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INTERACTIVE SIMULATION TRAINING SYSTEM FOR THE OBJECTIVE INDIVIDUAL COMBAT WEAPON SYSTEM

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ABSTRACT

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The Objective Individual Combat Weapon (OICW) is a revolutionary weapon system. It is being developed to satisfy Department of Defense requirements for individual and crew served weapons with improved range, penetration, and combat effectiveness capabilities. It is a remarkable weapons system which will substantially increase the lethality and survivability of United States service members on the modern battlefield.

The objective of this research paper to identify a comprehensive training simulation design/system, capable of adequately addressing the operational needs for training the unique, interactive, simulation training requirements of the OICW. Specifically, it identifies industrial capability and related technology to provide state-of-the-art solutions to support personnel training on the revolutionary weapons system known as the Objective Individual Combat Weapon and its ancillary munitions.

Though the enhanced capabilities of the OICW are indeed revolutionary, so too are the multifaceted challenges ushered in with this new weapons system. Perhaps the biggest challenges facing the OICW are the training and associated cost considerations. These cost factors are further complicated by the time requirements involved in training this unique and highly sophisticated weapon system. The focus must not be limited to simply establishing the best means for achieving training proficiency, but on the long term goal of determining the best means for *maintaining* and *sustaining* that desired level of proficiency.

As with any sophisticated system, more cognitive skills are required (in addition to the basic motor skills of the conventional weapon system). Similarly, when learning a more sophisticated system, comes a higher degree of *perishability*, the decay or memory loss associated with these learned skills if not properly or frequently exercised. Whatever system or systems developed to train, maintain and sustain proficiency on the OICW, they must include the capability to

accurately train *and* with a frequency designed to mitigate the perishability of these cognitive skills.

The military's use of modeling and simulation as it pertains to marksmanship training is nothing new. Various simulation devices have been developed in the last 20 years to this end. The Army has systematically examined basic, advanced and unit marksmanship training programs since 1977 in order to ensure that training procedures were capable of producing quality marksmen for the United States Army. Though numerous weapons simulations systems have been developed to date however, none of them adequately address the high fidelity needs or provide the technology required to accurately replicate the unique *indirect fire* characteristics of the OICW weapon system.

Due to the nature of the OICW, new and revised training requirements are vast. They run the complete spectrum from basic weapon familiarization and proficiency to complicated collective training using the Tactical Engagement Simulation System (TESS). Research emphasis therefore, was placed on the requirements that pertain to the development of individual and limited collective training skills, as well as the sustainment of those proficiency skills.

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INTERACTIVE SIMULATION TRAINING SYSTEM FOR THE OBJECTIVE INDIVIDUAL COMBAT WEAPON

The Department of Defense (DOD) has determined there is a requirement for individual and crew served weapons with improved range, penetration, and combat effectiveness capabilities. These new systems must be acquired, trained, maintained and sustained at lower total costs than existing systems. The Objective Individual Combat Weapon (OICW) is the first developmental weapon within the Objective Family of Small Arms (which will also include the Objective Crew Served Weapon or OCSW), as outlined in the Small Arms Master Plan, to provide these improved capabilities and satisfy DOD requirements.

Though a DOD initiative, the United States Army has the responsibility for the development, fielding and training of this weapon system. Recognizing the factors associated with cost, training, etc., the Chief of Staff of the Army (CSA), has mandated that all new weapons systems being researched, tested and evaluated for use by the United States Army must be fielded with their own inherent training systems. The OICW will be the first such system to be fielded with it’s own organic interactive simulation training system.

The objective of this research paper is to identify a comprehensive interactive training simulation design/system, capable of adequately addressing the operational needs for training the unique, interactive, simulation training requirements of the OICW. Specifically, it identifies industrial capability and related technology to provide state-of-the-art solutions to support personnel training on the revolutionary weapons system known as the Objective Individual Combat Weapon and its ancillary munitions.

BACKGROUND

The OICW is a revolutionary weapons system, which will substantially increase lethality and survivability of US soldiers on the battlefield[1]. It may replace the current family of M16/M4 weapons and the M203 weapons grenade launcher, to include the night vision devices and laser rangefinders (Modular Weapons System or MWS) currently in use, with a single, integrated system with enhanced operational capability and increased effectiveness. The OICW will offer enhanced probability of hit and kill at ranges out to 500 meters over current weapons systems[2]. Additionally, it will possess a revolutionary defilade target attack capability with a maximum range of 1000 meters and an effective range of 500 meters. The OICW is modular in design; it can be employed as a dual munitions weapons system, or as either a separate high explosive (HE) launcher, or a stand-alone carbine. Key components of the OICW will be a distinct family of HE bursting munitions and a target acquisition/fire control system (TA/FCS).

The fire control system (FCS) is the "brains" behind the weapon system. It includes an accurate laser range finder, a ballistic computer, direct view optics, a video camera, an electronic compass, a thermal module and an automatic target tracker (Appendix A). Target acquisition and engagement will be significantly enhanced through the use of this highly sophisticated, fully automatic ballistic solution fire control system, with day/night and automatic range capabilities. The "brawn" of the system, comes in the form of two separate munitions, conventional kinetic energy (KE) bullets and bursting type high explosive (HE) rounds. Capable of firing either the 20mm HE ammunition or the standard NATO 5.56mm KE ammunition, the OICW integrates ballistics computation in the fire control system (FCS). The modular FCS will range to the target (with day or night optics) and automatically communicate the range to the ammunition fuzing system. Using advanced turn-count fuze arming technology, the ammunition proceeds to the target and bursts precisely overhead.

The OICW lethality goals are to meet and/or exceed current KE capabilities, and to precisely deliver point detonating or airburst HE rounds in rural, mounted operations in urban terrain (MOUT) or desert conditions that are 5 times more lethal than, and at distances greater than twice the range of, the M203 grenade launcher[3]. A dramatic increase in soldier survivability is achieved by the increased standoff range capability (up to 1000 meters), and the ability to engage enemy soldiers in defilade or otherwise "covered" (i.e. behind rocks, trees, etc., or in buildings, on roofs, etc.) positions inaccessible by current KE direct fire weapons systems capabilities.

In January 1999, Major General Carl Ernst, then Commandant of the U.S. Army Infantry Training Center at Ft. Benning, Georgia, stated that the OICW was *"the first revolutionary capability provided to the infantry soldier since the musket".* Though the enhanced capabilities of the OICW are indeed revolutionary, so too are the training challenges which accompany this new weapons system. Perhaps the biggest challenge facing the OICW is the cost of training (Appendix D). These cost (and range/space) factors are further complicated by the time requirements involved in training this unique weapon system. The focus therefore, must not be limited to simply establishing the best means for achieving training proficiency, but on the long term goal of determining the best means for *sustaining* and *maintaining* that desired level of proficiency.

As with any sophisticated system, more cognitive skills are required (in addition to the motor skills of the conventional KE system). Likewise, when learning a more sophisticated system (requiring these increased cognitive skills), comes a higher degree of *perishability*, the decay or memory loss associated with these learned skills if not properly exercised. Whatever system or systems are developed to train, maintain and sustain proficiency on the OICW, they must include the capability to train with a frequency designed to mitigate this perishability of cognitive skills.

Whether the final design will yield a weapon which offers fully embedded training functionality or consists of a series “part-task” trainers, which together provide the capability to conduct both individual and collective training tasks, is yet to be determined. Whatever the final outcome, one thing is certain: interactive simulation is the key to addressing these unique, complex training issues/challenges.

CURRENT MARKSMANSHIP TRAINING DESIGN AND TECHNOLOGIES

The use of modeling and simulation as it pertains to marksmanship research is nothing new. The Army Research Institute (ARI) began a systematic examination of basic, advanced and unit marksmanship training programs in 1977 in order to address growing concerns that training procedures at the time were not producing quality marksmen for the United States Army[4]. A series of improved marksmanship and training programs were developed in the 1980s under the joint sponsorship of the United States Army Infantry School (USAIS) and the United States Army Forces Command (FORSCOM)[5]. Though these training support programs, products, and techniques did produce improvements in performance, they generally only provided “hit or miss” information about targets engaged. ARI researchers increasingly began to focus on the more detailed aspects of effective marksmanship, as well as how to provide precise and timely performance feedback to soldiers in rifle marksmanship training. It was in addressing these inherent difficulties that the idea of simulation training devices and how they might provide better performance feedback to marksmen came about. Though many simulation devices have been developed in the last 20 years to this end, I will briefly discuss three of those that are particularly effective and used widely today.

The Multipurpose Arcade Combat Simulator (MACS) was developed by ARI in the early 1980s. It is an interactive simulation system consisting of a commercially available microcomputer, a pair of external disk drives, a video monitor, light pen and software developed by ARI. The light pen, fitted with a converging lens system is mounted on a dummy M-16. Triggered by an electronic switch attached to the actual trigger mechanism, the pen is focused to read the raster scan on a video monitor at distances of 4 to 20 feet[6]. MACS configured in this manner provides such features as automatic zeroing, a variety of scaled targets and backgrounds, an exercise to teach the effects of wind and gravity, auditory and visual feedback on the location of the hits and misses, and programs to diagnose errors in marksmanship fundamentals[7]. It has numerous instructional features embedded within the software, allowing instructors to determine the appropriate starting point for each individual soldier. Specific performance standards were established for each of nine distinct training levels, such that soldiers do not automatically progress to more difficult tasks without first demonstrating proficiency of the more basic skills[8]. MACS is considered a part-task trainer because it does not simulate the noise and recoil associated with firing live ammunition. It is relatively inexpensive, primarily due to it's off-the-shelf hardware, and has been particularly well suited for preparatory marksmanship and dry-fire applications where levels of performance are typically low[9].

The Engagement Skills Trainer (EST), which can accommodate up to 12 soldiers at one time, is able to provide both individual and limited squad level collective training. It uses a combination of both analog and digital video, synchronized image projection, laser hit detection and microcomputer technology to display a variety of target arrays on an 8 foot high by 30 foot wide screen[10]. It is considered a full task trainer as it is able to simulate both recoil and sound effects. Use of EST has demonstrated it can support limited squads level defensive training if the squad remains stationary. Of particular significance is the study conducted to examine the relationship between EST and annual rifle qualification scores. When EST and qualification scores were measured, a close relationship was determined to exist between these measures; this analogy allows fairly accurate predictions to be made, pertaining to expected qualification performance[11].

The Laser Marksmanship Training System (LMTS), developed primarily to provide rifle marksmanship to Army Reserve units at their home stations, allows soldiers to train using their assigned unit rifles[12]. The LMTS consists of a laser transmitter, the mandrel to which the laser is attached, laser sensitive targets and a laptop computer. Each laser transmitter has two distinct modes of operation. In one mode, vibrations from the rifle's firing mechanism activate the transmitter when "dry" firing. A laser sensitive target then provides shot location feedback[13]. In another mode, the transmitter emits a continuous beam, allowing precise aiming feedback on a reflective version of the 25 meter zeroing target. The LMTS uses the M-16 BLAZER sound/recoil replicator device, which allegedly provides for 100% of the recoil and 50% of the sound affects. ARI has also determined that the LMTS has been very successful in conducting preparatory marksmanship training in the Basic Rifle Marksmanship (BRM) program at Fort Benning[14].

MACS probably has the best overall instructional design features and does not require the presence of an instructor. EST provides training on the widest range of marksmanship tasks. LMTS offers excellent preparatory marksmanship training on a relatively large scale[15]. In short, the systems currently used in marksmanship training generally do an exceptional job in providing the interactive simulation environment necessary to train the tasks they were designed to perform.

With the fielding of the OICW however, and the corresponding development of future infantry doctrine and tactics, techniques and procedures (TTPs), marksmanship and small unit training within infantry units will be radically altered forever. With its increased capabilities, previous performance techniques and objectives will no longer provide a valid measure of weapons system or operator training performance. It is expected that many of the KE characteristics of the OICW will remain more or less the same as those of systems presently in use. There are currently however, no TTPs, let alone corresponding training performance criteria on which to train those TTPs, to address the "revolutionary" aspects of the HE portion of this weapon system.

CURRENT MARKSMANSHIP TRAINING ISSUES & TECHNOLOGY LIMITATIONS

Typically, the small arms training technology used today addresses the two-dimensional (2D) aspects required to obtain appropriate feedback information pertaining to KE rifle marksmanship. In most cases this involves the projection of high-resolution photo imagery onto a screen or monitor. Though what is depicted is of the highest fidelity (as only real photos currently provide) and offers a vast array of possible scenes or scenarios (limited only by the number of photos taken/desired), it is still simply a 2D picture projected onto a 2D screen. The light source or laser device mounted to the weapon or weapon mock-up, when fired, sends out a beam that bisects this 2D screen. The software is then able to read the point of impact and subsequently provide the kinds of information and desired feedback discussed above. But what happens when you no longer must actually strike the target in a direct fire mode? What must occur when you have the capability to achieve affects merely by detonating munitions near or over the desired target? How do you measure these "effects" on the target? With the current 2D technology used widely in training today, the answer is nothing; it cannot be done. Though numerous weapons simulations systems exist, none of them adequately address the high fidelity needs or provide the technology required to accurately replicate the unique indirect fire characteristics of the OICW weapon system.

NEW AND EMERGING TECHNOLOGIES

The Naval Air Warfare Center Training Systems Division (NAWCTSD), working with the Army Armament Research Development and Engineering Center (ARDEC) and the Army Research Laboratory (ARL) has been looking into this problem. Their efforts have yielded a highly successful, interactive, Small Arms Simulator Test-bed (SAST). Developed primarily for research and development purposes as a re-configurable engineering tool for the small arms community which uses modeling and simulation techniques to support the design, modifications, and testing of new weapon concepts[16], the SAST clearly has future application in the training realm as well.

The SAST is a virtual interactive system with the "user" performing within a simulated environment (Appendix C). The user is provided with a high-fidelity physical model representing the weapon and scenario; he engages simulated live fire targets depicted on a virtual test range (scenario). The scenario is presented to the user via a large screen, high resolution/high contrast (1280 x 1024), Barco LCD visual projection system at a distance of approximately 10-18 feet[17]. The display field-of-view and apparent scene resolution are adjusted to match the testing and training requirements. The screen is calibrated or mapped to the tracking/detection device, which provides a 30 degree field of view (optimized for accuracy)[18]. The weapon mock-up replicates the actual OICW in weight, center of gravity, ergonomics, functionality and performance. It includes a real FCS device, 3 X scope, trigger mechanism, lasing devices, etc.; in effect, it is a "de-milled" OICW weapon[19]. Computer hardware devices primarily consist of off-the-shelf components. The most significant difference between the SAST and previous marksmanship simulations devices however, is in its use of 3D graphics to depict scenarios/targets.

SAST uses an open architecture Windows NT platform with OpenGL compliant 3D graphics scene manager software[20]. Graphics processing is handled by an SGI multi-processor Windows NT workstation. This design not only allows the conduct of present KE marksmanship TTPs, but adds the here-to-fore "missing" dimension. Each "object" in the scenario is literally "built" from a series of polygons (complexity & composition determined by the level of fidelity desired) and has a specific 3D structure and hierarchy.

Since each object is depicted in 3D vice 2D, so too can the unique affects of the OICW weapons system be depicted. The "indirect" HE rounds no longer must actually "hit" the intended target (bisect a point on the 2D screen); they are able now to burst over, in close proximity to, in front of, or beyond the prospective target. As each object in the scenario has its own 3D structure (as opposed to merely being a picture projected onto a screen), when munitions detonate, the particles “collide” with various portions of the polygons making up the objects within the scenario. “Effects” on the intended target, in addition to all the other information collected, can then be determined based on this data. Other kinds of real world added value, such as occlusion, are possible, since the round can now impact in the vicinity of or in close proximity to, the physical object depicted on the screen.

The SAST provides both rural and urban virtual scenarios, rapidly created using Multigen’s 3D graphics modeling software. These scenarios, based on standard Open Flight format, are developed and loaded into the SAST, allowing them to be easily reconfigured to depict whatever scenario/training event is desired[21]. They are created using an embedded runtime scenario planning tool that allows the user to rapidly develop training scenarios for numerous targets including dismounted soldiers, E-silhouettes, and vehicles[22]. This software also allows objects to be placed anywhere within a user defined database. Once placed, objects can be scripted to follow specific paths and actions. This capability to rapidly create specific training scenarios meets the unique and dynamic requirements of complex real world environments in which today’s soldiers must fight and win.

It should be noted however, that though the SAST certainly shows vast potential, it is not the answer to the problem. It is primarily a research and development tool, developed to test and evaluate the potential of new technological advances and their impact on the small arms environment. SAST is an engineering tool and is not adequate in its current configuration to support the voluminous and demanding, complex requirements and specifications as set forth in the OICW Operational Requirements Document (ORD) and/or System Training Plan (STRAP). Additionally, though SAST represents an attempt to satisfy this unique problem via true 3D depiction, there is also much research ongoing into yet other areas involving high fidelity 2D photo images mapped onto 3D objects (sometimes referred to as 2 ½ D technology).

