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A comparison of current naval marksmanship training vs. simulation-based marksmanship training with the use of Indoor Simulated Marksmanship Trainer (ISMT)

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THESIS

A COMPARISON OF CURRENT NAVAL MARKSMANSHIP TRAINING VS. SIMULATION-BASED MARKSMANSHIP TRAINING WITH THE USE OF INDOOR SIMULATED MARKSMANSHIP TRAINER (ISMT)

by

Tommy J. Getty

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Results demonstrate that simulation training improved performance on the seven-yard line to a greater extent than current naval training. Exploratory analyses suggest that simulation training may be most beneficial for less-experienced shooters, and that a minimum of two weeks' time is needed to detect group differences in the retention of skills.

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LIST OF ACRONYMS AND ABBREVIATIONS

CO^2	carbon dioxide
COF	course of fire
COMNAVSURFLANT	Commander Naval Surface Forces Atlantic
CPU	computer processing unit
CZP	center zeroing point
DISALT	Dismounted Infantry Survivability and Lethality Test-bed
DOD	Department of Defense
GM	gunners mates
ISMT	Indoor Simulated Marksmanship Trainer
MA	master at arms
MPI	mean point of impact
SAWS	small arms weapons simulators
SME	subject matter experts
SWOS	Surface Warfare Officer School
VBSS	visit board search and seizure

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I. INTRODUCTION

A. STUDY PURPOSE

The purpose of this thesis was to determine whether simulation-based marksmanship training with the Indoor Simulated Marksmanship Trainer (ISMT) improves marksmanship performance to a greater extent than current naval marksmanship training. This research was intended to provide information on the performance of a shooter to meet a qualification standard and on the retention of skills over time if basic marksmanship training was conducted with the use of a simulator. Any benefits on different methods of training and the quality of the feedback to a trainee can preserve a perishable skill like marksmanship. Naval commands could use the information to effectively maintain gun qualifications for inport duty section watch bills and constant anti-terrorism readiness.

The motivation for this thesis was due to the author's personal experiences of the lack of hands-on weapons training prior to a weapon qualification. The majority of the naval watch standers only handle a gun when they check in and out of the armory. Sailors may know what needs to happen during force protection exercises but may not have the marksmanship skills required to effectively employ their weapon for deadly force. The vessel, board, search and seizure (VBSS) team endured an extensive training program but the majority of ship’s crew does not receive in-depth marksmanship training or experience with live fire. In many cases, when a sailor failed to qualify on the standard navy handgun qualification course of fire (COF) they simply were ordered to the back of the line to shoot again. The anti-terrorism watch officer, chief of the guard, and topside rovers are a few watch standers that rely heavily on the sailors’ ability to remember pre-planned responses. There are pre-requisite weapons qualification required to stand those watches and the quality of that training is critical. Sailors are required to stay sharp and have a high level of knowledge for pre-planned responses to know when to use deadly force, but it is equally important to learn, acquire and practice marksmanship skills for inherent right of self-defense of any naval unit.

This study attempted to identify any benefits in training techniques and procedures for improving marksmanship performance via ISMT. The Navy uses marksmanship simulators at shore facilities for sustainment qualification, at a gun range or conducts a gun shoot on the flight deck while underway in order to ensure gun qualification cards are current for all watch standers. Surface Warfare Officer School (SWOS) in Newport, Rhode Island exposes department head students to a marksmanship simulator that goes over several security scenarios. However, it is uncommon for naval vessels to have a dedicated compartment for a simulator to determine improvement in watch stander marksmanship performance. Ships compile a list of shooters based on expiration of gun qualifications and periodically make the flight deck ready for live-fire training exercises while underway. Any practice prior to a gun qualification is nonexistent due to ammunition onboard, facilities available and/or time constrains. Familiarity with weapon capabilities is based on duty section training and it is uncommon to include dry fire training at the same time. Figure 1 is a picture the author took of his commanding officer during a pistol qualification.

Figure 1. Commander J. L. Killman, Commanding Officer of *USS Elrod* (2012–2013) and GM1 Clay as the range safety officer during a pistol qualification on April 10, 2013.

A qualification conducted while underway adds extra challenges to a sailor because the sea state may create significant pitch and roll that will affect the shooters stability as the flight deck shifts. The targets are weighted down and tied off however the weather could cause the targets to sway if the wind is strong enough. The shooters must adapt and overcome these factors to qualify. By using simulation-based training, sailors can re-enforce their marksmanship skill with repetitive weapon handling drills and receive feedback on accuracy. This technology can be used to add training value to a watch stander onboard a ship regardless of geographic location or time in the current training cycle.

Commander Naval Surface Forces Atlantic (COMNAVSURFLANT) released a naval message, with date time group of R 271735ZFEB14, for a small arms live fire and simulator facility information request. Paragraph 1 of this message reads (COMNAVSURFLANT, 2014).

