oblivious of the fact that, for example, the unit being observed has received new overlays or orders. Digitization has the potential to greatly

increase the amount of information available to a unit, and it leaves the O/C with the challenge of finding out what information was examined by the unit, what the unit did to filter a glut of information, and if/how the unit employed information.[39]

FORCE MODERNIZATION

Study Report 98-04, "Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support" was conducted in response to a request from the TRADOC Combat Training Support Directorate (CTSD) in 1998. This report estimates the effects of force modernization on the workload of O/Cs and analysts in live force-on-force exercises at maneuver CTCs. In the absence of interventions, force modernization will increase the workload of O/Cs and analysts in live force-on-force exercises and pull trainers out of the tactical information loop. A spiraling workload is forecast for trainers and a degradation in combat readiness if action is not taken to upgrade support for live training. With the advent of battlefield digitization; tactical decision aids; "smart, intelligent, and brilliant" munitions; advances in non-lethal weapons, and new reconnaissance, surveillance, and target acquisition (RSTA) systems, the workload for O/Cs will continue to spiral. Force modernization is creating new control and feedback tasks that have the potential to rob O/Cs of time they would otherwise spend observing, coaching, and facilitating the learning of exercising players.[40]

The following trends in weapon capabilities present major implications for the NTC instrumentation system.

Line of Sight (LOS) Weapons- Improved acquisition and engagement ranges for emerging direct-fire systems will exceed the simulation capabilities of MILES laser technology. For example, smoke and dust degrades the effectiveness of the MILES eye-safe laser. The gunner of a direct-fire platform may thermally acquire an OPFOR combat vehicle through smoke at an extended range, but he will be unable to engage the target at the weapon's maximum effective range due to MILES limitations.[41]

Instrumentation system data collection does not reliably pair the direct-fire shooter to the victim for purposes of extrinsic feedback. Workstations are capable of displaying a direct-fire vector between the shooter and the victim; however, the NTC instrumentation system detects only 30 percent of the pairings that actually occur. The instrumentation system is unable to pair the impact location of rounds that missed the target to the shooter that fired the round. These two pairings (shooter to victim and shooter to misses) are data needed by trainers to provide post-exercise feedback on how well the units controlled direct fires in the engagement area or during the assault of the objective.

Hit avoidance is a force modernization initiative that will provide combat platforms an active defense against the top-down or horizontal attack of smart weapons. Sensors on the platform will detect acquisition by precision ordnance and will use jammers, obscurants, false target generators and counterfire to reduce the hit probability of the incoming projectile. Today's NTC instrumentation system does not have the capability to selectively dial down the probability of kill (Pk) for combat platforms that employ active protection measures against precision munitions.

Non-Line-of Sight (NLOS) Weapons- Force modernization is creating a situation in which NLOS engagements are not restricted to field artillery and mortars. Emerging weapons and munitions will provide a NLOS capability that permeates the battlefield extending to the individual soldier equipped with the Objective Individual Combat Weapon (OICW). Indirect-fire engagements using SAWE require intensive exercise control actions to provide feedback to the rotational military unit. Acquiring additional O/Cs, analysts and firemarkers to perform these control procedures for every emerging NLOS system is not a feasible alternative.

Current and future precision-guided, smart, intelligent and brilliant NLOS munitions will have a major impact on the future generation NTC instrumentation system. Current BDA algorithms do not account for the capability of these munitions to semi-autonomously or autonomously seek and destroy targets with the equivalent accuracy of direct-fire systems. Further, O/C and analyst control actions to simulate these precision munitions are far more complicated than for conventional indirect-fire projectiles that travel along ballistic trajectories with no terminal guidance or detection capability. Currently, simulation of precision-guided munitions such as Copperhead is the exception rather than the rule during artillery engagements at the NTC. When a BLUFOR unit executes a Copperhead mission, five geographically separated control personnel are required to simulate a single engagement. In the future, employment of terminally guided, smart ordnance will be prevalent during artillery, mortar and attack helicopter NLOS engagements. O/Cs and analysts will be unable to keep up with the OPTEMPO of the battle using manual control procedures. The result may be that the simulation will have no credibility.