IDENTIFICATION OF OPERATIONAL TRAINING NEEDS/REQUIREMENTS

Due to the nature of the OICW, new and revised training requirements are vast, running the complete spectrum from basic weapon familiarization and proficiency to complicated collective training using the Tactical Engagement Simulation System (TESS). TESS represents a whole different dimension to training than that falling under the general purview of interactive small arms and/or marksmanship simulation training; it is an extremely complex portion of any “indirect” weapons system and has traditionally presented problems for these types of weapon systems. Since the OICW weapon system is a dual system, and is the first infantry weapon to possess a highly sophisticated “indirect” fire or “airburst” capability, we will not try to solve the complex technical problems of TESS as they pertain to indirect fire, by incorporating those types of technical requirements in this paper.

The focus of this research paper, in terms of identifying the operational needs and/or requirements for training, is therefore on the unique, interactive, simulation training requirements of the OICW, specifically as they pertain to the development of individual and limited collective training skills, and the sustainment of those proficiency skills. One TESS is however, mentioned in both the OICW ORD and the STRAP. As such, it is clear that the intent is that any prospective OICW engagement skills trainer should have the capability to interface, have functionality or in some fashion, incorporate some level of compatibility with, One TESS devices.

The interactive simulation training "system" should provide institutional and tactical units with a multipurpose, multiple lane, small arms (with expansion potential for crew served weapons such as the Objective Crew Served Weapon (OCSW)) training simulation and/or simulator system. The OICW simulation system will be used to train and evaluate individual marksmanship training for initial-entry soldiers and for unit sustainment training in preparation for individual and crew small arms live-fire weapons qualification; it must effectively replicate weapon training events which lead to live-fire individual/crew weapon qualification[23].

A secondary purpose of the OICW training simulation system is to provide unit collective gunnery and tactical training for static (and eventually dynamic) dismounted Infantry teams, squads and platoons. The simulation system must effectively replicate team and squad collective gunnery and tactical tasks for offensive and defensive missions, and provide the medium for training leaders of fire teams and squads in command, control, and distribution of fires via realistic collective scenarios[24].

It is important to note that the interactive training simulation system being developed is not designed to replace live fire training. Rather, it is a training device which will allow soldiers to develop a high level of proficiency with the weapon system *prior* to the expenditure of live rounds.

OPERATIONAL/SYSTEM TRAINING REQUIREMENTS TRADE-OFF ISSUES

There are several key operational and system training requirements trade-off issues peculiar to the OICW that pose challenges to the interactive simulation development process. These problems obviously present opportunities for industry with the production of cost effective, innovative solutions to these unique challenges. Among the key issues are the following (Appendix B):

a. Current Technology versus OICW Capability: As indicated previously, the technology used today primarily addresses the 2D aspects required to obtain appropriate feedback information pertaining to KE rifle marksmanship. Though high-resolution photo imagery projected onto a screen or monitor generally does provide high fidelity and offers a vast array of possible scenes or scenarios, it is still just a 2D picture projected onto a 2D screen. And though these systems currently used in marksmanship training generally do an exceptional job in providing the interactive simulation environment necessary to train the tasks they were designed to perform, they fall well short of the requirements and specifications demanded by the OICW weapon system. Though the KE portion of the weapon system arguably functions in a similar fashion as previous weapons systems, the HE portion represents a dramatic departure from what has been the norm. The HE portion of the OICW no longer requires the shooter to actually strike the target in a direct fire mode. He must merely get the HE munitions close enough to the desired target such that the bursting radius of the round has *effects* on the target. These effects may be the suppression, neutralization, incapacitation or destruction of the particular target. Though numerous weapons simulations systems currently exist, none of them adequately address the high fidelity needs or provide the technology required to accurately replicate this unique characteristic (s) of the OICW weapon system.

b. Collective “all system” interactive simulation training: Though the OICW certainly poses new technological challenges to industry, the proposed weapons simulations system (s) must be used with “legacy” or existing small arms training systems as well. The rationale is simple: with the current projected distribution of two (2) OICW weapon systems per fire team, other members of the team, squad and/or platoon will still carry legacy weapons; in order for the team, squad, or platoon to train collectively, the interactive simulation training support system must support all of these legacy systems. Training capabilities therefore, should include but not be limited to the following[25]:

(1) Simulate weapon training events which culminate in live-fire individual/crew weapon qualification.

(2) Simulate training events currently not resourced under STRAC that contribute to increased weapon, crew, fire team, and squad combat effectiveness, namely, quick fire, engagement of moving targets, firing in pairs, etc.

(3) Simulate squad collective gunnery and tactical tasks for offensive and defensive missions.

(4) Provide the medium for training leaders of fire teams and squads in command, control, and distribution of fires while in a realistic collective mode.

(5) Save current required ammunition resources, OPTEMPO travel time and cost to and from ranges, other range support resources, while simultaneously providing meaningful, effective training to dismounted soldiers.

(6) Support the functional gunnery training strategies outlined in Chapter 3, Combined Arms Training Strategy (CATS) TRADOC Regulation 350-35, and DA Pamphlet 350-38, Standards in Weapons Training.

(7) Provide realistic target presentations in varying environments, that is, desert, forest, and military operations in urban terrain (MOUT).

(8) Because the interactive simulation training device will be used not only for the OICW weapon system, but during the interim period covering the transition (or as discussed above, perhaps indefinitely), it should also be capable of simulating the same physical, functional, and operational characteristics (to include I/O induced malfunctions), and the casualty-producing effects of the following service weapons:

(a) M16A1/M16A2, 5.56mm Rifle,
(b) M4, 5.56mm Carbine,
(c) M9, 9mm Pistol,
(d) M249, 5.56mm Machine Gun, in the Automatic Rifle Role,
(e) M249, 5.56mm Machine Gun, in the Light Machine Gun Role,
(f) M60, 7.62mm Machine Gun,
(g) M240B, 7.62mm, Machine Gun,
(h) M2, Heavy Barrel Caliber .50 Machine Gun,
(i) MK19 MOD3, 40mm Grenade Machine Gun,
(j) M203, 40mm Grenade Launcher,
(k) M136, Launcher and Cartridge, 84mm, HEAT,
(l) M1200, Winchester Shotgun, 12 gauge.

RESEARCH QUESTIONS

The development of a comprehensive training simulation system capable of adequately addressing the OICW operational training needs and/or requirements is indeed complex. Assuming this onerous task is achievable, we are faced with the equally difficult issue of developing the simulation training system in the most cost effective manner possible. As the review of available literature has shown, much work is yet to be done in the development of 3D technology as it pertains to marksmanship and/or small arms training. With this in mind, the research questions which arise as a natural consequence in this process are: 1) Is it possible to develop an interactive simulation training device and/or system that is capable of addressing these complex issues of marksmanship/small arms training, as well as the plethora of other tasks making up individual, collective and new equipment training team (NETT) engagement skills training? 2) Can this interactive simulation training device and/or system be developed in a cost effective manner such that widespread appropriation and distribution is possible? 3) Will the interactive simulation training device and/or system accurately replicate, in terms of physical representation, ergonomics and functionality, the characteristics of the actual OICW weapon system? The intent of this research effort is to address these issues.

RESEARCH AREA

RESEARCH PROBLEM

As has been pointed out previously, the development of an interactive training simulation system simultaneously with that of the actual weapon system itself, is a novel approach for the Army. Though the rationale for such an undertaking is certainly sound, there are inherent difficulties associated with this approach. The actual OICW weapons system is currently in the design phase of its life cycle. The vender responsible for the development of the OICW weapon system has not in fact, as yet, even developed a weapon capable of meeting all of the requirements set forth in the OICW ORD and/or the STRAP. As such, there is an absence of certain essential data and facts available with which to develop the OICW *training* system and/or simulator (s). On-going modifications are being made to the weapons system in an effort to improve shortfalls identified in performance, functionality and/or ergonomics, as well as to correct any deficiencies identified during the numerous experimental and operational tests and evaluations. Ancillary though equally significant areas, such as maintenance and the various linkage mechanisms required to support and/or interact with the other aspects of training simulations within the Synthetic Theater of War (STOW), have yet to be clearly identified and/or developed. Dealing with these specific “missing links” of key data will be discussed in more detail in later portions of this of this paper, but in terms of research, the impact is equally significant.

In short summation, the research problem may be articulated in the following manner. You have a truly revolutionary weapons system being developed with capabilities and requirements heretofore, unheard of. We have touched upon a few of the technological development challenges facing industry with respect to accurately replicating these new and unique capabilities. But equally onerous, is the task of researching this issue from a training support perspective. Perhaps best described as a “moving target”, it will be very difficult indeed to develop as thoroughly as is possible, and in consonance with the actual weapon itself, an interactive training simulation system to support it. Just as the weapons system itself and the corresponding training simulation system will evolve, so too must the research tool evolve over time. The development of such an interactive simulation training system must meet and/or exceed all requirements set forth in the ORD and STRAP; it must also maintain a degree of flexibility in order to be able to react to the inevitable changes and modifications that will be made throughout the development cycle of the actual weapons system itself. The research methodology therefore, must be equally flexible.

THE LONGITUDINAL FIELD RESEARCH DESIGN/METHODOLOGY

The development of an interactive simulation training system which will accurately replicate the actual OICW weapon system, falls into the very unique category described above. The changing, evolving nature of this weapon system requires an equally unique and flexible approach to research. The research approach I used therefore, was the *longitudinal* case study, as described in the book by George P. Huber and Andrew H. Van De Ven, *Longitudinal Field Research Methods, Studying Processes of Organizational Change*. The longitudinal case study approach provides the framework necessary to investigate this empirical topic via a set of pre-specified procedures, as noted above. It incorporates the required flexibility by its longitudinal nature; that is, it consists of a series of surveys to be administered over a period of time[26]. This longitudinal case study is comprised of an initial, comprehensive market survey, followed by subsequent surveys. These subsequent surveys will provide the venue for addressing the same issues over time, as well as the changes caused by alterations and/or modifications to the actual weapon system, particularly as they pertain to the interactive simulation training system, *as they occur*.

This approach allows us to focus not only on relevant technology, data and information currently available, but also allows us to study new and emerging technology, data and information as it become available in the future. From these innovations and/or changes, we can make assessments on the evolving nature of the OICW weapons system and ensure corresponding changes are made to the interactive simulations training system which will support it. There are two absolutely critical aspects of this research approach, however.

The first key issue is two-fold. The initial and subsequent market survey questions must be carefully and meticulously developed. As stated, the OICW weapon system has new and unique capabilities; the training simulation also must embody not only new, unique approaches to training, but technology and approaches that are heretofore, *untested*. The survey questions therefore, must address all of these critical requirements by asking the *right* questions. These interrogatives must be formulated in such a manner that the answers to these questions clearly describe how the respondent will satisfy the required specifications of a simulation training device that will yield the highly favorable results prescribed in the ORD and the STRAP.

A careful analysis of the responses to the survey questions is the second, equally critical portion of this first issue. Due to the extremely complex nature of the desired interactive simulation training system, both from a new technology and/or developmental perspective (*what* is the system/technology to be used, what are capabilities/limitations of the proposed interactive simulation system, and how well does it replicate the actual OICW weapon system?) as well as the operational approach, (*how* does the respondent intend to use this available technology to effectively conduct individual, collective and NETT training?), the survey responses must be carefully analyzed.

The second critical feature of this longitudinal case study pertains to the evolutionary nature of both the OICW weapons system and in turn, the interactive simulation training system being co-designed to replicate it. It is clear that the weapon is in a constant state of change. Key attributes such as the size of the munitions (currently undecided: 20 Vs 40 mm), the weight of the weapon (currently too heavy to meet ORD specifications) and the desired configuration and/or functionality of the fire control system (several modifications currently on-going) to name a few, are still being updated and modified. It is imperative that the researcher maintain currency in the design modifications of the weapons system. Changes, large and small, must be incorporated into the survey cycle. Carefully crafted to explain the modifications and elicit industry responses to those modifications, these subsequent surveys in this longitudinal approach are the key to ensuring the interactive simulation training system ultimately developed does not deviate from the actual weapon system it is being designed to support.

THE INITIAL OICW TRAINING SYSTEM MARKET SURVEY

The initial OICW training system Market Survey was developed to support a course requirement I had while at the University of Central Florida last year. The OICW interactive simulations training system survey questions were reviewed by experts both within and outside of the United States Army Simulation, Training and Instrumentation Command (STRICOM), as is recommended in *The Survey Handbook*.[27]

As stated, the development of the weapon training system simultaneously and in consonance with the development of the weapon itself, brings with it, new and unique challenges. The OICW ORD has indeed been written with system requirements, specifications, etc., but many of the actual weapon system performance parameters have yet to be determined. As these measures become more clearly defined, subsequent surveys will be required to address these changes. This initial survey offers a unique opportunity for industry to possibly influence the OICW ORD and system specifications. The intent was for all industry representatives participating in this survey therefore, complete it as thoroughly as possible, ensuring cost effective yet innovative state-of-the-art solutions are provided in response to the unique capabilities of this revolutionary weapon system.

INITIAL MARKET SURVEY ASSUMPTIONS

Since the actual OICW weapons system is currently in the design phase of its life cycle, there is an absence of certain data and facts available with which to develop the OICW training system/simulator (s). The assumptions listed below allow the training system development and planning to progress. These assumptions will remain constant during training system development until such time as data/facts are supplied to confirm or nullify their validity.

a. The exclusive use of the OICW weapons system, initially, will be the Infantry Career Management Field Soldiers (CMF) 11B MOS, serving in squad or infantry platoons with appropriate infantry combat missions.

b. The design of the training simulation system will target the typical level of education level/quality within the Infantry CMF 11B soldier. In the Infantry CMF 11B today, ninety percent of the soldiers are high school graduates; enlisted troops have an average Armed Services Vocational Aptitude Battery (ASVAB) score of sixty two percent (62 %).

c. The implementation of the OICW weapons system will receive no increase in the training support structure within units or institutions from current levels. That is to say, no substantial additional time will be allocated in the current programs of instruction/unit training schedules to train on the OICW. Any additional training requirements will be added in a zero-sum fashion (any additional time needed to train on OICW will be created by the deletion of other tactics, techniques and procedures currently being trained).

d. A cost effective, state-of-the-art interactive simulation device (s) can be developed to support prospective OICW trainees. The design of the training system must address the unique training challenges and/or requirements posed by the OICW system, must provide improvement over legacy training models in both individual and collective training techniques, and must include the capability for expansion in order to keep up with emerging technology. Additionally, these training devices must be applicable both to New Equipment Training Teams for initial familiarization/proficiency training to existing units, as well as those units themselves, which must have the future capability for continued proficiency training.

e. The overall training scheme may require some basic level of live fire training and/or proficiency (such as proficiency on the M16/M4 family of weapons developed during Advanced Rifle Marksmanship (ARM)).

f. The training scheme developed for OICW will be part of other Army weapons platforms and hardware systems.

g. Detailed maintenance procedures for the actual OICW weapon system have yet to be determined. There is not enough information currently available therefore to adequately address this portion of simulation oriented maintenance training. Though major areas of interest such as bore-sighting and weapon maintenance are indeed of critical importance in the development of any prospective training system, these issues cannot be adequately addressed until such information is available.

SUMMARY OF OICW SIMULATION TRAINING TASKS

The majority of tasks found in the Market Survey were extrapolated from such documents as the ORD and the STRAP. It is important to note, that any prospective OICW engagement skills trainer should have the capability to interface, have functionality, or (in some manner or fashion) incorporate some level of compatibility with the following devices:

(1) Land Warrior (LW)
(2) Tactical Engagement Simulation Systems (TESS)
(3) Close Combat Tactical Trainer (CCTT)

Interface and data requirements issues are identified in the documents referenced above. By ensuring that any prospective OICW engagement skills trainer has some level of compatibility with requisite interface specifications and data requirements (pertaining to those systems listed above) now, the need for any significant future specification and/or data modification will be greatly minimized.

INITIAL MARKET SURVEY STRUCTURE

The initial Market Survey (MS) had three sections:

a. MS 1: Company and General System Overview. This portion of the survey was used to provide basic data on respondent company, company point of contact, current business status, relevant experience, etc.

b. MS 2 – System Design Overview. This portion of the survey was used to indicate which compliant system elements, subsystems, or components respondent company might provide for OICW.

c. MS 3 – Material Systems Data (Appendix F). This portion of the survey was used to provide detailed technical information, such as absolute or relative data on system configuration, simulation of weapon capabilities etc. Items judged to be notably innovative or cost-effective solutions to the key operational and system requirement trade-off issues, or other critical trade-off issues were to be highlighted and explained here. Wherever possible, data comparisons with respect to respondent company prospective OICW offering should have been made with one or more of the following references: (1) the OICW ORD, (2) the OICW STRAP, (3) the Baseline Specifications, or (4) a relevant operational system you choose to identify and use as a point of comparison. Respondents were guided by the fact that the Army is seeking specific information from prospective suppliers with innovative and cost-effective solutions, particularly materiel alternatives that address the challenging trade-off issues identified in this paper, or other critical trade-off issues industry wished to identify and explain in this part of the response.