> Feedback from the fleet indicates a need to analyze the capabilities of navy ranges and small arms weapons simulators (SAWS). In order to determine if efficiencies in scheduling, throughput, operational hours, physical expansion and new construction of small arms ranges are required to meet operational requirements. (p. 1)

With the increase in operational tempo, the U.S. Navy has had little opportunity for sailors to receive training and practice on a live range prior to qualifications. As a result, there has been limited training afforded to sailors who must receive a passing qualification score in order to stand a force protection watch that required a gun. COMNAVSURFLANT further states (COMNAVSURFLANT, 2014):

> …Although Commanders have done an excellent job qualifying personnel, this practice has resulted in insufficient data to make informed operational, budgetary, and resource allocation decisions with regard to range capabilities, limitations, scheduling, maintenance, and the optimization of training. (p. 1)

The ISMT is a portable stand-alone marksmanship trainer that currently is used to help train U.S. Navy and Marines. The ISMT is designed to train sailors and marines in a classroom setting and uses various weapons such as the M9 and M16A2 as its training weapons. It has the capability to train up to four individuals and provides immediate

feedback to the instructor and trainee on weapon trigger pull, cant position, barrel movement, rifle butt pressure, tracing of the muzzle on a weapon prior to and after a shot, and impact grouping. This feedback enables the participants to adjust their weapon accordingly to improve accuracy. More importantly, this feedback allows the instructor to effectively evaluate the individual's technique because the muzzle movement is recorded and displayed for review under a trace profile feature. The human eye may not be able to see what happens to the weapons when the participant pulls the trigger. This tracking technology allows instructors to take advantage of improving the feedback to the shooter for better performance.

The focus of this thesis is to provide data regarding the improvement of training via ISMT. In order to have an effective training program, marksmanship training needs to be divided into three phases: learning what shooting a weapon entails (breathing, etc.); understanding the basic knowledge of weapons handling, techniques, and fundamentals; and execution of skills acquired on a range (Chung, Delacruz, Vries, Bewley, & Baker, 2006). Gunners mates (GMs) and master at arms (MAs) are generally proficient on the first phase because there are several power point tutorials and training instruction that cover what shooting entails. Training weapons are used for the second phase, basic knowledge of weapons handling, techniques and fundamentals; this training typically happens a few months prior to an antiterrorism or force protection certification.

The third phase, execution of skills, is critical, yet is the most lacking in the program in the experience of the author. In the author's experience, sailors are expected to execute skills acquired on a range if a real-world threat presented itself. However, sailors only handle weapons during watch turnover on duty days that occur once or twice a week depending on the number of duty sections. Sailors do not shoot again until their qualification is about to expire in order to maintain the number of duty sections. As previously stated, sailors that fail to meet the marksman category are sent to the back of the line for a second attempt to qualify. If sailors qualify as a marksman or sharpshooter, they are expected to carry out their duties and are not allowed to shoot again. There is no expectation that a sailor needs to perform better or to continue to practice any marksman

skills and techniques. It is this third phase in which simulation training may be particularly useful.

B. LITERATURE REVIEW ON SIMULATED MARKSMANSHIP TRAINING

Below, literature regarding the use of simulation in marksmanship training is reviewed. The focus of the literature review is the few studies that have compared simulation training in marksmanship to live training. Emphasis is placed on studies that specifically examined the ISMT. Baker et al. (2004) conducted research for rifle marksmanship performance focusing on predicting the shooting performance of participants utilizing advance distributed learning environments (i.e., sensing apparatus). Her research showed evidence to suggest a base knowledge component to shooting performance and differences in knowledge of marksmanship. Using the advanced distributed learning environment, she was able to predict the participant's marksmanship scores regardless of the participant's prior performance scores (Chung et al., 2006).

Scribner, Wiley and Harper (2007) conducted a training transfer study using dismounted infantry survivability and lethality test-bed (DISALT) for simulation-based training to determine differences between the dependent performance and subjective measures for a live versus simulated pop-up target shooting with a rifle. They used 12 Army soldiers with a military occupational specialty of indirect fire dismounted infantryman. In their experiment, each participant was exposed to ten trials in a simulation facility and 10 trials on a live fire range (Scribner et al., 2007). Half of the 12 Amy soldiers completed trials in the simulator and then on the live fire range. The other half completed their trials in the opposite order. The results showed no significant difference in the main marksmanship score or hit percentages between the two different types of exercises. In other words, simulation performance was equivalent to live fire performance on main measures of performance. However, differences did emerge on more subtle measures of marksmanship performance: reaction time and radial aiming error. Reaction time was longer and the radial error was lower in the simulated environment. When they were engaged in live fire, they experience more of the elements when compared to people in a simulator and thus react more quickly. Human attributes,

such as rifle movement with a live weapon and rounds, may change the psychological dynamic of the scenario (Scribner et al., 2007). Because of these results, this thesis focused on the use of a simulated 9mm Beretta to prevent this human attribute from affecting the study of standard Navy marksmanship training and simulation-based marksmanship training.