Area Weapon Effects- Today, O/Cs and Training Analysis Facility analysts perform intensive control actions to simulate the effects of manually and dynamically emplaced minefields and breaching operations. However, it is unfeasible to employ manual control procedures to simulate the capabilities of emerging mines and minefield Command and Control (C2) systems. For example, the Intelligent Minefield, which employs the top-down-attack Wide Area Munitions, also referred to as the Hornet, will have a surveillance, reporting, and self-

defense capability. The minefield will detect and report vehicles approaching the minefield, detonate by self-activation or on command, and request reinforcing fires. A remote C2 station provides a capability to detonate the whole minefield or a selected portion(s) of the minefield. Today, an analyst enters into the Simulated Area Weapons Effects (SAWE) control station the minefield location and technical data provided by the O/C. SAWE compares the location of the player entities to the geographic area affected by the minefield and electronically assesses mobility kills to vehicles entering the minefield. SAWE cannot simulate the reduced effectiveness of the minefield as vehicles encroach on the obstacle, mines detonate and minefield attrition occurs.[42]

Future Nuclear, Biological, and Chemical (NBC) detection systems will provide an increased standoff capability to warn units of NBC strikes. These new detection systems will require stimulation by the future instrumentation system to activate detector alarms, which, in turn feed, digital C2 systems that predict the area affected by the hazard and disseminate the warning. Today, SAWE can simulate a chemical strike with extensive support from O/Cs and analysts; however, SAWE cannot simulate a biological or nuclear strike.[43]

The future capability of multi-spectral obscurants will impact the instrumentation system. Emerging multi-spectral obscurants will screen the activities and dispositions of friendly units and defeat enemy precision-guided ordnance and RSTA capabilities. Currently, the NTC uses smoke generators, fog oil, and smoke pots to simulate artillery and mortar smoke and generator-produced smoke. The smoke defeats visual and optical surveillance, but does not defeat thermal sights or radar acquisitions or block target acquisition lock by smart ordnance with a seek-and-destroy capability. Manual control procedures are not a feasible alternative to simulate the effects of multi-spectral smoke. Sophisticated enhancements to the instrumentation system are required to degrade the Pk of smart ordnance entering a target area obscured by multi-spectral smoke.

Non-Lethal Weapons-Military Operations Other than War (MOOTW) are becoming more frequent, more complex, and politically charged. These new missions bring an increased use of non-lethal weapons such as the Aqueous Foam Barrier and the 12 Gauge beanbag round. Current Tactical Engagement Simulation systems do not support the play of these new weapon systems. Non-Lethal weapons pose special challenges for the realism of training. For example, MILES players in the current instrumentation system exist in one of two states. They are either "on" or "off". If a player's MILES sensor receives laser energy, a loud audible alarm goes off. If the player receives a direct hit, he must inactivate his laser transmitter to silence the alarm. This player is now "out-of-action." For feedback on the wounds he sustained, the player must

take out a casualty card to identify the extent of his wounds. This type of "on" or "off" feedback is sufficient when dealing with deadly weapons, but in the non-lethal arena, there are many different levels of effects that are possible. For example, a soldier may engage an antagonist with a 12 Gauge beanbag round. The antagonist will be disabled initially, but he will recover and either leave the area or rejoin his fellow antagonists in the confrontation.[44] The current NTC instrumentation system cannot account for this type of play.

CONCLUSION

The following story illustrates the respect that Army leaders have for the NTC training experience. In 1982, then Major General John R. Galvin, the Commanding General of the 24th Infantry Division (Mechanized), after participating in PT with an infantry company in the division, asked the Company Commander if his company was ready to fight the Soviets. The Company Commander stated unequivocally they were ready to go tomorrow. MG Galvan then asked if the company was ready to go to the NTC. The commander paused and then said, "It will take us a couple of weeks to get ready for the NTC."[45]

It is evident that the digitization of the force and other force modernization advances are going to significantly change the units and their equipment that come to train at the NTC. If we, as an Army are to continue to train as we fight, then changes have to be made to the NTC instrumentation system to accommodate force modernization wave and to rectify the deficiencies that now exist. Increased workload of the O/Cs and other exercise controllers are now masking the impact of these deficiencies and shortcomings. The NTC has been referred to as one of the crown jewels of the U.S. Army's training program and played a major part in our success in Desert Storm. To insure the continued credibility of this premier training facility will require decisive action on the part of the U.S. military leadership.

In order to retain the confidence that our leaders and soldiers have in the NTC training experience; in order to adequately prepare our soldiers for the accomplishment of tasks and missions in support of the National Security Strategy, the NTC instrumentation system must be upgraded.

The NTC instrumentation system is one of three pillars of NTC training. This pillar is crumbling and is in serious need of repair; the instrumentation system is dependent today on the other two training pillars of the NTC, thereby, also weakening them.