INITIAL OICW TRAINING SYSTEM MARKET SURVEY RESULTS

The initial Market Survey, after comprehensive review, was sent out to industry representatives. Respondents were allowed approximately 60 days to complete the survey. The results of this initial survey were mixed and, for the most part, inconclusive.

Much of the information provided by *Reality by Design* and *FATS, Inc*., in regard to their perspective systems was incomplete; as such, I could not provide a complete assessment of their capability to accommodate OICW requirements. Neither *FATS* nor *Reality by Design* responded to requests for further information about their systems and possible approaches to address or satisfy the technological challenges put forth in the OICW requirements and/or specifications documents. Likewise, though *BeamHit* did address 2D training capability, they made no attempt at all to address the third dimension component necessary for OICW HE round. *ECC International* was the only company that provided a rather extensive description of their current weapon as well as fairly detailed discussion of how they plan to incorporate possible OICW requirements into their proposed OICW system. Again, these were significant omissions and led to inconclusive results; the results of the initial Market Survey are contained in the report found in Appendix F.

Though the questions were detailed and specific, the responses in many cases, where not. Much of the data received was incomplete. Some respondents opted to address only their company's capability to satisfy *current* industry requirements and made little or no attempt to discuss future technological advances that might satisfy the new and revolutionary specifications demanded by OICW. Still others mentioned that they did in fact have this new technology, but referenced brochures for specific details that were never made available to actual data collectors.

Very few of the respondents answered the questions to the level of detail required to draw adequate conclusions. In short, my initial attempt to identify industrial capability and related technology to provide state-of-the-art solutions to support personnel training on the revolutionary OICW weapons simulations training system and its munitions has met with less than successful results.

INITIAL OICW TRAINING SYSTEM MARKET SURVEY LESSONS LEARNED

Though the initial Market Survey responses fell short of anticipated survey goals and objectives, it was not without some significant benefits. These benefits include a number of "lessons learned" which will likely lead to increased success as this longitudinal case study, with its independent surveys, progresses. Three of the major lessons learned are briefly discussed below.

The first key lesson learned was the scope of the Market Survey. I have stated on several occasions that the initial Market Survey was extremely meticulous. The fact of the matter is, it was perhaps *too detailed*. The OICW ORD and the STRAP do list many specifications and requirements. The Market Survey, though *initially* developed to address primarily the technological implications and issues of the HE versus the KE aspects of the weapon system (since this is the most significant issue from a new technology perspective), ultimately covered *all* aspects of the OICW. Reviewed by many individuals, with each iteration, more items, questions, and areas were included in the survey until the issue of HE versus KE was lost in a sea of questions, literally buried in a voluminous matrix spanning almost 20 pages.

A second, equally important lesson learned had to do with the industry representatives themselves, or more specifically, the industries selected to participate in the Market Survey. Since this was the initial Market Survey for this prospective new weapon system, and since OICW characteristics and capabilities cross the boundaries of previous weapons and weapons trainer manufacturer requirements (as has been previously stated), the survey had to go out to a broad spectrum of "prospective" industry representatives. I understood up front that a few of these companies possessed either the capability or the desire to address many aspects of these issues.

A third critical problem, which predated the actual survey, was the obvious omission of any type of task analysis. A comprehensive task analysis is absolutely critical in the development of an effective market survey. Though the ORD and the STRAP do provide the essential information pertaining to requirements and capabilities, without this detailed, comprehensive task analysis, it was impossible to develop a focused questionnaire, with clearly defined tasks.

Each of these critical lessons learned affect and facilitate the development of the next segment of the longitudinal case study. The “follow-up” survey has a much more narrowly defined scope, one which is focused on the technological capability to address the characteristics, requirements and specifications of the HE portion of the OICW weapon system. It is aimed specifically at those industry representatives that specialize in this type of trainer and training systems. It uses as its base document, the critical OICW task identification and description to support the OICW training simulation requirements analysis. And finally, the follow-up survey cuts out all the “intermediary” problems described above. Again, the initial Market Survey certainly served a purpose; it formed the basis from which the next segment of the longitudinal case study was developed.

RESEARCH METHODOLOGY

THE OICW TRAINING SYSTEM QUALITATIVE RESEARCH INTERVIEW

The next step in this longitudinal case study process was the development and administration of a survey interview. The interview then becomes a critical tool for obtaining information and collecting and refining data pertaining to the technological developments and industrial capability available to provide a training simulation system for the OICW weapon system. The ultimate goal of the survey interview was to produce some type of quantifiable measure by which to evaluate this commercial capability that can be statistically analyzed in order to generate reliable observations. Arguably, this is best done using standardized questionnaires[28].

The type of survey interview selected in this case was the Qualitative Research Interview (QRI). These types of interviews, sometimes called “depth interviews”, “motive interviews”, and/or “focused interviews” are used extensively in today’s market research to predict and control consumer behavior[29]. The intent of this type of interview is to disclose both the factual information as well as the meaning behind the information provided.

Interviewees had to describe and identify as precisely as possible, what technology is available and how their respective organizations will use state-of-the-art technological solutions to support personnel training on the OICW weapon training systems. As stated, the QRI was based largely on material developed in the initial Market Survey. Necessary modifications were incorporated in order to address each of the lessons learned identified in the sections above.

For the reasons explained above, the QRI was a structured interview using a standardized questionnaire (Appendix G). The questions, derived from the initial Market Survey and the subsequent *OICW Task Identification and Description to Support the OICW Training Simulation Requirements Analysis* (TI/D), describe specific aspects of the OICW HE characteristics and requirements. It was a face-to-face interview using this predetermined, meticulously developed, though concisely written questionnaire. The intent was not to obtain general opinions and/or responses; but rather, to these specific characteristics and requirements, interviewees had to provide equally specific responses[30].

Of the list of those respondents queried in the initial Market Survey, only three were interviewed during the QRI. These commercial industry representatives were: *Reality By Design, Inc*., *Verizon* and *ECC International Corporation*. These organizations were selected both because they provided the most comprehensive answers to questions posed in the initial Market Survey, and because they were based locally in the Orlando, the area I was able to adequately cover while home on leave. A fourth organization was also interviewed; this organization is the government agency that pioneered the Small Arms Tactical Trainer (SAST), mentioned earlier in this paper, the Naval Air Warfare Center Training Systems Division (NAWCTSD). In many respects NAWCTSD has already demonstrated, albeit in a test-bed, analytical environment, that the technology exists to develop a simulation training system capable of replicating the unique and revolutionary characteristics of the OICW weapon system.

The QRI questionnaire format, though based on the critical information developed in the initial Market Survey, was greatly reduced in breadth and scope. The questions contained therein, as mentioned above, focused specifically on those requirements and capabilities that are unique to the OICW weapon system, namely those pertaining to the HE aspects of the system. Since the KE portion of the weapon function essentially the same as legacy small arms weapon systems, the assumption was made that existing or newly developed technology will allow us to continue to successfully replicate these functions as well.

TASK IDENTIFICATION SUPPORTING SIMULATION REQUIREMENTS ANALYSIS

As stated previously, the development and use of a comprehensive task analysis upon which to focus the interview, is absolutely critical. It not only provides the insight from which operational tasks are derived, but also serves as the foundation for which technology can be focused in developing the interactive simulation systems necessary to train on this new weapon system. This detailed analysis, which was completed by Madison Research Corporation (MRC) and the Institute for Simulation & Training (IST), the University of Central Florida, after the initial Market Survey, was used extensively in the development of the QRI.

The intent of the OICW TI/D is to provide sufficient information about the specific actions that the OICW gunner must complete in preparation for and during combat in order to use this weapon effectively against the types of targets and within the engagement scenarios anticipated for combat[31]. The TI/D also focuses on identifying performance conditions that must be simulated during the training process. The task and performance condition information support comparisons among various simulation based training aids, devices, and systems (TADS) identified by this QRI. The TI/D also presents and discusses the process for the OICW Concept Formulation; the methodology for the TI/D process is described and the TI/D results are presented. This includes a description of how the OICW is operated and a listing and discussion of the tasks for weapon operation and maintenance and training[32].

DATA ANALYSIS

BACKGROUND FOR DATA COLLECTION

As previously stated, the focus of this research paper is the identification of a comprehensive training simulation design/system capable of adequately addressing the operational needs and/or requirements for training the unique, interactive, simulation training requirements of the OICW. Emphasis was placed on these requirements specifically as they pertain to the development of individual and limited collective training skills, as well as the sustainment of those proficiency skills. The research questions, which were designed to address these multifaceted issues, are: 1) Is it possible to develop an interactive simulation training device and/or system that is capable of addressing these complex issues of marksmanship/small arms training, as well as the plethora of other tasks making up individual, collective and new equipment training team (NETT) engagement skills training? 2) Can this interactive simulation training device and/or system be developed in a cost effective manner such that widespread appropriation and distribution is possible? 3) Will the interactive simulation training device and/or system accurately replicate, in terms of physical representation, ergonomics and functionality, the characteristics of the actual OICW weapon system? The intent of this research effort was to address these issues.

FOCUS FOR DATA COLLECTION

Three organizations participated in this QRI. There were two commercial industry representatives*, Reality By Design, Inc*., and *ECC International Corporation*. *Verizon*, which did not participate in the initial Market Survey, failed to respond to calls and subsequent emails. Though initially disappointed at the loss of a third prospective commercial entity, this disappointment quickly abated once the results from the first two respondents were obtained. The research questions posed in this paper were addressed quite satisfactorily with the two commercial responses provided. The third organization queried was the Naval Air Warfare Center Training Systems Division (NAWCTSD), the government agency that pioneered the Small Arms Tactical Trainer (SAST).

Each organization was first contacted telephonically. The primary purpose of this initial, telephonic conversation was threefold. First, the interviewer was introduced to establish credibility, both as a student in pursuance of data for a research project, as well as an active duty Army officer in the rank of Lieutenant Colonel. Secondly, it was explained that the research involved a real Department of Defense initiative; the essence of OICW and the interactive simulation training device/system which was to be developed in consonance with this weapon system. Additionally, the purpose of this specific interview process was the identification of possible technological solutions, *within the parameters of their subject matter expertise*, to the OICW problem. It is perhaps relevant to note that both commercial industry representatives were motivated not only to meet for the prescribed purposes of this interview, but to ensure accuracy was captured/annotated regarding their organization's capability to accomplish what could possibly evolve into a defense related contract to develop an OICW interactive simulation training device/system. Hence the possibility of potential benefits to respective respondents only increased the degree of participation as well as the accuracy of material provided.

The third purpose of the telephonic liaison was to outline the "plan of attack". There would be a face-to-face interview with each representative using as a framework, a short but comprehensive list of questions pertaining to OICW simulation/technology requirements. To assist them in answering the questions contained therein, and to ensure each question received the appropriate amount of organizational research, each organization representative (immediately following this initial telephonic contact) would receive an *advance letter* read-ahead packet. The purpose of the advance letter is to reduce the element of surprise and increase the time that a potential respondent has to think about participating in the interview[33]. This advance letter read-ahead packet consisted of the formal questions to be discussed during the actual QRI, the first three sections of this research effort, and all relevant appendices pertaining to the background, requirements, specifications, etc., which might have bearing on the development of an OICW interactive simulation training system.

QUALITATIVE RESEARCH INTERVIEW QUESTIONNAIRE OVERVIEW

The actual QRI questionnaire responses are found in Appendix G. The matrix at the end of this Appendix summarizes and compares key elements of critical data. An overview of respondent data augmenting the matrix is provided below.

The Naval Air Warfare Center Training Systems Division: The first organization interviewed in this QRI process was NAWCTSD. NAWCTSD was scheduled first by design, since it is the organization which successfully developed and pioneered what might be deemed the research and development prototype for the interactive training simulation device for the OICW weapons system. This prototype is none other than the Small Arms Simulator Test-bed (SAST), discussed in detail in the first portion of this paper.

The key benefit to initiating the QRI with NAWCTSD personnel was not so much to reveal new technologies developed since the initial research was conducted, but more importantly to ascertain the technology available to industry, and how industry can utilize current technology to extend the research and engineering capabilities available in the SAST; how industry can extend these technological capabilities into the realm of the training world. In this respect, NAWCTSD with the tremendous successes experienced with the SAST to date, provides the litmus test and point of departure for prospective industrial competitors in this technological arena. NAWCTSD personnel provided invaluable insight and feedback into the development of the final QRI questions as well as the actual "phrasing" of those questions in such a manner so as to elicit desired responses from industry.

ECC International (ECC) **EST 2000**: *ECC* reported that the **EST 2000** system uses 3D graphics technology for both target models and terrain databases. This technology provides support for the latest generation of nVidia rendering hardware on personal computers (PCs). It features animated soldiers and civilians (both armed and unarmed, both rural and urban) using high level scripting. It also has weather (snow, fog, hail, smoke, rain, and sleet) features as well as time of day effects and support for night vision goggle training. It is capable of depicting animated ground vehicles (civilian and military), rotary wing and fixed wing aircraft (transport and attack), as well as such special effects as explosions, smoke plumes, bullet splash, flares, muzzle flash, fire, etc. It uses photo-realistic terrain and provides high resolution rendering at high rates allows clear identification of objects at a distance according to "Johnson's Criteria."

The **EST 2000** system is an indoor trainer that displays targets, terrain, and weapon effects in real-time in a 3-dimensional computer-based presentation. It uses US Army validated ballistics related to the weapons/ammunition simulated by the system. This data currently includes both HE and KE rounds. The ballistics data and fly-out model provides for accurate trajectories, flight times, wind effects, tracers, hit probabilities, and dispersion. The ballistics model is table driven and therefore addition of new ammo type is relatively straightforward. The current ammunition simulation calls only for symmetrical 3D ground bursting shapes, however, the inclusion of alternate terminal effects can be accommodated.

The **EST 2000** system will show explosions, smoke, flames and target damage models for vehicle and bunker targets. Vehicle targets have three levels of incapacitation (mobility kill, firepower kill, and catastrophic kill). Incapacitation is based on the damage assessment model which assigns damage based on the protective armor, damage potential of the round, and hit probability based on range from the detonation point. It is a Pre-planned Product Improvement (P3I) to include non-lethal hits on the soldier model which will add wounded behaviors.

The high-resolution (1600 x 900) display of the **EST 2000** system allows for effective use of direct view optics with magnification powers of up to 7x.   For higher magnifications and thermal imagery, the use of injected video is required. The use of the AN/PAS-13 sight is a preplanned product improvement. Additionally, the **Javelin BST** uses injected video to simulate the various powers of direct view optics and the thermal imagery sight.

The TA/FCS module/mock-up will have support for BIT and embedded diagnostics as well as closed loop tests stimulated from the **EST 2000** diagnostic mode of operation. This approach will provide effective system status and fault isolation.

The **EST 2000** has been designed to be a classroom environment training system. There is a preplanned product improvement however, for a deployable system. Additionally, DIS/HLA interoperability is also currently a preplanned product improvement.

The **EST 2000** system includes marksmanship and collective modes of training. In the marksmanship mode, individual trainees can attain and sustain skills to acquire and engage static, pop-up and moving targets. In the collective mode squad level teams can perform in combat engagement simulations.

All of the weapons on the **EST 2000** system replicate the weight and balance of the actual weapon to within 95%. The ergonomic feel of the weapon is maintained through the use of actual hardware (handles, switches, etc.). The **EST 2000** system has incorporated weapon mock-ups that have been embedded, clamp-on or fully simulated. The final design of the OICW and the requirements of the simulation will dictate the method employed based on weapon availability, safety and required level of fidelity. Trainees are able to hear their weapons as well as the "OPFOR" weapons and vehicles while experiencing actual weapon weight and recoil.

The Instructor on an **EST 2000** system can vary the environmental conditions of any exercise. The effects supported include time of day, fog, smoke, rain, sleet, hail and snow. The system currently employs light intensifying optics (AN/PVS-4, AN/TVS-5, etc.) for use in night scenarios. The use of thermal imaging sights (AN/PAS-13) is a preplanned product improvement. Each **EST 2000** subsystem contains 5 training lanes. Multiple subsystems can be networked together to provide a higher number of training lanes under the control of one instructor. In the marksmanship training mode up to 3 subsystems can be networked together to provide 15 lanes of training. In the collective training mode two subsystems can be networked together to provide 10 lanes of training supporting up to 12 weapons (some trainees are allowed multiple weapons, i.e. and M16 rifle and an AT4 rocket). The video based *Shoot-Don't Shoot* mode is available on one subsystem only supporting 5 training lanes. Instructor controlled training features individual marksmanship training, collective training and judgmental training and is supported by After Action review support and scenario editing. A fifteen-lane system with average weapon mix is approximately $300,000. *ECC* reports one separate instructor is required for system operation.