Two studies that specifically focused on the use of ISMT for training were written by Major William Yates (2004) and by Lieutenants Timothy Jensen and John Woodson (2012). Both studies examine training transfer, but Yates used a M16A rifle while Jensen and Woodson used a 9mm Beretta. Yates's study contained two experiments the first experiment evaluated and quantified the effectiveness of the ISMT in training novice shooters in the technical operation of the M16A service rifle. The second experiment assessed whether task performance in the ISMT is of predictive value with respect to the actual task performance using live ammunition on the Marine Corps' standard known distance course of fire (Yates, 2004).

The participants for the first experiment were an all-male platoon of Marine Corp recruits at Edson Range on Camp Pendleton Marine Corps Base, California. The control group had no knowledge of the ISMT and conducted training with a technique referred to as "snapping-in." Snapping-in ordered the participants to assume the shooting position, aim an unloaded rifle with an empty magazine and "dry-fire." Dry-firing is the actuation of the trigger without any ammunition being loaded in the weapon (Yates, 2004). The test group had approximately nine hours of training with ISMT. The control group and test group both utilized the same instructor and had 55 participants in each group.

The second experiment provided insight on the acquisition of marksmen skill with repetitive practice on the ISMT without the presence of a skilled coach. The 28 participants included civilians with no affiliation to the Department of Defense (DOD) and military officers assigned as students and civilian employees at the Naval Postgraduate School (Yates, 2004). Thirteen subjects completed at least seven trials. The other 15 participants completed four or fewer trials. Every participant was characterized as either trained or untrained based on any formal marksmanship instruction. This experiment measured the consistency of their aim based on the average diameter of their

shot groupings. They were expected to fire two strings of three rounds each and the third string fired four rounds. The furthest outlying round of the third string of fire was discarded. These participants lacked the advice of a skilled coach but were briefed on how to use the rifle, fundamentals of good shooting position, weapon support, sight picture and alignment, trigger squeeze and breather control (Yates, 2004).

The results from the first experiment show equivalent performance in marksmanship scores of recruits trained on ISMT versus recruits in a control group without ISMT training. It is important to note that the test group experienced foul weather condition on the last three days that led up to the qualification day, while the control group experienced optimal weather condition all five days leading up to qualification day. Yates's study was able to prove that subjects with ISMT training does not result in negative training transfer (2004). Additionally, there was a positive correlation between simulated qualification COF scores and live fire qualification COF scores (Yates, 2004). The second experiment found no evidence to support that untrained participants produced steady improvement using ISMT without a coach (Yates, 2004). However, a trained shooter retained proficiency and showed small increments of steady improvement without a coach (Yates, 2004).

The results above are somewhat ambiguous, but they indicate that simulator training can lead to equivalent performance as live fire training for certain tasks, and therefore, may be a good alternative when live fire training is unavailable. People may not be ready to replace live fire training with simulated marksmanship training but these advances in marksmanship simulators are vital to improving the performance of a shooter through part task training in a virtual environment. Of note, the above experiments used a rifle as the weapon of choice. A comparison of simulator and live fire training on other weapons, such as pistols is needed.

Jenson and Woodson (2012) informally interviewed approximately 50 Navy officers that served in billets located near the 41 ISMT systems across the fleet and only one person knew ISMT existed. This finding pinpoints the current problem in Navy marksmanship training. By instruction, sailors are expected to use simulators to aid in marksmanship training, yet the Navy commands are not utilizing available assets or

ISMT training facilities are not supporting the fleet. The purpose of their study explored whether simulation-based marksmanship training with ISMT transfers to live fire and provided insight into how long beneficial effects of simulation training lasted (Jenson & Woodson, 2012). Their study used 34 participants of active duty military or faculty at Naval Postgraduate School in a two (control versus simulated training) by two (two or four week gap between training and live fire qualification). Thus, there were four groups: two control groups trained with standard Navy marksmanship training and the two test groups trained with simulation training on ISMT. One control and test group received no additional training after two weeks, and the other control and test group received no additional training after four weeks. All four groups conducted a final live fire Navy handgun qualification course that determined retention of marksmanship knowledge. Importantly, participants were blocked into the groups by self-reported previous marksmanship experience.

The training programs provided were baseline training, control group marksmanship fundamental training and simulation group marksmanship fundamental training. All participants received baseline training and covered safety, weapon conditions and commands, training environment familiarity, and approved firing position. The control groups marksmanship fundamentals covered dry fire procedures, aiming, sight alignment, proper grip and control, trigger pull, breather control and practiced dry fire training. The simulation group marksmanship training covered the same topic but excluded the dry fire procedures because the simulated 9mm Beretta was connected to ISMT and a carbon dioxide (CO^2)bottle in order to provide video and audio feedback and simulated recoil.