The deficiencies and shortcomings of the NTC instrumentation system are well known to all who serve at the NTC. The shortcomings of the instrumentation system are presently being addressed by transferring the O/Cs, Training Analysis Facility analysts and other exercise

controllers from their primary duties to perform control and feedback functions the instrumentation system should be accomplishing.

As BG Webster, former NTC commander states, "The primary reason we need the Objective Instrumentation System (a new NTC instrumentation system) is to be able to provide feedback to the brigade and battalion leaders on what happened and why. We need to have the truth about what happened and the system must reflect the capabilities of the actual weapons systems that were used. The system must be something close to reality, otherwise our training will not accomplish what we want it to."[46]

> In no other profession are the penalties for employing untrained personnel so appalling or so irrevocable as in the military.
>
> —GEN MacArthur, 1933

Word Count = 7,498

ENDNOTES

[1] Anne W. Chapman, The National Training Center Matures 1985-1993 (Fort Monroe, VA: U.S. Army Training and Doctrine Command, 1997), 1-2.

[2] Ibid., 6-7.

[3] Lieutenant Colonel Ronald L. Bertha, The Future of the Combat Training Centers to Meet the National Military Strategy, Strategy Research Project (Carlisle Barracks: U.S. Army War College, 31 March 1999), 3-4.

[4] Chapman, 7.

[5] U.S. Army Simulation, Training and Instrumentation Command, Combat Training Centers-Objective Instrumentation System Domain Model of the NTC (Austin, TX: Applied Research Laboratories, 21 February 2000), 3-46.

[6] Bill R. Brown et al., Cognitive Requirements for Information Operations Training (CRIOT) (Alexandria,VA: United States Army Research Institute for the Behavioral and Social Sciences, June 1999), 4.

[7] Ibid., 5.

[8] Bill R. Brown et al., Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support (Alexandria, VA: United States Army Research Institute for the Behavioral and Social Sciences, July 1998), 2.

[9] Ibid.

[10] Ibid., 4,10.

[11] Brown et al., Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support, 60-62.

[12] Bill R. Brown et al., Advanced Tactical Engagement Simulation Concepts (ATESC) (Alexandria, VA: United States Army Research Institute for the Behavioral and Social Sciences, September 1999), 15.

[13] U.S. Army Simulation, Training and Instrumentation Command, Combat Training Centers-Objective Instrumentation System Knowledge Acquisition Interviews Conducted at the National Training Center (Austin, TX: Applied Research Laboratories, January 2000), N47-2 and N47-3.

[14] Chapman, 252.

[15] Ibid., 253.

[16] Ibid.

[17] U.S. Army Simulation, Training and Instrumentation Command, Combat Training Centers-Objective Instrumentation System Knowledge Acquisition Interviews Conducted at the National Training Center, N31-8.

[18] Chapman, 267.

[19] Brown et al., Advanced Tactical Engagement Simulation Concepts (ATESC), 16.

[20] Ibid., 16-17.

[21] Ibid., 17.

[22] Ibid., 18-19.

[23] Ibid., 19.

[24] Brown et al., Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support, 17.

[25] Ibid., 14.

[26] Ibid., 52.

[27] Ibid., 18.

[28] U.S. Army Simulation, Training and Instrumentation Command, Combat Training Centers-Objective Instrumentation System Domain Model of the NTC (Austin, TX: Applied Research Laboratories, 21 February 2000), 3-35.

[29] Ibid., 3-37.

[30] U.S. Army Simulation, Training and Instrumentation Command, Combat Training Centers-Objective Instrumentation System Knowledge Acquisition Interviews Conducted at the National Training Center, N47-3.

[31] Ibid., N47-3 and N47-4.

[32] Brown et al., Advanced Tactical Engagement Simulation Concepts (ATESC), 1.

[33] Ibid., 52.

[34] Brown et al., Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support, 10.

[35] Ibid.

[36] Ibid., 54-55.

[37] Ibid., 56.

[38] Brown et al., Cognitive Requirements for Information Operations Training (CRIOT), 51.

[39] Ibid., 2.

[40] Brown et al., Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support, i.

[41] Brown et al., Advanced Tactical Engagement Simulation Concepts (ATESC), 21.

[42] Ibid., 21-23.

[43] Ibid., 24.

[44] Ibid., 24-25.

[45] Professor Douglas Campbell, Director, Center for Strategic Leadership, U.S. Army War College, Interview by author, 1 February 2001.

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