Reality by Design (RBD) **SVS2**ä Immersive: *RBD* produces the **SVS2**ä Immersive simulation system as a commercial-off-the-shelf (COTS) computer-based training solution for individual and collective small arms weapons. This system portrays an immersive 3D virtual world where trainees can navigate and interact with each other and participate realistic scenarios. *RBD* currently uses the nVidia GeForce3 graphics board, which supports high resolutions at real-time frame rates. *RBD* currently uses a COTS LCD projector; however, states that any projector (including high-resolution CRT) could be used. The visual subsystem for **SVS2**ä is based on the OpenGL standard.

All weapons currently supported by **SVS2**ä Immersive are direct fire (KE) weapons. *RBD* is currently under contract to STRICOM to provide an M203 capability which will provide an indirect engagement alternative. Ballistic models can either be physically based or table driven with the EST firing tables.

RBD states that currently, representation of "effects" as described in the QRI have not yet implemented in the **SVS2**ä, but can easily be integrated in its software's modular and extendable architecture. The explosions of the OICW HE round can be physically modeled, and collision detection can be made with the surrounding object to determine target effects. The **SVS2**ä Immersive does include accurate simulation of the red battle sight (it is distributed, meaning the trainee can see other participants red dots in his simulator, and others can see his as well), laser range finder, ballistic computer, video camera, compass, GPS, Thermal, and Night Vision Goggles.

OICW fuze characteristics, namely “high explosive air bursting” (HEAB), “point detonating” (PD), “point detonating delay” (PDD) and “window mode” detonating munitions are not yet implemented in the **SVS2**ä , nor does the simulated Fire Control System currently replicate the magnification settings of the actual OICW. However *RBD* states that these attributes can easily be integrated into its software’s modular and extendable architecture.

With respect to training, *RBD* is currently developing the virtual simulation system for the Land Warrior (LW) system under the (SBIR) contract with STRICOM. **SVS2**ä Immersive currently supports and provides an embedded training solution for the Land Warrior 0.6 system. *RBD* continues to work with STRICOM in providing support for LW 1.0.

RBD states that it is the first company to receive HLA certification from DMSO in December 1997. **SVS2**ä Immersive is compliant with the DIS protocols, the DMSO (and other) RTI, and the HLA RPR-FOM. **SVS2**ä Immersive is built using the **SimStorm**ä software architecture and toolkit. This software supports a flexible FOM interface, allowing it to support multiple and diverse FOMs.

RBD is developing the front-end user interface for the CCTT Dismounted Infantry Manned Module (DIMM) under contract to Lockheed Martin Information Systems and STRICOM. The CCTT DIMM has adopted, and *RBD* is supplying, the **SVS2**ä Immersive front-end user interface and surrogate weapon system. Via DIS or HLA, **SVS2**ä Immersive can interoperate in combined-arms simulations with a variety of simulation systems.

SVS2ä Immersive can be configured to support any number of training scenarios. The CGF and scenario development tools allow the user to define, setup and execute tactically correct and diverse scenarios. **SVS2**ä Immersive supports a variety of synthetic environment standards for terrain and moving model databases including OpenFlight and SEDRIS. While the standard **SVS2**ä Immersive is intended to be used as an individual trainer, *RBD* can provide a version of **SVS2**ä that can provide multiple screens supporting 4 (or more) firing positions and that can be networked to support collective training scenarios.

SVS2ä Immersive currently provides an m4 surrogate weapon to the user. this weapon can be configured (in software) to fire a variety of rounds including 5.56mm, 7.62mm and an

AT8 round. *RBD* is currently enhancing **SVS2**ä Immersive (under the ACRT contract to STRICOM) to support surrogate M16, M203, M4, M240, M249, combat shotgun and M9 pistol weapons and to correctly simulate (in software) the appropriate ballistic rounds for the weapons partially using the Engagement Skills Trainer (EST) firing tables. All of these weapons provide a night vision capability by rendering the 3D scene appropriately (not by using a surrogate viewing device such as a scope). All of these weapons are in effect, real weapons that have been modified to be used in the simulator; they are manufactured in the *RBD* facility in Melbourne, Florida. The surrogate weapons have the feel, weight, and look of the real weapons. **SVS2**ä weapons can be supplied with full recoil as an option. **SVS2**ä Immersive also simulates the Land Warrior "look around corner" capability with simulated video presented to a surrogate helmet-mounted display (i.e. LW IHAS)

The **SVS2**ä Immersive has full environmental capabilities, meaning that it support time of day (visual changes depending of time of day), rain, snow, clouds, fog (with multiple density parameters), smoke (with multiple color parameters), and wind direction (will change direction of smoke).

The **SVS2**ä Immersive has the capability to engage stationary (such as lights and windows) and moving targets (such as enemy personnel and tanks). The IC has an area of 10x10 feet where he can move; therefore he can engage any target from any position in this area (moving or stationary).

In its Immersive version, the **SVS2**ä needs an instructor or operator to be present during system startup and shut down, though he is not required to be present during the training exercise. One instructor/operator can control multiple **SVS2**ä systems during one working session. The computer/instructor station allows the operator to control any/all other **SVS2**ä Immersive (and desktop) simulators that are connected to the same computer network. The controller can pause, resume, reset, and teleport any individual simulator. The system costs range from $80,000 to $100,000. On-site installation, support and training is sold on an hourly basis.

CONCLUSIONS

SUMMARY

This QRI identified industrial capability and related technology to provide state-of-the-art solutions to support personnel training on the revolutionary weapons system known as the Objective Individual Combat Weapon (OICW) and its ancillary munitions. The rationale and training requirements of the OICW referenced by the QRI are identified from a training perspective; because of the technological challenges created by the OICW weapon system, marksmanship and small unit training within infantry units may be forever radically altered. With the increased capabilities of OICW, previous performance techniques and objectives will very likely no longer provide a valid measure of weapon system and operator training performance.

Though the KE portion of the weapon system arguably functions in a similar fashion as previous weapons systems, the HE portion represents a dramatic departure from what has been the norm. The HE portion of the OICW no longer requires the gunner to actually strike the target in a direct fire mode. Instead, the gunner must get the HE round close enough to the desired target such that the bursting radius of the round has “effects” on the target, even if the target is concealed or otherwise not visible via direct line of sight to the gunner. These effects may be the suppression, neutralization, incapacitation or destruction of the particular target. This QRI attempts to illuminate the current state of industrial capability and technology available to accurately replicate the unique characteristics of the OICW weapon system.

CONCLUSIONS BASED ON THE QUALITATIVE RESEARCH INTERVIEW

The findings of the research conducted provide the answers to the research questions posed in the first portion of this paper: 1) It *is* possible to develop an interactive simulation training device and/or system that is capable of addressing the complex issues of marksmanship/small arms training, as well as the plethora of other tasks making up individual, collective and new equipment training team (NETT) engagement skills training, 2) this interactive simulation training device and/or system *can* be developed in a cost effective manner such that widespread appropriation and distribution is possible, and 3) the interactive simulation training device and/or system *can* accurately replicate, in terms of physical representation, ergonomics and functionality, the characteristics of the actual OICW weapon system. These findings are based on data and information provided primarily by two highly competent, competitive representatives of commercial industry specializing in this area; findings were derived via face-to-face interviews, written responses/narratives outlining both current and future technological capabilities, and actual hands-on demonstrations using interactive simulation training prototypes.

Both commercial industry representatives responded to the QRI with great enthusiasm, providing conclusive, comprehensive information/data in each of the critical areas described therein. Both respondents indicated clear, concise and comprehensive solutions to developing an effective interactive simulation training system/device for the OICW weapon system. Both clearly established that they could, using state-of-the-art technology, build an interactive training simulation system/device that accurately replicates the OICW as prescribed by the requirements set forth in this research paper. The two most significant elements, the use of 3D technology and the demonstration of casualty effects were adequately addressed, albeit by different means.

ECC addressed this area by using the process of photo realistic terrain. High resolution rendering at high rates allows clear identification of objects at a distance and optimizes the view from the perspective of the stationary shooter. The advantage to this method is a vivid, real-world portrayal of terrain and prospective targets. The disadvantage is the fact that it is based primarily on a stationary shooter. If however, the trainer wishes to move around *within* the 3D database, say, to behind the object/target under study, he will only see what is referred to in the industry as a “billboard”. More specifically, there is no backside to the object being looked at. Though this could be a significant “downside” to this approach, the respondent emphatically stated that with evolving technology in the area graphics and processing power, coupled with actual contractual requirements (accompanied by the requisite funding) this deficiency could be easily overcome.

RBD uses an “immersive” technology that allows the trainee to actually move behind or all around the object(s) in question. This allows the trainee/trainer much more latitude and flexibility in moving “through the data base” for teaching/training purposes. This capability is very important in understanding how and why things occur in a 3D world. The disadvantage in this method is the degree of realism able to be portrayed; objects appear more “cartoonish”, less realistic. Whereas *ECC* graphics reflect a higher resolution, closer to real-life picture, *RBD* images are less so. *RBD* was equally emphatic in stressing how easily this apparent deficiency could be overcome, given technological advances and, of course, adequate funding.

The tradeoffs indicated above however represent *current* limitations of technology and how different commercial industry representatives have chosen to address these limitations, based on their understanding of what the requirements are. Both respondents indicated that technology is improving at an extremely fast pace and that they are flexible enough to provide the degree of resolution *as well as* the degree of immersion prescribed by whatever the actual requirements demand, within these technology limitations.

TECHNOLOGY INSIGHTS

In short, industry, using current state-of-the-art technology, appears to be quite capable of addressing the unique aspects of the OICW weapon system via an interactive simulation training device/system. There are however, two areas that merit perhaps a bit more scrutiny.

One of these is in the realm of “lasing the target”; the other deals with the topic of accurate replication of the “effects” on the intended target. Each of these areas is critical to the success of the any prospective OICW trainer. They are inextricably linked, and both require more research.

With regard to lasing, we must first identify or clarify real world lasing problems before discussing the simulation of these capabilities. As previously stated, with the OICW weapon system, it is not necessary to actually hit the target. The idea is to get the HE round close enough to the target such that it is within the busting radius of the munitions fired, thus enabling it to then have the desired effect on that target. Herein lies the potential problem.

If the intended target is in a defilade position, such as in a ditch or trench, the target itself *cannot be lased*. The shooter must identify *something* to reflect the laser that is very close to the target, such that the round fired will burst within the radius of the munitions expended. This object being lased must not only be close enough to the actual target such that it is within the bursting radius of the munitions fired, it must also provide a lasing surface or plane capable of providing adequate feedback to the fire control system. This real world problem is one of many of the “moving targets” discussed in earlier chapters of this research paper. It is a significant, real weapon system issue being addressed in consonance with the development of the interactive simulation training system. Nevertheless, whatever simulation system is used in the training device, it must be able to accurately replicate this lasing characteristic.

Neither *ECC* nor *RBD* currently utilize a laser capability in the small arms systems being developed to support the OICW prototype. It is, however a preplanned product improvement to integrate *ECC's* stand-alone **Javelin Basic Skills Trainer** into the **EST 2000** system. This is significant because the **Javelin BST** does provide a sophisticated fire control system that is comparable functionally to the OICW TA/FCS, including both a day and IR optics simulation. This system, which includes BIT and embedded diagnostics, integrates a laser range finder, ballistic computer, direct view optics, video camera, compass, thermal module and an automated target tracker. These features are preplanned product improvements for the **EST 2000** system presently under contract. The technology therefore, does currently exist that will address the laser optics issue.

The second, and perhaps more difficult key area requiring more research, is the area of “effects”. Both commercial industry representatives interviewed in this QRI discussed and demonstrated the replication of effects in some fashion (generally as they applied to vehicles; personnel targets, though the *capability* does exist, have yet to be modeled). In each case however, effects were determined using *probability based models*. These models assess various levels of incapacitation based on a type of damage assessment model; that is, damage is assigned based on 1) the degree of protection afforded the prospective target (armor, etc), 2) damage potential of the round fired and 3) the hit probability based on the distance between the target and actual munitions detonation. Though probability based/damage assessment models have been adequate to date for current weapons systems, it is perhaps time for the development and use of technology/a model which more accurately portrays effects of bursting munitions.

One such solution to this problem is a *physics based, collision detection model*. This type of model is based on the cutting edge, 3D technology capability discussed previously. It is predicated on a true 3D database where each object within that database is constructed via polygons (or some other equally flexible venue); this allows much more precision than the probability models currently used.

Using the physics based, collision detection model, theoretically, portions of the bursting munitions are able to collide with the individual polygons that make up the prospective target. Much more accuracy is provided when assessing effects on an intended target. This is a major improvement over current technology, with equally vast training potential.

In a given scenario, if it is possible to portray exploding fragments of bursting munitions, then it would also be possible to determine what part of the prospective target, say the arm, leg or torso, etc., might be affected by the fragments of the bursting munitions. The obvious benefit to this improved accuracy is enhanced realism. An enemy (or friendly) soldier is able to receive a leg or head wound, for example, providing more realistic “injury”, instead of a calculated degree of generic incapacitation provided by the probabilistic model.

Not only is the realism increased and enhanced, but so too is the training potential. The ability of the intended target to react (continue to fight, become immobilized and/or neutralized, etc.) and the subsequent actions required of the shooter can be more accurately portrayed in a constantly developing, fluid scenario, not unlike one the shooter might encounter in real life. This ability also opens the door for more realistic simulation situations involving friendly casualties (in terms of the development and treatment of the severity of wounds, medical evacuation requirements, medical processing, etc.) and the required actions that must be taken based on those casualties.

FUTURE RESEARCH

The research identified multiple re-use opportunity of technology from other weapons systems for use on the OICW. For example, the research identified the potential for reuse on the OICW training system of technology currently applied to M203 and the Javelin. Additionally, future weapon systems may benefit from the commonality in technology identified through this research. With greater emphasis on precision weapons for the future, the use of lasers may become even more prominent. One weapon system that comes to mind is the recently develop MK 19 Mod 3 with its laser ranging system. The MK 19 is a widely fielded weapon. If Mod 3 is implemented on all systems, the transfer of this technology to a future weapon training system would bear significant savings. The potential for this application can be determined through future expansion of this longitudinal case study.

The *Art of War* has always been influenced and, to an extent, limited by, the *Science of War*. This statement is clearly demonstrated today in these two critical features discussed above. The training discussion of replicating weapons lasing capability and improving the means by which we replicate and demonstrate “effects”, or more precisely, achieving a more accurate means of depicting these effects, are critical milestones to be addressed in the next phases of this longitudinal case study. Current technology, though it does allow us to depict probabilistic, damage assessment models, falls short of the goals desired and perhaps required, by new weapons systems such as the OICW.

This more realistic portrayal of reality via interactive simulation is the future challenge of technology and commercial industry. Maintaining currency of this and other future issues is the responsibility of those who might proceed with the next phase of this longitudinal case study.