The results comparing performance at baseline qualification to live fire qualification found that simulation groups showed significantly less degradation in mean point of impact (MPI) performance than the control group. The MPI provides a more accurate measure of marksmanship performance than score and therefore may be more indicative of how well a watch stander would perform in an actual threat situation (Jenson & Woodson, 2012). It is important to note that the simulation group achieved better MPI performance than the control group at the seven- and 15-yard distance during

post training and performed better at the three-yard distance for live fire. The results on retention show no significant difference in either two or four week gaps. All groups showed a pattern of performance degradation since their post-training but also showed improvement from their baseline qualification to the live fire qualification.

The Navy could benefit from a study that compares current naval marksmanship training and simulation-based marksmanship training. The experiment presented in this thesis assessed whether ISMT can be used as an effective part-task trainer to improve marksmanship performance for the 9mm Berretta on the standard navy handgun qualification COF compared to current naval marksmanship training. Like the Jenson and Woodson (2012) study, participants in this thesis were categorized based on their qualification score in accordance with standard Navy Handgun Qualification COF (Chief of Naval Operations, 2009). The categories are as follows: novices, marksman, sharpshooter, or expert prior to training on the ISMT (Clark, 2010; Chief of Naval Operations, 2009). This thesis also assessed how well participants retained marksmanship skills over a one-week period. Pistol marksmanship training was the focus of this experiment because the majority of the naval security watch standers do not carry rifles. The next section explains the details of the training programs created for this experiment.

C. MARKSMANSHIP TRAINING BACKGROUND

1. Training Requirement

The current naval training requirements are specifically addressed in the small arms training and qualificaiton instruction within enclosure three, paragraph five (Chief of Naval Operations, 2009).

> Before each qualification fire and sustainment training session, all shooters shall receive instruction on marksmanship, safety and weapon familiarization… Shooters shall also practice drawing from the holster, and **must** demonstrate the ability to safely handle and present the weapon to the instructor before live firing. Shooters must also demonstrate knowledge of the four general safety rules, weapons commands, and weapon condition codes before live firing… (p. 2)

All of the required training can be found in the separate enclosures of the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009). Enclosure one covers the range regulations, general safety rules, general range safety rules, range operations, weapons commands, pistol safety rules, and training time out. Enclosure two covers the procedure to properly conduct dry fire training and enclosure three explains the qualification criteria for pistols and the navy handgun qualification course of fire (Chief of Naval Operations, 2009). Enclosure three was used to ensure that the qualification course of fire (COF) scenario created in ISMT was within the current naval standards. This thesis also used the *Force Protection Weapons Handling Standard Procedures and Guidelines* (U.S Fleet Forces Command, 2003), *Pistol Marksmanship* (Headquarters, United States Marine Corps, 2003), the *Combat Training with Pistold, M9 and M11* (Headquarters, Department of the Army, 2003). These reference were used to enhance the training provided by the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009).

D. RESEARCH QUESTIONS AND HYPOTHESIS

1. Question One

Can the ISMT be used as an effective part-task trainer to improve marksmanship performance for the 9mm Berretta on the standard Navy handgun qualification COF?

Null hypothesis (H0): Participants who receive simulation-based marksmanship training in ISMT will have the same amount of improvement, from the baseline qualification to the training qualification, in marksmanship performance and scores on the standard navy handgun qualification COF than the participants who received current naval marksmanship training. The control group and the experimental group will have the same level of improvement regardless of the marksmanship training provided.

Alternate hypothesis (HA): Participants who receive simulation-based marksmanship training in ISMT will have a greater improvement, from the baseline qualification to the training qualification, in marksmanship performance and scores on the standard navy handgun qualification COF than the participants who received current

naval marksmanship training. The experimental group will improve more than the control group as a result of the marksmanship training provided.

2. Question Two

If a participant in the experimental (simulation) group does not pass the baseline standard navy handgun qualification COF, will they have a better chance of meeting the marksmanship standard after receiving simulation-based training in ISMT than a participant in the control group?

H0: Among those who do not meet the qualification standard for the standard navy handgun qualification COF at baseline, there will be an equal number of participants in each group who do not meet the qualification standard after their simulated marksmanship training. Those in control group and the experimental group that fail the baseline COF will have the same level of improvement regardless of the marksmanship training provided.

HA: Among those who do not meet the qualification standard for the standard navy handgun qualification COF at baseline, a greater number of participants in the experimental group will reach the qualification standard after simulation-based marksmanship training than in the control group. Those in the experimental group that fail the baseline COF will improvement more than those control group that fail the baseline COF as a result of the marksmanship training provided.

3. Question Three

Will participants in the experimental (simulation) group have a better chance of retaining what they learned after one week of no instruction, than participants in the control group?

H0: Participants in each group will be equally likely to maintain their marksmanship performance and scores on the retention standard navy handgun qualification COF one week after the training qualification. Those in the control group and the experimental group will retain the same level of marksmanship skill after a week of no training.

HA: Participants in the experimental group will be more likely than those in the control group to maintain their marksmanship performance and scores on the retention standard navy handgun qualification COF one week after the training qualification. Those in the experimental group will retain a higher level of marksmanship skill than the control group after a week of no training.

4. Overview of Thesis

A demographic survey was administered to all participants prior to the beginning of the experiment (see Appendix H). A baseline qualification assessed their current level of marksmanship performance. The participants' baseline scores along with their reported previous experience on the demographic survey were used to block the participants into the control and experimental groups. The performance measurements and score on the baseline qualification were recorded before the participants received any simulated marksmanship training. The second handgun qualifications were administered after the control and experimental groups receive their designated simulated marksmanship training to establish any main effects from their baseline. Participants did not receive additional training for a week and the instructor administered a final handgun qualification to establish retention of marksmanship skills.

E. THESIS ORGANIZATION

The introduction chapter provides the rationale behind this thesis. The literature review gives focused overview of studies in the field of marksmanship and how previous work lead up to this thesis. The background information on marksmanship training is an explanation of the current naval standards, and naval training requirements .The research questions and corresponding hypotheses are listed, as well as an overview of the experiment.

The methods chapter explains the research design, demographic characteristics of the participants, equipment and scenarios, main measures, and procedures. The research design section provides a depiction of independent and dependent variables followed by a list of controls used to conduct the experiment. The next section goes into the process of how participants were recruited and a description of how they were split up into either the

control group or experimental group. The methods chapter closes with an explanation of the procedures to conduct the experiment and provide enough detail for future thesis students to repeat the same work.

The results chapter provides the results of the experiment starting with a broad look at the descriptive statistics and then describing the results for each hypothesis. The discussion chapter leads into an interpretation of the findings based on the significant and non-significant results.

The last chapter is the conclusions and recommendations. This chapter focuses on any shortcomings and how to improve future work. This chapter also identifies all ISMT technical difficulties with the software while creating the naval standard handgun qualifications scenarios and the malfunctions with seven of the M9 Berettas.

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II. METHOD

A. STUDY OBJECTIVES

The objective of this thesis was to determine any changes on marksmanship performance based on the type of training a participant received. The ISMT was used as a part task trainer to help participants in the experimental group learn how to fire a pistol one step at a time. Dry fire training was conducted with the control group for the same purpose of teaching marksmanship. The experiment determined if simulation-based training conducted in ISMT was able to increase marksmanship performance to a greater extent than a training program that meets current naval marksmanship requirements.

1. Research Design

The experimental design for this thesis utilized between-groups comparisons in which participants were blocked by previous marksmanship experience. The independent variables were the different training programs: the control group and experimental group. The control group received current naval marksmanship training that went over fundamentals of marksmanship followed by untimed dry fire and a practice qualification that implemented time limits. The experimental group received simulation-based marksmanship training that consisted of fundamentals of marksmanship followed by untimed simulation practice and a practice qualification that implemented time limits.

2. Training Methods Used

A brief overview of the procedure was administered to the participants before they received what was referred to as baseline training in this thesis. The participant then received their baseline qualification. Enclosure one of the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009) was used to ensure that the safety training requirements were met. The purpose of this training was to establish a basic level of knowledge for participants that have never fired a weapon. All the participants were from the Naval Postgraduate School (NPS); however the level of marksmanship skill at the beginning of the experiment will drastically vary depending on

if a participant is a civilian (either a NPS student or facility and staff) or active duty military (assigned to NPS). The participants that were active duty could still have a lot of variability in their skill level because of the different services.

With all the many possibilities, the baseline training program ensured that at a minimum, everyone started with a basic understanding of the requirements for this experiment. The training covered how to use the M9 Berretta, and explained the specific weapon commands used in the experiment. Refer to Table 1 for the content of the entire baseline training program.

Baseline Training
General Range Safety Rules
General Safety Rules
Weapon Conditions
Weapon Commands
Pistol Safety Rules
Ready Line
Firing Line
Range Operations
Training Time Out
Loading the Pistol
Making the Pistol Ready
Fire
Cease Fire
Unload, Showing the Pistol Clear
Dry Reload
Isosceles only
Isosceles Standing Position
Isosceles High Kneeling Position

Table 1. Baseline Training Program

It is important to note that no marksmanship fundamental training was provided because the purpose of the baseline qualification was to capture the level of marksmanship skill that each participant had at the beginning of the experiment.

The second training programs that the participants received were used to determine if there were any changes from the baseline qualification. The second chapter

of both the *Force Protection Weapons Handling Standard Procedures* and *Guidelines* (U.S Fleet Forces Command, 2003), and the *Pistol Marksmanship* (Headquarters, United States Marine Corps, 2003) were also used to establish the baseline training program. It is also essential to note that the last part of the baseline training program specifically addressed the isosceles firing positions. Refer to Figure 2 for a picture of the isosceles standing position and refer to Figure 3 for a picture of the isosceles high kneeling position.