Word Count = 12,681

APPENDIX A: OICW SPECIFICATIONS & COMPONENTS

Key Program (Target) Capabilities:

- 500 percent increase in probability of incapacitation
- New soldier capability to defeat targets in defilade
- Effective range to 1,000 meters
- Day/night fire control; wireless weapon interface
- Substantial weight reduction
- Ergonomic design

System Features

- Lethality Capability: 20MM High Explosive (Air Bursting) projectiles and 5.56MM Kinetic Energy projectiles
- Weapon Length: < 33 in
- Weapon Weight: < 12 lbs
- Rates of Fire: 20MM - 10 RPM, 5.56MM - equal to M16A2
- Range: 20MM - 1,000 meters, 5.56MM equal to or better than M16A2.
- Combination 5.56mm and 20mm HE
- Single trigger control for both barrels
- Ambidextrous weapon and switches
- Simple red dot day/night sighting system
- Laser adjustment for targets in buildings and in defilade
- Unique recoil mitigation and tactical operational awareness

Technology Advancements

- Weapon recoil mitigation
- Fuzing miniaturization and accuracy
- Warhead performance and packaging
- Target acquisition and man in the loop
- Laser ranging accuracy at extended ranges
- Extensive composite use

*Information provided via the Military Analysis Network, http:/www.fas.org/man/dod-101/sys/land/oicw.htm

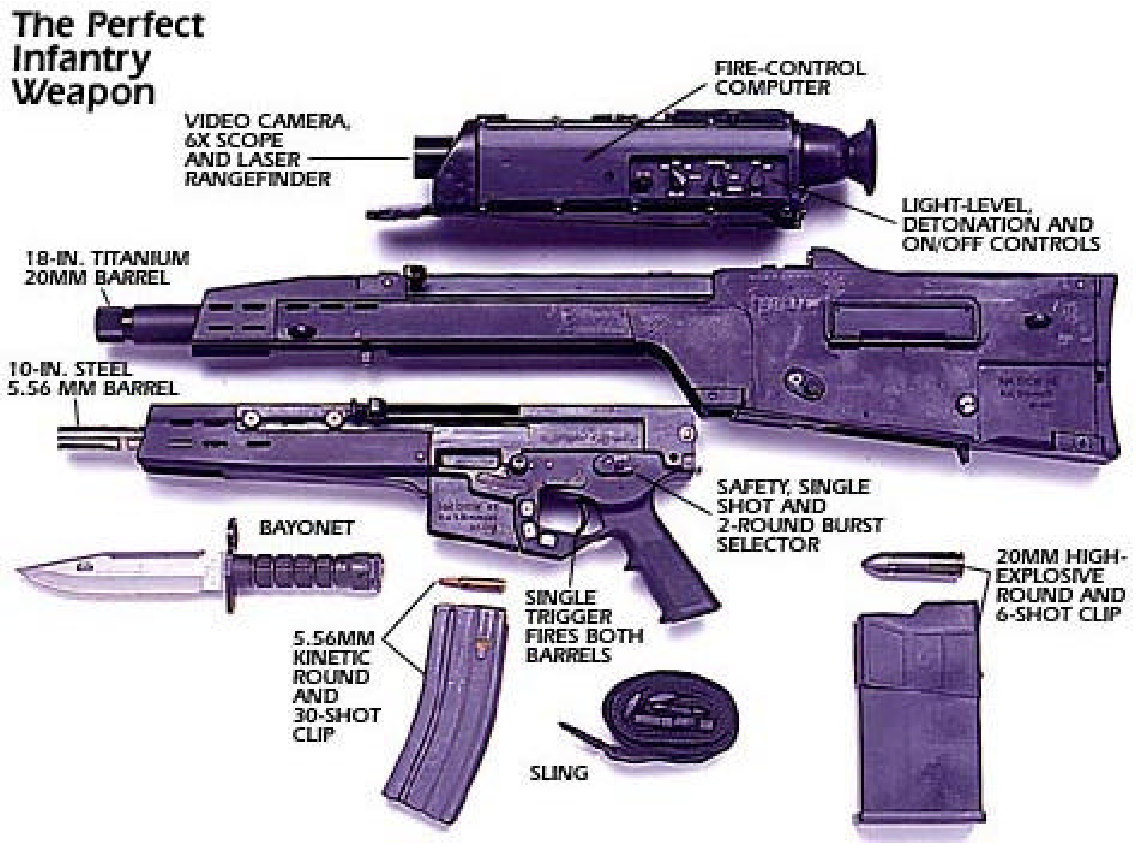

FIGURE 1. THE OBJECTIVE INDIVIDUAL COMBAT WEAPON

APPENDIX B: OICW TRAINING SPECIFICATIONS/REQUIREMENTS COMPONENTS

Training specifications will provide training capability that meets OICW performance, proficiency and affordability objectives. These specifications serve as the base-line for the training simulator requirements and training program documents. The specifications include, but are not limited to, individual training, collective training, embedded training, and simulation and/or simulators of OICW training. In addition to the training simulation/simulator requirements, the OICW system must replicate the capabilities of the actual weapon listed below.

Specifications/Requirements:

1. Accurately resemble the OICW in weight, feel and functionality:
   - Will be modular in design, able to be deployed as a dual munitions weapon system or as either a separate 20mm high explosive (HE) dispenser or a stand alone 5.56mm carbine.
   - Will have a target acquisition/fire control system (TA/FCS), which includes an accurate laser rangefinder, ballistic computer, direct view optics, video camera, compass, thermal module and an automated target tracker.
   - Will be capable of representing both kinetic energy (KE) bullets and bursting type HE rounds.
   - Will be able to engage and suppress targets out to a maximum range of 1000 meters and have an effective range of 500 meters, in virtually any scenario.
   - Will have day/night engagement capability.
   - Will have limited visibility engagement capability (i.e. fog, haze, smoke)
   - The TA/FCS will have a built in test (BIT) and embedded diagnostics to provide system status and fault isolation.

2. Embedded Training Features will include:
   - The TA/FCS will incorporate Embedded Training (ET) technology.
   - ET capability shall function at a level of reliability that will support accomplishment of training objectives/agenda when employed in any training environment (individual/collective virtual training sessions, classroom, field training exercises, live fire range training events, etc.)
   - Software interface must be Distributive Interactive Simulation/High Level Architecture (DIS/HLA) interoperable.
   - These embedded capabilities must include and/or support live fire practice munitions as well as provide links with live & virtual simulation.
   - Embedded features must be interoperable with existing synthetic training simulations (i.e. the Close Combat Tactical Trainer (CCTT) and the Engagement Skills Simulator (EST)).
   - ET capability may be appended to the weapon system for training, or integrated by a wireless system or umbilical interface into the live fire and synthetic battlefield.
   - The ET system objective will be to attain (train) and sustain individual (and collective groups) in system operations and combat engagement simulations.

3. In addition to individual training, the training program must:
   - Be supportive of new equipment training (NET) for initial fielding of the system.
   - Be supportive of institutional Training (in the various schools for Basic/Advance Individual Training (BIT/AIT).
   - Be supportive of unit level (collective) training.

4. Training Program shall include programs (software):
   - For user assistance and live and virtual simulation capability plus integral connections for interoperability with collective training simulators and training simulations.
   - Replicating misfire cues, target acquisition and engagement procedures, and collective combat skill engagement simulations.

5. Training Program shall include the capability to conduct force-on-force training. The TA/FCS, in the ET non-firing mode shall be adaptable for force-on-force training.

6. Training Program shall incorporate symbology and icons common with all land warrior systems (dismounted, mounted, air).

7. Training Program shall include the capability to engage stationary and moving targets from a stationary position.

8. System will be sufficiently durable to withstand military use in any scenario without degrading the performance of the weapon.

* (Note: Information obtained through various sources, most notably the OICW Operational Requirements Document (ORD) and the System Training Plan (STRAP)

APPENDIX C: ADDITIONAL SMALL ARMS SIMULATOR TESTBED (SAST) CHARACTERISTICS

Weapon Aim Point Tracking/Validation – To maximize the lethality of a new weapons system such as OICW, the gunner must be able to accurately deliver the projectile onto or in close proximity to, the intended target. In the SAST, this measure of performance is accomplished with the capability to continuously tracking the gunner's aim point during any given training scenario. The SAST weapon aim point tracking system utilizes NAWCTSD's patented high-speed infrared spot tracker, which has been validated to live fire data for both M16 (flat trajectory) and the M203 (parabolic trajectory).

Ergonomics/Weapons Recoil – In the development of any new weapons trainer, ergonomics is of critical importance. The weapon simulator must have the "feel" and perform like the real weapon. To accurately replicate the weapon recoil, NAWCTSD has developed an electromechanical variable recoil system in which the trainee is able to experience both the shock and duration of simulated recoil forces.

After Action Review – A key component of the SAST is the After Action Review (AAR) capability which allows the user to visually observe all scenario information. Target paths and actions, as well as weapon aiming data, are continuously collected before, during, and after trigger pull for each target presentation. During the AAR, the trainee is visually shown his continuous aim point, laser range finder designation aim point, adjusted aim point, and finally the ballistic path and impact position of the projectile relative to the virtual range and active target. The AAR feature, not possible during live fire exercises, has proven to be extremely valuable during recent testing and training exercises at NAWCTSD, ARDEC, and ARL.

Information provided by Ron Wolff, a senior research engineer with the Naval Air Warfare Center Training Systems Division, Orlando, Florida, in various papers, briefings and a series of personal interviews. Mr. Wolff has worked extensively in the area of small arms weapons simulation for the last 15 years. He holds a Master of Science degree in Electrical Engineering from the University of Central Florida.

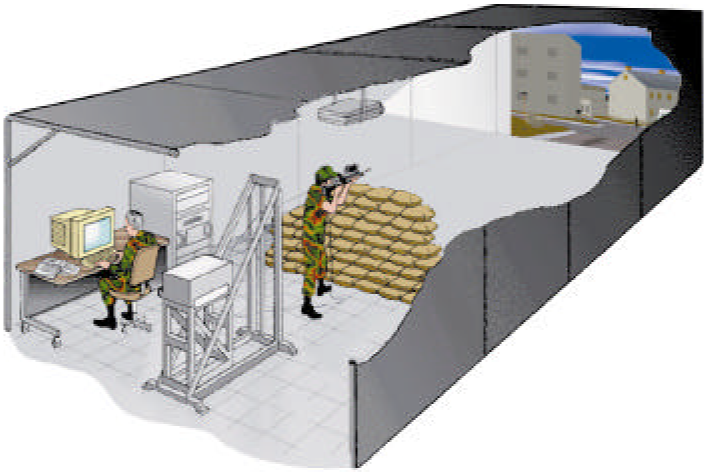

FIGURE 2. SAST II

FIGURE 3. SAST II

(From Ron Wolff's' Bringing Together Live Fire Testing and Training Real World Applications of a Reconfigurable, High Fidelity Small Arms Simulator Testbed)

APPENDIX D: OICW TRAINING AMMUNITION AND OTHER COST FACTORS

Perhaps the biggest challenge facing the OICW is the cost of training. The OICW will be used by all active and reserve component soldiers with the designation of career management field (CMF) 11C MOS, who are "assigned to infantry squads and platoons in execution of infantry unit missions". Currently, by the Table of Organization and Equipment (TO & E), there are approximately 17,500 soldiers with the 11C MOS who fall into this category.

The requirements for training these soldiers are clearly laid out in such documents/manuals as the U.S. Army System Training Plan (STRAP), the Basic Rifle Marksmanship (BRM) techniques and procedures manual and the Operational Requirements Document, among others. In accordance with these references, in order to train U.S. soldiers to an adequate level of proficiency, there are three major training requirements.

- Modified small arms ranges (range, type of targets, target postures, etc)
- Specified number of 20 mm HE rounds fired per soldier, per year
- Tactical Engagement System (TES) to support force on force

Of these three basic training requirements *as they pertain to the OICW*, the first two are unaffordable, and the third does not yet exist. Current ranges, which were developed for conventional kinetic energy weapons systems, will no longer satisfy the needs of this weapons system with its "revolutionary" capabilities, and by extension, the unique training requirements which accompany them. A systematic overhaul of all small arms ranges to satisfy these new requirements would prove not only prohibitively high, but would take years to complete. Even if these costs were deemed affordable, the time required to construct a whole series of new ranges (to say nothing of the additional range/space requirements needed—old style ranges would still be needed to support all non 11C soldiers) would be unacceptable. By the same token, a quick analysis of the costs associated with the just HE portion of the weapons system, clearly shows how quickly traditional live fire training techniques becomes cost prohibitive.

As stated, though the KE module of this system will fire conventional 5.56 mm bullets, the HE portion will require the development of an entirely new family of munitions. These munitions will be costly to produce and even more costly to be used in the individual, collective and new equipment proficiency and sustainment training requirements needed to field the system. By comparison, the standard 5.56 bullet costs about $1.75 each; these requirements for the OICW KE portion will not change substantially, but will remain as a constant training cost with the new system. The 20 mm HE munitions however, costs about $30 per round.

The table below, provided by the Directorate of Combat Developments (DCD) at Ft. Benning, Georgia, demonstrates the requirements needed to ensure proficiency in tasks for one soldier, once a year (NOTE: qualification and familiarization are generally conducted semiannually or twice/year):

1. 4 Sights (TV, Direct Mode, Thermal Iron)
2. Threat (enemy) to overcome: 4 times

a. Point exposed, 450-500m (day/night) (offense/defense)	4/8	20/40
b. Defilade targets, 500 m (day/night) (offense/defense)	4/8	
c. Area Exposed, stationary dismounted squad, 1000m (day/night) (offense/defense)	8/16	
d. Vehicles		
i. Unarmored, 500m (day/night) (offense/defense)	2/4	
ii. Lightly Armored, 800m (day/night) (offense/defense)	3/6	
e. Helicopters, 1000m (day/night) (offense/defense)	1/2	
		160

3. Positions of Fire
   - a. Standing
   - b. Crouching
   - c. Kneeling
   - d. Prone
   - e. Sitting
   - f. Foxhole

This does not include NBC/Practice/Live-fire or squad live-fire exercises

6 times

960

4. The math (20mm HE only): 960 rounds/year X $30/HE round = $28,800

17,500 soldiers X $28,800 = $504,000,000

Figure 4. OICW Approximated Training Cost Factors

These cost (and range/space) factors are further complicated by the time requirements involved in training this unique weapon system. The focus must be not be limited to simply establishing the best means for achieving training proficiency, but on determining the best means for *sustaining* and *maintaining* that desired level of proficiency. As with any sophisticated system, more cognitive skills are required (in addition to the motor skills of the conventional KE system). Likewise, when learning a more sophisticated system (requiring these increased cognitive skills), comes a higher degree of *perishability*, or memory loss associated with these skills. Whatever system or systems are developed to train, maintain and sustain proficiency on the OICW, they must include the capability to train with a frequency designed to mitigate this perishability of cognitive skills.

Though cost and training may indeed be the primary drivers behind the development of a feasible, reliable and accurate simulation/training plan, there are other considerations as well. Environmental awareness has increased in recent years, forcing the reduction of available areas (and even the hours of operation in some cases) on which to conduct live fire exercises. And perhaps the most significant area of concern is that of safety. Combat weapons, by design, are inherently dangerous. The level of danger is directly proportional to the level of soldier proficiency on the particular weapons system.

There is no doubt--the best way to train is to train live. This however, is not feasible or practical due to the substantial time and cost constraints involved in live fire training. Though live fire will continue to be a part of the individual soldier training, it must be augmented by a less expensive, more effective, safer means of training. Interactive simulations, with a properly devised instructional training program, is the key to addressing these unique, complex issues/challenges.

The interactive simulator/simulation will become the primary means of achieving weapons system familiarization and proficiency. The demonstration of a high level of proficiency will became the “gate” or prerequisite to graduating to the live fire exercise. The live-fire event will be the capstone event to a long series of training events developed to familiarize and build high levels of weapon proficiency.

(Note: In addition to (and partially because of) these budgetary constraints and training requirements, the Chief of Staff of the Army (CSA), has mandated that all new weapons systems being researched, tested and evaluated for use by the United States Army, must be fielded with their own organic simulation training systems. The OICW system will include embedded fire control training features and will be fielded with the capability to conduct both individual and collective training tasks.)

APPENDIX E: TASK IDENTIFICATION SUPPORTING SIMULATION REQUIREMENTS ANALYSIS

Under normal circumstances, task identification and description (TI/D) is completed as the first step in the concept formulation process. As previously discussed, this did not occur for OICW training simulation technology, devices, and/or systems prior to the development of the Market Survey. TI/D takes in to account the procedural, discrete and continuous tasks associated with system usage which must be identified and described; operator behaviors within these tasks must be delineated to specify the decisions, as well as the cognitive and motor responses required in controlling, monitoring, and operating the weapon system[34]. Once this comprehensive set of required tasks and associated subtasks have been identified, analysis can be completed to identify the particular tasks that are required of the simulation training devices and systems as part of a program of instruction for the equipment or system to be trained.

The TI/D goal was to complete this logical step for the OICW. Found in the TI/D is a comprehensive listing and description of most, if not all tasks that might be completed by the OICW gunner either prior to or during combat either as an individual or as a member of a small combat unit[35]. The TI/D accomplishes this goal, examining and documenting use of the OICW in both its KE and HE modes of operation from the perspective of the individual OICW operator; the principle objective was to identify as many tasks and subtasks as possible down to the level of specific switch and display related human actions[36]. For the purpose of this paper, we will focus on the HE mode of operation. Due to the nature of the OICW, however, we must first briefly touch upon some of the KE characteristics that are unique to this weapon system.

OICW Kinetic Energy (Direct) Mode of Operations:

In the case of typical small arms weaponry, “iron sights” are used for weapon/target alignment; the operator must manually estimate target range use these iron sites to aim the weapon at the target. The OICW however, has a fire control system (FCS) to accomplish this target aiming and ranging process. The FCS allows the operator to aim the weapon by providing a 300 meter battlesight “red dot” aimpoint, which is placed on the target “center-of-mass”. The FCS ranging capability is not operative in the KE mode so the OICW gunner must still make accurate range estimates[37].

OICW High Explosive (Indirect) Mode of Operations

The HE firing mode of operation is the focus of this paper. As such, a discussion of the HE firing process is necessary prior to determining and discussing the applicable tasks required. This process yields which operational tasks are required and in turn, which of those tasks must be properly simulated in order to provide a satisfactory replication of the weapon system for training purposes. A brief discussion of the operation of the HE firing mode is therefore necessary in order to distill those tasks that will make up the questionnaire pertaining to the interactive simulation training requirements in the Qualitative Research Interview.

As previously stated, the FCS supports both target aiming and ranging in the HE firing mode. Both of these characteristics must be broken down into simulation tasks/requirements. As in the KE firing mode, the OICW gunner is provided with a battlesight "red dot" aimpoint, which for the HE firing mode is 100 meters[38]. The gunner may opt to aim at the center-of-mass of a target 100 meter (or closer) target without using the FCS ranging capability. When this option is chosen, the HE fuze setting is automatically set to the "point detonating" (PD), meaning the round will explode upon impact with the prospective target[39]. For targets at ranges in excess of 100 meters, the FCS ranging capability is generally used. Use of the FCS ranging capability provides the gunner with an accurate target range as well as an "adjusted aimpoint".

For targets greater than 100 meters in distance, the gunner activates the he FCS laser rangefinder. He places the battlesight "red dot" on a target center-of-mass and presses the lase switch located in front of the weapon trigger housing. Assuming the target provides a satisfactory vertical surface, "returns" from the FCS laser range finder are sensed and interpreted to produce a numerical value[40]. This value is shown above the battlesight "red dot" in the FCS display. Simultaneously, an "adjusted aimpoint" appears below the battlesight "red dot". Once this second red dot appears, the gunner moves the adjusted aimpoint to the target center-of-mass[41]. This movement increases the elevation of the weapon (and thus the HE round's trajectory) relative to the elevation in which it was held at the time the target was lased for its range; this is called "super-elevating" the weapon[42]. This super-elevation is necessary in order for the HE round to reach the target and these increased ranges. Once the gunner is satisfied that the range shown in the FCS makes sense, he squeezes the HE weapon trigger, just as with any other weapon. At this point the fuze in the HE round is automatically set for the range shown in the FCS display, and the round is fired[43].

When firing the HE munitions, the gunner has several fuze options. These fuze options must also be capable of accurate replication in the simulation system. If the FCS is set to the bursting mode, the round will explode just above but at the same distance as the target. If it is set to the PD mode, the round will burst when it impacts the target. If the FCS is set to the point detonating delay (PDD) mode, the round will explode at a predetermined fixed amount of time after it impacts the target. Finally, if the FCS is set to the window mode, the round will break travel the window and burst at a preset distance beyond the actual range to the window[44].

There are several other critical areas pertaining to the FCS capabilities and corresponding requirements. Each of these areas will also have to be accurately replicated in any prospective simulation training system. The first are the magnification characteristics of the FCS. In its "nominal" day viewing mode, the FCS magnifies the target image by a factor of three, enabling easier viewing of more distant targets. If placed in the "video-viewing" mode, the magnification can be adjusted so the image is magnified by either a factor of three or six[45].

The next two unique characteristics of the FCS are the thermal imaging and target tracking capabilities. The FCS is expected to provide a built-in thermal imaging capability, allowing targets to be "seen" and engaged through obscurants such as smoke, moderate rain, fog, and snow and in low light level/night illumination conditions[46]. It is also expected to have a target tracker and laser steering mode to support the tracking of moving targets. This tracker will also provide an aim point for moving targets that have gone into defilade positions[47].

Again, as seen from the brief description provided above, the HE portion of the OICW weapon system has some truly revolutionary capabilities. This description provides the backdrop for the plethora of tasks and responsibilities found in the body of the TI/D. Each of these unique characteristics pose significant cognitive and motor skill training challenges. Similarly, these training challenges must be overcome in a cost effective manner; these challenges carry with them the requirement to accurately and effectively replicate via simulation training systems, each of these unique and revolutionary capabilities. The QR I questionnaire must address these requirements as well as the proposed technological solutions for them. The next step in this process is a discussion of the design of the QRI and how this design will most effectively elicit the desired responses to these technological issues.

APPENDIX F: COMBINED MARKET SURVEY RESPONSES, MATERIEL SYSTEM DATA

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	A. OICW SPECIFIC Weapon System Requirements/Capabilities:
						(1) Trainer Configuration
Yes	Yes	Yes				Does the system provide the capability for multiple lane training? If so, what is the configuration & up to how many weapon lanes? What is the number of personnel able to be trained in a given training session?
Yes	**No**	Yes				Can lanes be used both autonomously (individual training) and networked (collective training)?
Yes	Yes	Yes				Can weapons be interchanged between lanes? If so, how long does this take? If lane is configurable, can the system be divided into independent subsystems?
Yes	Yes	Yes				Can each independent subsystem support multiple firing positions? If so, how many?
No	Yes	Yes				Does the system require a number of non-firing support personnel? If so, what is the number of support personnel required?
Yes	Yes	Yes				Does the system have a target feedback mechanism? Explain how it works in detail.; does it have immediate, delayed, local, or networked capabilities?
Yes	Yes	Yes				Does the system use 2D technology? If so, provide brief description of system technology capabilities/limitations.
Yes	Yes	**No**				Does the system use 3D technology? If so, provide brief description of system technology capabilities/limitations.
Yes	Yes	Yes				Does the system accurately depict KE ballistic simulation? Are simulated trajectories, flight times, wind effects, traces and hit probabilities included? Explain.
Yes	Yes	Yes				Does the system accurately depict HE ballistic simulation? Are simulated trajectories, flight times, wind effects, traces and hit probabilities included? Explain.
Yes	Yes	**No**				Is the system capable of providing "effects" on the target? If so, provide brief description of system capabilities/limitations.

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	**(2) Simulation of Weapon/System Capabilities (Continued)**
Yes	Yes	**No**				Is the system capable of providing percentage of effects (such information as may apply to incapacitation (suppression or neutralization vs destruction)? what type of suppressive fire criteria will be used?
Yes	**No**	Yes				Does the system use a mock-up weapon? If so, explain how the weapon mock-up simulator works (embedded, clamp-on, simulator capabilities/limitations).
Yes	Yes	**No**				Does the weapon mock-up accurately replicate weapon malfunction (s) and procedures? List the malfunctions covered.
Yes	Yes	Yes				Does the weapon allow for corrective action (s)?
Yes	Yes	Yes				Does the system replicate firing of an actual weapon? Provide a description of recoil, blast, flash, noise, and smoke if simulated or represented. Is recoil provided without use of blanks, caps or other combustible or toxic material? Are consumables required for the system to produce recoil?
Yes	Yes	Yes				Is compensation for parallax and sensing error provided?
Yes	Yes	Yes				Are boresighting and zeroing procedures provided for the weapon system?
Yes	Yes	Yes				Are procedures provided for boresighting and zeroing at the .95 confidence level?
Yes	Yes	Yes				Are magazine changing and ammunition usage provided for?
Yes	Yes	Yes				Does the system replicate firing of an actual weapon? Provide a description of recoil, blast, flash, noise, and smoke if simulated or represented. Is recoil provided without use of blanks, caps or other combustible or toxic material? Are consumables required for the system to produce recoil?
Yes	Yes	Yes				Is compensation for parallax and sensing error provided?
Yes	Yes	Yes				Are boresighting and zeroing procedures provided for the weapon system?
Yes	Yes	Yes				Are procedures provided for boresighting and zeroing at the .95 confidence level?

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	(2) Simulation of Weapon/System Capabilities (Continued)
Yes	Yes	Yes				Are magazine changing and ammunition usage provided for?
Yes	Yes	**No**				Does the system detect, record and display weapon cant?
Yes	Yes	Yes				Does system facilitate I/O remedial instruction to the shooter based on above?
Yes	Yes	Yes				Does system provide for all shooter/crew firing positions in accordance with the OICW ORD?
Yes	Yes	Yes				Does the system provide same targetry as depicted in the Army Standard Course of Fire?
Yes	Yes	Yes				Does the system provide immediate identifiable feedback indication of hit/suppression?
Yes	Yes	**No**				Does the interactive training simulation system support a weapon/weapon mock-up that is modular in design, able to be deployed as a dual munitions weapon system or as either a separate 20mm high explosive (HE) weapon or a stand alone 5.56mm weapon?
Yes	Yes	**No**				Does the interactive training simulation system accurately replicate the target acquisition/fire control system? Will the target acquisition/fire control system module/mock-up have a built in test (BIT) and embedded diagnostics to provide system status and fault isolation.
No	Yes	**No**				Does the interactive training simulation system include an accurate simulation/replication for any of the following weapon components: the laser rangefinder, ballistic computer, direct view optics, video camera, compass, thermal module and the automated target tracker?
Yes	Yes	Yes				Is the interactive training simulation system capable of engaging targets in virtually any scenario out to a maximum range of 1000 meters (effective range of 500 meters)?
Yes	Yes	Yes				Does the interactive training simulation system have day/night engagement capability? Does it have limited visibility engagement capability (i.e. fog, haze, smoke)?

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	(2) Simulation of Weapon/System Capabilities (Continued)
Yes	Yes	**No**				Does the interactive training simulation system have embedded training (ET) features which include: a. A capability which functions at a level of reliability that will support accomplishment of training objectives/agenda when employed in virtually any training environment (individual/collective virtual training sessions, classroom, field training exercises, live fire range training events, etc.)? b. Software interface, which is Distributive Interactive Simulation/High Level Architecture (DIS/HLA) interoperable? c. The capability to interact with existing synthetic training simulations (i.e. the Close Combat Tactical Trainer (CCTT) and the Engagement Skills Simulator (EST)). d. The capability to attain (train) and sustain individual (and collective groups) in system operations and combat engagement simulations.
Yes	Yes	**No**				Does the interactive training simulation system include programs (software): For user assistance and live and virtual simulation capability plus integral connections for interoperability with collective training simulators and training simulations? Replicating misfire cues, target acquisition and engagement procedures, and collective combat skill engagement simulations?
No	**No**	Yes				Does the interactive training simulation system incorporate symbology and icons common with Land Warrior systems (dismounted, mounted, air)?
Yes	Yes	No				Does the interactive training simulation system include the capability to engage stationary and moving targets from a "stationary" position?
Yes	Yes	**No**				Does the interactive training simulation system include the capability to engage stationary and moving targets from a "moving" position?
Yes	Yes	Yes				Is the interactive training simulation system sufficiently durable to withstand military use in any scenario without degrading the performance of the weapon.

ECC	**FATS**	**Beamhit**	**PM TRADE/ NAWC**[1]	**SAAB**[2]	**Reality by Design**[3]	**(3) Individual Training Capabilities**
Yes	Yes	**No**				Does the system provide individualized instructional capabilities? If so, explain in detail. How does it determine measures of effectiveness collected- such as number of hits per scenario, etc.? (Total number targets available to be hit per scenario, aiming error (radial standard deviation) per range, time to first hit, rounds to first hit, time to first trigger pull, time to shift (re-lay sights) between targets, average time between shots, hits to shot ratio per target, etc)
Yes	Yes	Yes				Does system provide capability of producing and storing individual feedback on simulated fire scoring in printed form? How does the system calculate/tabulate firing record content (aimpoint, hits, misses, firing record of each individual round in burst, etc.)?
Yes	Yes	Yes				Can the above capability be used with the individual marksmanship training? Does the system provide feedback/instruction to allow individual aim point, sight adjustment or zeroing procedures?
Yes	Yes	Yes				Does the system have After Action Review (AAR) capability? Explain.
Yes	No	Yes				Does the system provide any associated computer-based tutoring or coaching systems for specifically for individual trainees? Explain
Yes	Yes	Yes				Does the system produce hard copy training records? In what format are these records maintained? Does it address Individual, collective? Explain.
Yes	Yes	Yes				Does the system identify the individual shooter in training records?
Yes	Yes	Yes				Does the system store and produce electronic individual performance?
Yes	Yes	Yes				Does the system store and produce electronic individual performance?
						(4) Unit/Collective Training Capabilities
Yes	Yes	Yes				Does system provide capability of producing and storing individual feedback on simulated fire scoring in printed form?
Yes	Yes	Yes				Can the above capability be used with individual/crew weapon marksmanship training?
Yes	**No**	Yes				Does the system provide any associated computer-based tutoring or coaching systems for specifically for collective or team training? Explain.
Yes	Yes	Yes				Does the system have After Action Review (AAR) capability? Explain.

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	(5) Facility Issues
Yes	Yes	Yes				Can each power subsystem operate from 110/220 V, 50/60 Hz?
Yes	Yes	Yes				Does the system provide safeguards to prevent attachment to mismatched power supply?
						B. Pre-existing Weapon Engagement Simulation System Performance Requirements:
						(1) Trainer Configuration
Yes	Yes	Yes				Does the system provide the capability for multiple (up to 12) lane training? If so, what is the configuration & up to how many weapon lanes? What is the number of personnel able to be trained in a given training session?
Yes	Yes	Yes				Can lanes be used both autonomously (individual training) and networked (collective training)?
Yes	Yes	Yes				Can weapon be interchanged between lanes? If so, how long does this take to set up?
Yes	Yes	Yes				Can system be divided into three (3) independent subsystems?
Yes	Yes	Yes				Can each independent subsystem support at least four (4) firing positions?
						(2) Simulation of Weapon Capabilities
Yes	Yes	Yes				Does system include all the service weapon types listed below?
Yes	Yes	Yes				M16A1/M16A2, 5.56mm Rifle, with AN/PVS-4 Night Vision Sight?
Yes	Yes	Yes				M4, 5.56mm Carbine, with AN/PVS-4 Night Vision Sight?
Yes	Yes	Yes				M9, 9mm Pistol?
Yes	Yes	Yes				M249, 5.56mm Machine Gun, in the Automatic Rifle Role?
Yes	Yes	Yes				M249, 5.56mm Machine Gun, in the Light Machine Gun Role?
Yes	Yes	Yes				M60, 7.62mm Machine Gun, with AN/PVS-4 Night Vision Sight?

ECC	**FATS**	**Beamhit**	**PM TRADE/ NAWC**[1]	**SAAB**[2]	**Reality by Design**[3]	**(2) Simulation of Weapon Capabilities (Continued)**
Yes	Yes	Yes				M2, Heavy Barrel Caliber .50 Machine Gun?
Yes	Yes	Yes				MK19 MOD3, Grenade Machine Gun, with AN/PVS-5 Night Vision Sight?
Yes	Yes	**No**				M203, 40mm Grenade Launcher, with AN/PVS-4 Night Vision Sight?
Yes	Yes	Yes				M136, Launcher and Cartridge, 84mm, HEAT
Yes	Yes	Yes				M1200, Winchester Shotgun, 12 gauge
Yes	Yes	Yes				Are all physical, functional and operational (including instructor/operator malfunctions) provided?
Yes	Yes	**No**				Are all casualty-producing effects for each weapon provided?
Yes	Yes	**No**				Are weapons demilitarized or simulated?
No	**No**	**No**				Are weapons capable of chambering live ammo?
Yes	Yes	Yes				Are weapons hardened to withstand droppage and repeated mechanical functioning?
						(3) Boresighting and zeroing
Yes	Yes	Yes				Are procedures provided for boresighting and zeroing at the .95 confidence level for all devices?
Yes	Yes	Yes				Are boresighting and zeroing procedures provided for each weapon systems?
Yes	Yes	Yes				Are boresighting and zeroing procedures provided for optical sights?
Yes	Yes	Yes				Are boresighting and zeroing procedures provided for night sighting devices?
No Response	Yes	Yes				Are boresighting/zeroing procedures provided for weapon-mounted lasers?
Yes	**No**	**No**				Can boresighting and zeroing record/store zero information for up to 4,000 shooters for any weapon system be saved?
Yes	**No**	**No**				Does system provide immediate recall and automatic application of zero information for weapon being fired?

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	**(4) Weapon Recoil**
Yes	Yes	Yes				Does system provide for net-force weapon recoil for each weapon type?
Yes	Yes	**No**				Is recoil provided without use of blanks, caps or other combustible or polluting material?
Yes	Yes	Yes				Can recoil power source be replenished/recharged at or below direct support maintenance level?
No	Yes	Yes				Are consumables required for the system to produce recoil? If yes, then identify consumables.
						(5) Ballistic Simulation
Yes	Yes	Yes				Are ballistics simulated for each identified service weapon?
Yes	Yes	Yes				Are simulated trajectories, flight times, wind effects, traces and hit probabilities included for each weapon?
						(6) Ammunition Basic Loads
Yes	Yes	Yes				Are basic load characteristics for each service weapon type provided?
Yes	Yes	**No**				Are basic service loads adjustable by the instructor/operator?
						(7) Magazines/Ammunition Belts
Yes	Yes	Yes				Are magazine changing and ammunition belts usage provided for?
Yes	Yes	Yes				Are magazine changing provided for M116A1/A2/M4 Rifle/Carbine, M9 Pistol and M249 AR/LMG?
Yes	Yes	Yes				Are ammunition belts usage provided for M249, M60, M2 Machine Guns and MK 19 Grenade Machine Gun?
						(8) Parallax Error Compensation
Yes	Yes	Yes				Is compensation for parallax and sensing error provided for all weapons simulated?