Figure 2. Isosceles Standing Position from Pistol Marksmanship (from Headquarters, United States Marine Corps, 2003)

Figure 3. Isosceles High Kneeling Position from Pistol Marksmanship (from Headquarters, United States Marine Corps, 2003)

According to the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009) the isosceles and Weaver firing positions were acceptable. The Weaver stance was not allowed in this thesis because of the difficulty in maintaining controls for the experiment. The instructors would have had a difficult time trying to ensure that every participant assumed the exact same Weaver standing position every single time. The Weaver high kneeling position would have provided so much support that it would have been more difficult to determine if the participant was actually utilizing the proper breathing technique, sight picture and sight alignment. The isosceles high kneel position would have provided enough support for the participant to maintain their balance. It would have also been just enough instability to make it easier to determine if the participant used proper marksmanship fundamentals. Refer to Figure 4 for a picture of the Weaver standing position and Figure 5 for a picture of the Weaver high kneeling position.

Figure 4. Weaver Standing Position from Pistol Marksmanship (from Headquarters, United States Marine Corps, 2003)

Figure 5. Weaver High Kneeling Position from Pistol Marksmanship (from Headquarters, United States Marine Corps, 2003)

The control group training program was created by using enclosure two of the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009), Chapter 2 of the *Force Protection Weapons Handling Standard Procedures and Guidelines* (U.S Fleet Forces Command, 2003), and Chapter 3 of the *Pistol Marksmanship* (Headquarters, United States Marine Corps, 2003). The participants were allowed to handle the M9 Berretta and follow along with the recorded lessons. It was important that the participants were afforded the opportunity to practice without any time constraints. During the lecture, the participants focused on slow, smooth and methodical motions when drawing and dry firing the pistol. The participants in the control group received 18 minutes of recorded lecture. Refer to Table 2 for a complete list of the items covered in the lecture.

Control Group Training
Dry Fire Safety Training
Drawing Process
Grab
Draw
Smack
Look Squeez
Holstering
Introduction to Fundamentals
Aiming
Sight Alignment
Establishing Sight Alignment
Grip with respect to (WRT) Aiming
Controlled Muscular Tension
Sight Picture
Relationship Betweent the Eye and the Sights
Trigger Control
Sight Alignment and Trigger Control
Grip WRT Trigger Control
Trigger Finger Placement
Uninterrupted Trigger Control
Interrupted Trigger Control
Breath Control
Begin Dry Fire Training
Single Action
Five to Ten Times Repitition
Start Adding Time Limits
Draw Sweep Safety Dry Fire

Table 2. Control Group, Marksmanship Fundamental Training Program

A practice qualification was administered to the control group after completing the marksmanship fundamentals lecture. The M9 Berretta was disconnected from the ISMT which prevented the use of carbon dioxide (CO^2) and only dry fire training techniques was used. The purpose of this practice was to implement time constrains and to build the participants' expectations towards a navy handgun qualification. There was a pause between trials at the three, seven and 15-yard line. This pause was provided to the instructor in case any training was required for the participant to maximize training needs. Upon completion of the practice qualification, no further training was administer for the duration of their involvement with the experiment. A second qualification was

administered to the participants in the control group to determine any main effects as a result of the current naval marksmanship training program. After a week of no further training the participants came back on the same day of the week and time of day for a third qualification. This qualification was done to determine if any of the participants retained any marksmanship skill.

3. Use of ISMT

The experimental group training program was created in a similar manner, but without using enclosure 2 of the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009). Instead of conducting dry fire during the marksmanship fundamentals training lecture, they received simulation-based training that provided instant feedback from the ISMT. The current simulator training requirements for the navy are specifically addressed in the small arms training and qualificaiton instruction within Enclosure three, paragraph 5 (Chief of Naval Operations, 2009).

> Where available, simulator training shall include marksmanship training drills to assist instructors in identifying and correcting personnel shooter fundamental errors. Courses of fire should be programmed into the simulator to provide personnel the opportunity to simulate firing the COF prior to live fire operations. (p. 3)

The participants received 16 minutes of recorded lecture. The control group lecture was 2 minutes longer because it took longer to read the requirements for dry fire versus simulation training requirements. The difference in time did not cause any drastic differences between the two groups. The experimental group replaced the time lost in the lecture with time to review trace profiles from their baseline qualification during the pauses in between stages of the practice qualification. Refer to Table 3 for a complete list of the items covered in the experimental group, marksmanship fundamentals lecture.

Simulation Group Training
Simulation Safety Training
Drawing Process
Grab
Draw
Smack
Look Squeez
Holstering
Introduction to Fundamentals
Aiming
Sight Alignment
Establishing Sight Alignment
Grip with respect to (WRT) Aiming
Controlled Muscular Tension
Sight Picture
Relationship Betweent the Eye and the Sights
Trigger Control
Sight Alignment and Trigger Control
Grip WRT Trigger Control
Trigger Finger Placement
Uninterrupted Trigger Control
Interrupted Trigger Control
Breath Control
Begin Simulation Training

Table 3. Experimental Group, Marksmanship Fundamental Training Program

The participants were allowed to handle the M9 Berretta and follow along with the recorded lessons. During the lecture, the participants focused on slow, smooth and methodical motions when drawing and dry firing the pistol. The simulation group received immediate feedback from the ISMT because the weapon displayed where the shots were fired on the target. They experienced the simulated recoil from the CO^2 tanks and the ISMT simulated the sound of a pistol being fire as audio feed back. The training scenario created for this phase of the training is called unlimited practice and its purpose is to provide the participants with information identifying which shot was the last one fired and displayed a value associated with that last shot. The scenario permanently displayed three targets to the participant to represent the actual size of the three, seven and 15 yard line targets. The control group saw the same scenario for the same phase of their dry fire training except the M9 Berretta was disconnected from the ISMT.