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	**(9) Rifle/Pistol Cant**
Yes	Yes	**No**				Does system detect, record and display M16A1/A2/M4 Rifle/Carbine and M9 Pistol cant?
Yes	Yes	**No**				Does system facilitate I/O remedial instruction to the shooter based on above?
						(10) Simulation of Shooting Positions
Yes	Yes	Yes				Does system provide for all shooter/crew firing positions in accordance with weapon field manuals?
						(11) Targetry
Yes	Yes	Yes				Does system provide same targetry as depicted in the Army Standard Course of Fire?
Yes	Yes	Yes				Does system provide for both individual and crew served marksmanship training?
Yes	Yes	Yes				Does system conform to the appropriate Army field manual for each weapon?
Yes	Yes	Yes				Does system conform to the Training Circular 25-8 for Training Ranges?
Yes	Yes	Yes				Does the system provide film resolution, or better, for the following types of scenarios?
Yes	Yes	Yes				1) collective gunnery/tactical training,
Yes	Yes	Yes				2) quick fire shooting,
Yes	Yes	**No**				3) engagement of moving targets,
Yes	Yes	Yes				4) machine guns firing in pairs and
Yes	Yes	**No**				5) shoot--don't shoot scenarios
Yes	Yes	Yes				Does the system provide immediate identifiable feedback indication of hit/suppression?

ECC	FATS	Beamhit	PM TRADE/ NAWC[1]	SAAB[2]	Reality by Design[3]	(13) Initial Entry Training
Yes	Yes	Yes				Does system provide capability of producing and storing individual feedback on simulated fire scoring in printed form?
						(14) Unit Training
Yes	Yes	Yes				Does system provide capability of producing and storing individual feedback on simulated fire scoring in printed form?
Yes	Yes	Yes				Can the above capability be used with the individual/crew weapon marksmanship training?
Yes	Yes	Yes				Can the above capability be used with the individual and collective training events as follows?
Yes	Yes	Yes				1) Quick Fire (M16A1/A2?M4Rifle/Carbine, M9 Pistol),
Yes	Yes	**No**				2) Engagement of Moving Targets (all weapons),
Yes	Yes	Yes				Machine Guns Firing in Pairs (as appropriate),
Yes	Yes	**No**				Shoot--Don't Shoot Decision Training (all weapons)
						(15) Deployable Packages
No	Yes	Yes				Does system have an option for prefabricated, water-proofed, enclosure for deployable containment?
No	Yes	Yes				Does enclosure provide sufficient room for system with additional storage for packing containers?
No	Yes	Yes				Does enclosure provide lighting necessary for safe operation?
No	Yes	**No**				Does enclosure contain a self-contained power-generating system providing for equipment, lighting & environmental control system?
No	Yes	Yes				Does system have a means to eliminate power fluctuation and a means to connect to external power?
No	Yes	Yes				Does system have a positive environmental control system to maintain it within safe operating parameters: temperatures, humidity and dust levels?

ECC	**FATS**	**Beamhit**	**PM TRADE**[1]	**SAAB**[2]	**Reality by Design**[3]	**(15) Deployable Packages (continued)**
No	Yes	Yes				Does system utilize ruggedized packing containers for all equipment?
No	Yes	Yes				Are containers provided to preclude damage to equipment from effects of extreme temperatures, humidity, dust or rough and frequent handling?
Yes	Yes	Yes				When packed for shipment will the deployable system fit into a standard 20' MILVAN/container for sealift and be capable of air shipment using 463L pallets?
						(16) Preplanned Product Improvements (P3I)
Yes	Yes	Yes				Does system allow for insertion of preplanned product improvements such as identified in the EST ORD?
						C. Logistics and Readiness
						(1) Operational Availability
Yes	Yes	Yes				Does system support an operational availability rate of .85 for a 10-hour training day, five days per week?
						(2) Built-In-Test (BIT) & Fault-Isolation-Test (FIT)
Yes	Yes	Yes				Does system contain a built in test or fault isolation test capability to determine if system is operating correctly?
						D. Other System Characteristics
						(1) The OICW EST will not increase physical security requirements.
No	**No**	**No**				Does the demilitarized or simulated weaponry required for the device increase physical security requirements?

[1] PM TRADE and NAWC-TSD Material System Data may be found under separate covers

[2] SAAB responded, "All (questions) are N/A"

[3] Reality By Design indicated they would complete their response later. No Materiel System Data was received from RBD at the time of this report.

APPENDIX G: QUALITATIVE RESEARCH INTERVIEW, GENERAL SYSTEM OVERVIEW

Synthetic Environment Representation Section:

1. Does your system use 3D technology? Can you provide brief description of system technology capabilities and/or limitations?

2. Does your system accurately depict HE ballistic simulation? Are simulated trajectories, flight times, wind effects, traces and hit probabilities included? Please explain.

3. Is your system capable of providing "effects" on the target? Specifically, can your system represent the individual components of an exploded OICW HE round as they impact with portions of a prospective target? Provide brief description of system capabilities/limitations. Since the heart of the HE mode is its indirect fire capability, how are “less-than-kill” shots measured?

4. Is your system capable of providing percentage of effects (such information as may apply to incapacitation--suppression or neutralization or destruction)? Does the system provide immediate identifiable feedback indications of hit/suppression?

5. Is the interactive training simulation system capable of engaging targets in virtually any scenario from 100 to maximum range of 1000 meters (effective range, 500 meters)?

6. Does your system simulate and OICW fuze characteristics, namely “high explosive air bursting” (HEAB), “point detonating” (PD), “point detonating delay” (PDD) and “window mode” detonating munitions?

Training Section:

1. To what extent does your interactive training simulation system simulate indirect engagement of targets associated with the OICW Target Acquisition/Fire Control System (TA/FCS).

2. Does the interactive training simulation system have embedded training (ET) features which include:

a. A capability which functions at a level of reliability that will support accomplishment of training objectives/agenda when employed in virtually any training environment (individual/collective virtual training sessions, classroom, field training exercises, live fire range training events, etc.)?

b. Software interface, which is Distributive Interactive Simulation/High Level Architecture (DIS/HLA) interoperable?

c. The capability to interact with existing synthetic training simulations (i.e. the Close Combat Tactical Trainer (CCTT) and the Engagement Skills Simulator (EST)).

d. The capability to attain (train) and sustain individual (and collective groups) in system operations and combat engagement simulations.

3. Does the interactive training simulation system include programs (software) for replicating misfire cues, target acquisition and engagement procedures, and collective combat skill engagement simulations?

4. Does the system use a mock-up weapon, which accurately replicates the actual OICW ergonomically and operationally? If so, explain the how the weapon mock-up simulator works (embedded, clamp-on, simulator capabilities/limitations).

5. Is the interactive training simulation system weapon/weapon mock-up modular in design, able to be deployed as a dual munitions weapon system or as either a separate 20mm high explosive (HE) weapon or a stand alone 5.56mm weapon?

6. Does your system accurately replicate the TA/FCS? Will the TA/FCS module/mock-up have a built in test (BIT) and embedded diagnostics to provide system status and fault isolation?

7. Does the interactive training simulation system include an accurate simulation/replication for the following weapon components: the battlesight “red dot”, the laser rangefinder, “super-elevation” procedures, ballistic computer, direct view optics, video camera, compass, thermal module and the automated target tracker?

8. Does your system simulate and OICW fuze characteristics, namely “high explosive air bursting” (HEAB), “point detonating” (PD), “point detonating delay” (PDD) and “window mode” detonating munitions?

9. Is the interactive training simulation system capable of engaging targets in virtually any scenario from 100 to maximum range of 1000 meters (effective range, 500 meters)?
10. Does the interactive training simulation system have day/night engagement capability? Does it have limited visibility engagement capability (i.e. fog, haze, smoke)?

11. Does the interactive training simulation system include the capability to engage stationary and moving targets from a “stationary” position? From a “moving” position?

12. Does the simulated Fire Control System accurately replicate the magnification settings of the actual OICW?

13. Can the above capability be used with the individual marksmanship training? Does the system provide feedback/instruction to allow individual aim point, sight adjustment or zeroing procedures?

14. Does the system have After Action Review (AAR) capability? Explain this capability as it applies to individual training in detail.

15. Does the system provide any associated computer-based tutoring or coaching systems for specifically for individual trainees? If so, explain in detail.

16. Does the system provide the capability for multiple lane training? If so, what is the configuration & up to how many weapon lanes? What is the number of personnel able to be trained in a given training session?

17. Does your system provide for net-force service weapon recoil for the OICW?

18. Does your system have a target feedback mechanism? Explain how it works in detail; does it have immediate, delayed, local, or networked capabilities?

19. Does your system require a number of non-firing support personnel? If so, what is the number of support personnel required?

ECC RESPONSES

Synthetic Environment Representation Section:

1. Does your system use 3D graphics technology? Please provide a brief description of system technology capabilities/limitations.

Yes, the EST 2000 system uses 3D graphics technology for both target models and terrain databases.

Technology summary/feature list:

- **Support for latest generation of nVidia rendering hardware on PC.**
- **Animated soldiers and civilians (both armed and unarmed, both rural and urban) using high level scripting.**
- **Weather (snow, fog, hail, smoke, rain, and sleet) and time of day effects.**
- **Support for night vision goggle training.**
- **Animated ground vehicles (civilian and military), rotary wing and fixed wing aircraft (transport and attack).**
- **Special effects suite: explosions, smoke plume, bullet splash, flares, muzzle flash, fire.**
- **Photo-realistic terrain.**
- **High resolution rendering at high rates allows clear identification of objects at a distance according to "Johnson's Criteria."**

Limitations:

- **The number of simultaneous entities visible within a scenario is not limited, but is, in practice, a function of system performance (i.e., the capability is upwardly expandable indefinitely with increases in hardware performance).**
- **The weather effects are particle based, and these are not shared across screens, so a continuous snow effect is not provided. This is an implementation limitation, and not a technology limitation, so it could be resolved in a future version.**

2. Does your system accurately depict KE and HE ballistic simulation? Are the simulated trajectories, flight times, wind effects, traces and hit probabilities (based on non-symmetrical 3D air bursting shapes) included? Explain.

The EST 2000 uses US Army validated ballistics related to the weapons/ammo simulated by the system. This data currently includes both HE and KE rounds. The ballistics data and fly-out model provides for accurate trajectories, flight times, wind effects, tracers, hit probabilities, *and dispersion*. The ballistics model is table driven and therefore addition of new ammo type is relatively straightforward. The current ammo simulation calls only for symmetrical 3D ground bursting shapes, however, the inclusion of alternate terminal effects can be accommodated.

3. Is your system capable of providing "effects" on the target? Specifically, does your system represent the individual components of an exploded OICW HE round as they impact with portions of a prospective target? Since the heart of the HE mode is its indirect fire capability,

how are “less-than-kill” shots (providing percentage of effects as may apply to incapacitation—suppression, neutralization or destruction) measured? Provide a brief description of system capabilities/limitations in this area, as well as any immediate identifiable feedback indications of hit/suppression.

The EST 2000 system will show explosions, smoke, flames and target damage models for vehicle and bunker targets. Vehicle targets have three levels of incapacitation (mobility kill, firepower kill, and catastrophic kill). Incapacitation is based on the damage assessment model which assigns damage based on the protective armor, damage potential of the round, and hit probability based on range from the detonation point. It is a Pre-planned Product Improvement (P3I) to include non-lethal hits on the soldier model which will add wounded behaviors.

4. Does your system accurately replicate the functionality of the Target Acquisition/Fire Control System (TA/FCS)? To what extent does your system simulate indirect engagement of targets associated with the OICW TA/FCS.

It is a preplanned product improvement to integrate ECC's standalone Javelin Basic Skills Trainer into the EST 2000 system. The Javelin BST provides a sophisticated fire control system that has comparable functionality to the OICW TA/FCS including day and IR optics simulation. The system also includes BIT and embedded diagnostics.

The EST 2000 system utilizes 3D terrain databases that allow for the engagement of defilade targets within the capabilities of the weapons ballistics.

a. Does the interactive training simulation system include an accurate simulation/replication for the following weapon components: the battlesight “red dot”, the laser rangefinder, “super-elevation” procedures, ballistic computer, direct view optics, video camera, compass, thermal module and the automated target tracker?

The EST 2000 system currently supports the Close Combat Optics, “red dot”, sighting system. The use of the M203 and MK19 weapon systems in the EST 2000 requires the use of super-elevation to correctly engage targets at range.

ECC builds the Javelin Basic Skills Trainer that integrates a laser range finder, ballistic computer, direct view optics, video camera, compass, thermal module and an automated target tracker. These features are preplanned product improvements for the EST 2000 system under Contract N61339-99-G-0001.

b. Does your system simulate OICW fuze characteristics, namely “high explosive air bursting” (HEAB), “point detonating” (PD), “point detonating delay” (PDD) and “window mode” detonating munitions?

The EST 2000 system currently supports “point detonating” fuzes. The system has the necessary feature to incorporate the other fuze characteristics when required.

c. Does the simulated Fire Control System accurately replicate the magnification settings of the actual OICW?

The high-resolution (1600 x 900) display of the EST 2000 system allows for effective use of direct view optics with magnification powers of up to 7x. For higher magnifications and for thermal imagery the use of injected video is required. The use of the AN/PAS-13 sight is a preplanned product improvement. Additionally, the ECC developed Javelin Basic Skills Trainer uses injected video to simulate the various powers of direct view optics and the thermal imagery sight.

Training Section:

1. Will the TA/FCS module/mock-up have a built in test (BIT) and embedded diagnostics to provide system status and fault isolation?

The TA/FCS module/mock-up will have support for BIT and embedded diagnostics as well as closed loop tests stimulated from the EST 2000 diagnostic mode of operation. This approach will provide effective system status and fault isolation.

2. Does the interactive training simulation system have embedded training (ET) features which include:

a. A capability which functions at a level of reliability that will support accomplishment of training objectives/agenda when employed in virtually any training environment (individual/collective virtual training sessions, classroom, field training exercises, live fire range training events, etc.)?

The EST 2000 system has been designed for a classroom environment. There is a preplanned product improvement for a deployable system.

b. Software interface, which is Distributive Interactive Simulation/High Level Architecture (DIS/HLA) interoperable?

DIS/HLA interoperability is a preplanned product improvement under Contract N61339-99-G-0001.

c. The capability to interact with existing synthetic training simulations (i.e. the Close Combat Tactical Trainer (CCTT) and the Engagement Skills Simulator (EST)).

CCTT interoperability is a preplanned product improvement under Contract N61339-99-G-0001.

d. The capability to attain (train) and sustain individual (and collective groups) in system operations and combat engagement simulations.

The EST 2000 system includes marksmanship and collective modes of training. In the marksmanship mode, individual trainees can attain and sustain skills to acquire and engage static, pop-up and moving targets. In the collective mode squad level teams can perform in combat engagement simulations.

3. Does the interactive training simulation system include programs (software) for replicating misfire cues, target acquisition and engagement procedures, and collective combat skill engagement simulations?

Yes

4. Does the system use a mock-up weapon, which accurately replicates the actual OICW ergonomically and operationally? If so, explain the how the weapon mock-up simulator works (embedded, clamp-on, simulator capabilities/limitations). Does your system provide for net-force service weapon recoil for the KE and HE munitions of the OICW?

All of the weapons on the EST 2000 system replicate the weight and balance of the actual weapon to within 95%. The ergonomically feel of the weapon is maintained through the use of actual hardware in at least the areas of trainee manipulation (handles, switches, etc.). Operational accuracy is provided by the weapon model that exists both embedded in the simulated weapon system and as simulated/stimulated in the system host.

The EST 2000 system has incorporated weapon mock-ups that have been embedded, clamp-on or fully simulated. The final design of the OICW and the requirements of the simulation will dictate the method employed based on weapon availability, safety and required level of fidelity.

5. Is the interactive training simulation system weapon/weapon mock-up modular in design, able to be deployed as a dual munitions weapon system or as either a separate 20mm high explosive (HE) weapon or a stand alone 5.56mm weapon?

It is intended to build a modular weapon system simulator that will mirror the capabilities of the actual OICW weapon.

6. Is the interactive training simulation system capable of engaging targets in virtually any scenario to maximum range of 1000 meters (effective range, 500 meters)?

Yes. The EST 2000 system currently employs the MK 19 which can engage targets up to 1500 meters.

7. Does the interactive training simulation system have day/night engagement capability? Does it have limited visibility engagement capability (i.e. fog, haze, smoke)?

The Instructor on an EST 2000 system can vary the environmental conditions of any exercise. The effects supported include time of day, fog, smoke, rain, sleet, hail and snow.

The system currently employs light intensifying optics (AN/PVS-4, AN/TVS-5, etc.) for use in night scenarios. The use of thermal imaging sights (AN/PAS-13) is a preplanned product improvement.

8. Does the interactive training simulation system include the capability to engage stationary and moving targets from a "stationary" position? From a "moving" position?

EST 2000 currently supports the engagement of stationary and moving target from a stationary position. A preplanned product improvement for a moving eye-point system has been proposed under the BAA.

9. Can the above capability be used with the individual marksmanship training? Does the system provide feedback/instruction to allow individual aim point, sight adjustment or zeroing procedures?

Yes, the above capability is included in the EST 2000 marksmanship training mode. Feedback is supplied for each round fired included a trace of theaimpoint for each trainee. Zero courses of fire are implemented in the system allowing for the recognition of up to 4000 trainees' individual zeroing settings. The Instructor has the option of employing direct sight manipulation or "electronic" zeroing. Additionally, feedback can be viewed on a target by target basis to display the mean point of impact of a group of rounds.