A practice qualification was administered to the simulation group upon completion of the marksmanship fundamentals training lecture. The practice qualification paused in between the three, seven and fifteen yard line stages of fire. Unlike the control group, the simulation group had an opportunity to review 48 trace profile pictures before they shot the practice qualification. These trace profile pictures were recorded after their baseline qualification. The participant viewed all twelve shots fired at the three-yard line and tried, with the instructor, to gather any information addressing marksmanship fundamental errors. Then the participants shoot the three-yard line stage of the practice qualification. The ISMT scenario was paused to give the instructor time to present the next 12 trace profiles pictures of shots fired at the seven yard line from the baseline qualification. After the participant learned from the instructor's comments about the trace profile pictures they shot the seven-yard line stage of the practice qualification. The same process applied for the pause between the seven and 15-yard line.

Upon completion of the practice qualification, the participant had an opportunity to review the three-, seven- and 15-yard line shot group data for the practice qualification they just fired. This data provided feedback of their performance and the instructor identified any errors that can be addressed before the second qualification was administered to the participant. Once the second qualification began the participant no longer received any assistance from the instructor and had to rely of what they learned. After a week of no further training the participants came back on the same day and time for a third qualification. This qualification session was administered to determine participants' level of marksmanship skill retention.

All participants completed three qualifications. The first provided baseline marksmanship skills. The second was used to determine the effect of the training. A third qualification was administered to both groups exactly one week after the completion of training to determine if the participants retained their marksmanship skills. The dependent variables were the various marksmanship performance data that ISMT provided at the end of each qualification. Marksmanship performance was measured by diameter size of average shot group, diameter size of shot group for the three, seven and 15 yard line, length of mean point of impact to center zeroing point (MPI to CZP) for the

three-, seven- and 15-yard line, and scores on the standard navy handgun qualification COF.

Research Design									
Controls	55 Minutes Max per session	Recorded Course of Fire Instructions	Isosceles Standing Position	Isosceles High Kneeling Position	1 Week Between 2nd and 3rd Qual	Baseline and Fundamentals Training	Security Belt with Holster	Firing Line	M9 Beretta
Independent Variable	Current Naval Marksmanship Training	Simulation Based Marksmanship Training							
Dependent Variable	Average Shot Group Size	Qualification Score	Skill Level Rating	3 Yard Line Shot Group Size	7 Yard Line Shot Group Size	15 Yard Line Shot Group Size	3 Yard Line MPI to CZP	7 Yard Line MPI to CZP	15 Yard Line MPI to CZP

Table 4. Research Framework

4. Standardization of Methods and Reduction of Confounds

There were several controls in place to ensure standardization among the participants and to prevent any foreseeable confounds. Refer to Table 4 for a synopsis of the main variables of interest, and the factors that were controlled in the experiment. The majority of the participants were students and the maximum allotted time per session was 55 minutes. This time duration allowed students to participate in the study without interfering with any class schedule. To ensure that one group did not get an unfair advantage, close attention was paid to the amount of training time.

Additionally, the author conducted a class project (i.e., a pilot study) to learn how to use ISMT and to refine the experiment for this thesis. In the class project, the instructors read the instruction for the qualification COF and conducted the marksmanship training in between the baseline (first) and training (second) qualification. A retention (third) qualification was not part of the class project. The author determined that recording all the instructions for the COF and all the marksmanship stimulus training ensured that the participants were not affected by an inconsistent instructor. The ability to repeat the same playlist ensured that one group did not have an advantage over the other because of different teaching styles. Prerecorded media files also assisted the instructor with managing fatigue and lose of vigilance.

The decision to make every participant utilize the isosceles firing positions was an attempt to avoid any confounds between different stances. It was difficult to say that a person does not have an advantage over another simply because one person decided to use a Weaver firing position instead of the isosceles firing position. The isosceles standing position was easier and ensured that every participant was consistent. The shoulders had to be square to the target at all times and the feet had to be approximately shoulder width apart every time. It was very difficult to ensure that every participant had the same Weaver standing position, because there was no way to determine that each person had their body turned at the same angle every time. To reduce the amount of variability in this experiment the Weaver firing positions (standing and kneeling) were not allowed.