10. Does the system have an After Action Review (AAR) capability? Does the system provide the ability to move through the database to examine the air bursting effects from any angle relative to the target? Explain.

Yes, the EST 2000 system provides After Action Review detailing the location of every shot fired by each trainee in the simulation. In marksmanship mode, a zoomed in representation of the target is displayed for closer examination. For bursting munitions on area type targets, a top down view is shown relating the detonation point with the target.

11. Does the system provide any associated computer-based tutoring or coaching systems for specifically for individual trainees? Explain.

A complete training support package (TSP) is integrated into every EST 2000 system.

12. Does the system provide the capability for multiple lane training? If so, what is the configuration & up to how many weapon lanes? What is the number of personnel able to be trained in a given training session?

Each EST 2000 subsystem contains 5 training lanes. Multiple subsystems can be networked together to provide a higher number of training lanes under one instructors control.

In the marksmanship training mode up to 3 subsystems can be networked together to provide 15 lanes of training.

In the collective training mode two subsystems can be networked together to provide 10 lanes of training supporting up to 12 weapons (some trainees are allowed multiple weapons, i.e. and M16 rifle and an AT4 rocket).

The video based Shoot-Don't Shoot mode is available on one subsystem only supporting 5 training lanes.

13. Does your system have a target feedback mechanism? Explain.

All targets in the EST 2000 system will show immediate damage when hit with the appropriate strength round. They can be programmed to take contingency actions due to a close proximity hit or a threshold number of casualties in their squad.

14. Does your system require a number of non-firing support personnel? If so, what is the number of support personnel required?

One Instructor can operate the EST 2000 system.

RBD RESPONSES

Synthetic Environment Representation Section:

1. Does your system use 3D graphics technology? Please provide a brief description of system technology capabilities/limitations.

RBD produces the SVS2ä Immersive simulation system as a COTS training solution for individual and collective small arms weapons. This system is an immersive 3D virtual World where trainees can navigate and interact with other participant in a meaningful scenario. We currently are using the nVidia GeForce3 graphics board which supports very high resolutions at real-time frame rates. RBD currently uses a COTS LCD projector; however, any projector (including high-resolution CRT) could be used. The visual subsystem for SVS2 is based on the OpenGL standard.

2. Does your system accurately depict KE and HE ballistic simulation? Are the simulated trajectories, flight times, wind effects, traces and hit probabilities (based on non-symetrical 3D air bursting shapes) included? Explain.

All weapons currently supported by SVS2 Immersive are direct fire (KE) weapons. RBD is currently under contract to STRICOM to provide an M203 capability which will provide an indirect engagement alternative. Ballistic models can either be physically-based or table driven with the EST firing tables.

3. Is your system capable of providing "effects" on the target? Specifically, does your system represent the individual components of an exploded OICW HE round as they impact with portions of a prospective target? Since the heart of the HE mode is its indirect fire capability, how are “less-than-kill” shots (providing percentage of effects as may apply to incapacitation—suppression, neutralization or destruction) measured? Provide a brief description of system capabilities/limitations in this area, as well as any immediate identifiable feedback indications of hit/suppression.

All of these are not yet implemented in the SVS2, but can easily be integrated in its software’s modular and extendable architecture. The explosions of the OICW HE

round can be physically modeled, and collision detection can be made with the surrounding object to determine target effects.

4. Does your system accurately replicate the functionality of the Target Acquisition/Fire Control System (TA/FCS)? To what extent does your system simulate indirect engagement of targets associated with the OICW TA/FCS.

a. Does the interactive training simulation system include an accurate simulation/replication for the following weapon components: the battlesight "red dot", the laser rangefinder, "super-elevation" procedures, ballistic computer, direct view optics, video camera, compass, thermal module and the automated target tracker?

The SVS Immersive already include accurate simulation of the battlesight (distributed meaning that I can see other participant red dot in my simulator, and others can see mine), laser range finder, ballistic computer, video camera, compass, GPS, Thermal, and Night Vision Goggles.

b. Does your system simulate OICW fuze characteristics, namely "high explosive air bursting" (HEAB), "point detonating" (PD), "point detonating delay" (PDD) and "window mode" detonating munitions?

All of these are not yet implemented in the SVS2, but can easily be integrated in its software's modular and extendable architecture.

c. Does the simulated Fire Control System accurately replicate the magnification settings of the actual OICW?

It is not yet implemented in the SVS2, but can easily be integrated in its software's modular and extendable architecture.

Training Section:

1. Will the TA/FCS module/mock-up have a built in test (BIT) and embedded diagnostics to provide system status and fault isolation?

SVS2 Immersive is designed and built using a modular approach to both the hardware and software components. This allows faults to be quickly located and isolated.

2. Does the interactive training simulation system have embedded training (ET) features which include:

a. A capability which functions at a level of reliability that will support accomplishment of training objectives/agenda when employed in virtually any training environment (individual/collective virtual training sessions, classroom, field training exercises, live fire range training events, etc.)?

RBD is currently developing the virtual simulation system for the Land Warrior system under (SBIR) contract to STRICOM. SVS2 Immersive currently supports and provides an embedded training solution for the Land Warrior 0.6 system. RBD is continuing to work with STRICOM to provide support for LW 1.0 as well.

b. Software interface, which is Distributive Interactive Simulation/High Level Architecture (DIS/HLA) interoperable?

RBD was the first company to receive HLA certification from DMSO in December of 1997. SVS2 Immersive is compliant with the DIS protocols, the DMSO (and other) RTI, and the HLA RPR-FOM. SVS2 Immersive is built using our SimStormä software architecture and toolkit. This software supports a flexible FOM interface allowing it to support multiple and diverse FOMs.

c. The capability to interact with existing synthetic training simulations (i.e. the Close Combat Tactical Trainer (CCTT) and the Engagement Skills Simulator (EST)).

RBD is currently developing the front-end user interface for the CCTT Dismounted Infantry Manned Module (DIMM) under contract to Lockheed Martin Information Systems and STRICOM. The CCTT DIMM has adopted and RBD is supplying the SVS2 Immersive front-end user interface and surrogate weapon system. Via DIS or HLA, SVS2 Immersive can interoperate in combined-arms simulations with a variety of simulation systems.

d. The capability to attain (train) and sustain individual (and collective groups) in system operations and combat engagement simulations.

SVS2 Immersive can be configured to support any number of training scenarios. The CGF and scenario development tools allow the user to define, setup and execute tactically correct and diverse scenarios. SVS2 Immersive supports a variety of synthetic environment standards for terrain and moving model databases including OpenFlight and SEDRIS. While the standard SVS2 Immersive is intended to be used as an individual trainer, RBD can provide a version of SVS2 that can provide multiple screens supporting 4 (or more) firing positions and that can be networked to support collective training scenarios.

3. Does the interactive training simulation system include programs (software) for replicating misfire cues, target acquisition and engagement procedures, and collective combat skill engagement simulations?

> **Yes.**

4. Does the system use a mock-up weapon, which accurately replicates the actual OICW ergonomically and operationally? If so, explain the how the weapon mock-up simulator works (embedded, clamp-on, simulator capabilities/limitations). Does your system provide for net-force service weapon recoil for the KE and HE munitions of the OICW?

> **Svs2 immersive currently provides an m4 surrogate weapon to the user. This weapon can be configured (in software) to fire a variety of rounds including 5.56mm, 7.62mm and an at8 round. Rbd is currently enhancing svs2 immersive (under the acrt contract to stricom) to support a surrogate m16, m203, m4, m240, m249, combat shotgun and m9 pistol weapons and to correctly simulate (in software) the appropriate ballistic rounds for the weapons partially using the engagement skills trainer (est) firing tables. These weapons and ballistics will be delivered to ft. Benning in late 2001. All of these weapons provide a night vision capability by rendering the 3d scene appropriately (not by using a surrogate viewing device such as a scope). All these weapons are real weapons that have modified to be used in the simulator, and are manufactured in our facility in melbourne (florida). The surrogate weapons have the feel, weight, and look of the real weapons. Svs2 weapons can be supplied with full recoil as an option. Svs2 immersive also simulates the land warrior "look around corner" capability with simulated video presented to a surrogate helmet-mounted display (i.e. Lw ihas).**

5. Is the interactive training simulation system weapon/weapon mock-up modular in design, able to be deployed as a dual munitions weapon system or as either a separate 20mm high explosive (HE) weapon or a stand alone 5.56mm weapon?

> **The SVS Immersive have the capability of using four weapons at the same time, therefore the modularity of the OICW will fit perfectly in the existing system.**

6. Is the interactive training simulation system capable of engaging targets in virtually any scenario to maximum range of 1000 meters (effective range, 500 meters)?

> **The virtual world projected to the trainee has a user selectable front and back plane culling, meaning that the range of action is modifiable. As a default, the back culling plane is set to 6000 meters.**

7. Does the interactive training simulation system have day/night engagement capability? Does it have limited visibility engagement capability (i.e. fog, haze, smoke)?

> **The SVS2 Immersive have full environmental capabilities, meaning that it support time of day (visual changes depending of time of day), rain, snow, clouds, fog (with multiple density parameters), smoke (with multiple color parameters), and wind direction (will change direction of smoke).**

8. Does the interactive training simulation system include the capability to engage stationary and moving targets from a “stationary” position? From a “moving” position?

The SVS2 Immersive has the capability to engage stationary (such as lights and windows) and moving targets (such as enemy personnel and tanks). The IC has an area of 10x10 feet where he can move; therefore he can engage any target from any position in this area (moving or stationary).

9. Can the above capability be used with the individual marksmanship training? Does the system provide feedback/instruction to allow individual aim point, sight adjustment or zeroing procedures?

The position and orientation of the weapon are collected with high accuracy using position sensors, inertia cubes, and laser tracking, therefore the system is already set up to be used as a marksmanship training simulator. SVS2 Immersive provides a boresighting and zeroing capability at startup and/or during runtime.

10. Does the system have an After Action Review (AAR) capability? Does the system provide the ability to move through the database to examine the air bursting effects from any angle relative to the target? Explain.

The SVS2 uses a logger to record the data in an ongoing scenario in the virtual environment. This logged data is used to be replayed for AAR purpose, where the user can freely navigate in the environment while the logged data is played back. He can certainly have the capability to examine the air bursting effects from any angle relative to the target.

11. Does the system provide any associated computer-based tutoring or coaching systems for specifically for individual trainees? Explain.

It is not yet implemented in the SVS2, but can easily be integrated in its software’s modular and extendable architecture.

12. Does the system provide the capability for multiple lane training? If so, what is the configuration & up to how many weapon lanes? What is the number of personnel able to be trained in a given training session?

The standard SVS2 Immersive system is designed for a single participant. However, RBD can provide systems which can accommodate up to 4 shooters per system with multiple systems linked together.

13. Does your system have a target feedback mechanism? Explain.

Visual feedback is provided to show where the target was hit by using decals; they are superimposed on the location of the hit.

14. Does your system require a number of non-firing support personnel? If so, what is the number of support personnel required?

> **In its Immersive version, the SVS2 needs an instructor or operator to be present during system startup and shut down, he is not required to be present during the training exercise. One instructor/operator can control multiple SVS2s during one working session. The computer/instructor station allows the operator to control any/all other SVS2 Immersive (and desktop) simulators that are connected to the same computer network. The controller can pause, resume, reset, and teleport any individual simulator.**

COMPARISON OF COMMERCIAL INDUSTRY CAPABILITY

ECC **EST 2000**	**<u>Reality by Design</u>** **SVS2**ä **Immersive**	**NAWCTSD** **SAST**	**Synthetic Environment Representation/Training Requirements**
Yes	Yes	Yes	Does your system use 3D technology?
Yes	No*	Yes	Is your system capable of providing "effects" on the target?
No*	No*	Yes	Specifically, can your system represent the individual components of an exploded OICW HE round as they impact with portions of a prospective target?
No**	No*	Yes	Is your system capable of providing percentage of effects (such information as may apply to incapacitation--suppression or neutralization or destruction)?
Yes	No**	Yes	Does your system accurately depict HE ballistic simulation? Are simulated trajectories, flight times, wind effects, traces and hit probabilities included?
No, PD only**	No, PD only*	Yes	Does your system simulate OICW fuze characteristics (namely high explosive air bursting, point detonating, point detonating delay & window mode)?
No**	No**	Yes	Does your interactive training simulation system simulate indirect engagement of targets associated with the OICW Target Acquisition/Fire Control System?
Yes	Yes	Yes	Does the system use a mock-up weapon, which accurately replicates the actual OICW ergonomically and operationally?
Yes	Yes	Yes	Does the interactive simulation system include an accurate simulation/replication for the following weapon components: the battlesight “red dot”, the laser rangefinder, “super-elevation” procedures, ballistic computer, direct view optics, video camera, compass, thermal module and the automated target tracker?
Yes	Yes	Yes	Is the interactive training simulation system capable of engaging targets in virtually any scenario from 100 to maximum range of 1000 meters (effective range, 500 meters)?
Yes	Yes	Yes	Does the interactive training simulation system have day/night engagement capability and/or limited visibility engagement capability (e fog, haze, smoke)?
Yes	Yes	Yes	Can the above capability be used with the individual marksmanship training?
Yes	Yes	Yes	Does the system provide target feedback/instruction mechanism?
Yes	Yes	Yes	Does the system have After Action Review (AAR) capability?
Yes	No*	Yes	Does the system provide the capability for multiple lane training?
No**	Yes	Yes	Does your system a software interface that is DIS/HLA interoperable?
Yes	Yes	Yes	Does your system require a number of non-firing support personnel?

* There is no preplanned product improvement (P3I) requirement, though this can be done
** There is a scheduled (P3I) for this requirement

ENDNOTES

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[32] Ibid, 6.

[33] Frey & Oishi, 51.

[34] Madison Research Corporation (MRC) & the Institute for Simulation & Training (IST). *OICW Task Identification and Description to Support the OICW Training Simulation Requirements Analysis.* Orlando, FL, 2001, 8.

[35] Ibid.

[36] Ibid, 9.

[37] Ibid.

[38] Ibid.

[39] Ibid.

[40] Ibid, 10.

[41] Ibid.

[42] Ibid.

[43] Ibid, 11.

[44] Ibid.

[45] Ibid.

[46] Ibid, 12.

[47] Ibid.

GLOSSARY

AAR	After action review
AIT	Advanced individual training
ARDEC	Army Armament Research Development and Engineering Center
ARI	Army Research Institute
ARL	Army Research Laboratory
ARM	Advanced army marksmanship
ASVAB	Armed services vocational aptitude battery
BIT (1)	Basic individual training
BIT (2)	Built in test (fault indicator)
BRM	Basic rifle marksmanship
BST	Basic skills trainer
BTA	Best technical approach
CATS	Combined arms training strategy
CCTT	Close Combat Tactical Trainer
CFP	Concept formulation process/plan
CMF	Career management field
COTS	Commercial off the shelf
CSA	Chief of Staff of the Army
DA	Department of the Army
DCD	Directorate of Combat Developments
DEMIL	Demilitarized (weapon)
DIMM	Dismounted Infantry Manned Module
DIS	Distributed interactive simulation
DMSO	Defense Modeling and Simulation Office
DOD	Department of Defense
EST	Engagement skills trainer
ET	Embedded training
FCS	Fire control system
FORSCOM	(United States Army) Forces Command
HE	High explosive
HEAB	High explosive, air burst
HLA	High level architecture

IST	(University of Central Florida) Institute for Simulation and Training
KE	Kinetic energy
LMTS	Laser Marksmanship Training System
LW	Land Warrior
MACS	Multipurpose Arcade Combat Simulator
MOUT	Military operations in urban terrain
MOS	Military occupational specialty
MRC	Madison Research Corporation
MS	Market survey
MWS	Modular weapon system
NAWCTSD	Naval Air Warfare Center Training Systems Division
NET	New equipment training
NETT	New equipment training team
OCSW	Objective crew served weapon
OICW	Objective individual combat weapon
OPFOR	Opposing forces
ORD	Operational requirements document
P3I	Preplanned product improvement
PC	Personal computer
PD	Point detonating
PDD	Point detonating delay
QRI	Qualitative research interview
RBD	Reality by Design
SAST	Small Arms Simulator Testbed
STRICOM	Simulation Training & Instrumentation Command
STRAP	System training plan
STOW	Synthetic theater of war
TA	Target acquisition
TA/FCS	Target acquisition/ fire control system
TADS	Training aids devices and systems
TES	Tactical engagement system
TESS	Tactical engagement simulation system
TI/D	Task identification and description
TOA	Trade-off analysis
TOD	Trade-off determination

TOE	Table of organization and equipment
TRADOC	(United States Army) Training and Doctrine Command
TSP	Training support package
TSRD	Training system requirements document
TTP	Tactics, techniques and procedures
USAIS	United States Army Infantry School
2D	Two dimensional
3D	Three dimensional

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