The isosceles high kneeling position was an attempt to ensure that every participant will assume the same position every time. A kneeling position was more important because the author wanted to make sure the participants were implementing their marksmanship skills that they acquired from the marksmanship stimulus training. The pistol is constantly moving and the participants had to focus on their breathing, sight picture and sight alignment along with the other fundamentals. In the Weaver high kneeling position, the participants could sit on their foot and rest their elbow on their knee to try and stabilize their body.

By forcing every participant to assume the isosceles high kneeling position, the author reduced the amount of variability in marksmanship performance that could be accounted for by differences in position. This position forced the participants to focus on all the elements of marksmanship fundamentals similar to the standing position. If the participant failed to maintain proper muscular tension or properly place the finger on the trigger then the performance should vary more in the isosceles high kneeling position as opposed the being supported from the leading knee and sitting on the back foot with the weaver high kneeling position.

Every participant stayed behind the firing line during training and qualifications. They stayed behind the ready line until instructed to move forward to the firing line by the instructor. A blue sticker was placed as a guide to help all participants center

themselves on the target at all times. Every participant used the same holster, which was connected to the security belt, and the pistol rested on the side of the hip next to the participants shooting hand. If the security belt did not fit a participant, the instructor detached the same holster and attached it to the participant's personal belt. The author assumed that the difference in belt type would not have a significant effect on the study, but made sure that every participant used the same style of holster to draw from.

The participants ensured that before agreeing to the day and time of their second qualification that the same day and time was available for the following week. The procedure ensured that one group did not have an unfair advantage over the other simply because someone waited longer to complete their retention (third) qualification. Marksmanship is a perishable skill and the purpose of the retention phase was to determine if participants would retain what they had learned. It would not be fair if some participants waited two weeks when everyone else had one.

B. PARTICIPANTS

1. Establishing Control or Experimental Group

Participants were recruited by email or in person to volunteer for the experiment. The participants received the recruitment email with the demographic survey attached. They were instructed to fill out the demographic survey and submit it prior to their first qualification. After the participants completed their baseline qualification, the instructor reviewed their score and demographic survey and ranked the participant from highest to lowest. Participants were then blocked by this rank into the control and experimental groups. This process attempted to ensure that each group had similar distributions of marksmanship ability. It is important to note that the focus of the experiment was not the scores after completion of each qualification, but the difference between the scores on all performance measures to show any changes. For example, if a participant started out as an expert on the baseline (first) qualification, changes in his/her performance could still be detected by the individual performance measures, such as shot groups and MPI to CZP lengths.

2. Demographic Statistics

A demographic survey was administered to every participant at the beginning of the experiment to try and get an understanding of their level of marksmanship. This information along with their baseline score was required in order to assign them to the control or experimental group. Refer to Table 5 for descriptive statistics on participants' demographic characteristics. Refer to Appendix H for a copy of the demographic survey.

Demographic Survey	Control Group	Experimental Group
Age 18-25	0.07	0.13
Age 26-30	0.27	0.27
Age 31-35	0.40	0.33
Age 36-40	0.20	0.27
Age 41+	0.07	0.00
Male	0.87	0.80
Right Handed	0.93	0.93
Wear Corrective Lens	0.13	0.27
Civilian	0.07	0.27
Military	0.93	0.73
Navy	0.47	0.40
Army	0.20	0.20
Marine	0.13	0.00
Air Force	0.07	0.07
Inter Student	0.07	0.07
Year of Service (Mean)	11.63	8.47
Year of Service (SD)	5.43	6.51
Marksmanship Experience		
Novice	0.27	0.33
Marksman	0.33	0.40
Sharpshooter	0.33	0.07
Expert	0.07	0.20

Table 5. Descriptive Statistics on Participants' Demographic Characteristics

The demographic survey revealed that there were no significant differences between the control and experimental group based on age group, gender or dominant hand. The experimental group had more participants that wore corrective lens than the control group. The author ensured if a participant started the experiment with or without

their corrective lens that they consistently used/didn't use their corrective lens through the entire experiment. The experimental group also had a few more civilians and self-reported novices, but the control group had fewer self-reported experts. It is also important to show that the percentages of participants in separate branch of services are close, but the control group had more years in service. In summary, the two groups differed only in years of service and in the number of self-reported sharpshooters and novice.

3. Participant Agenda

The purpose of this section is to provide description of the scheduling requirements expected from every participant. The schedule also explains the chain of events from a day-to-day projection. Refer to Table 6 for the participant schedule.

Week 1			
Monday	Tuesday	Wednesday	Thursday
Control Group Baseline Qual	Control Group Training Qual	Simulation Group Baseline Qual	Simulation Group Training Qual
Day1	Day2	Day3	Day4
Week 2			
Monday	Tuesday	Wednesday	Thursday
	Control Group Retention Qual		Simulation Group Retention Qual
	Day9		Day11

Table 6. Participant schedule

(Day 0) A demographic survey was administered to all participants prior to the beginning of the experiment so as to be able to block participants into the control and experimental groups by previous marksmanship experience. It contained questions that asked about the participants' characteristics, marksmanship skill level and experience.

(Day 1) The ISMT qualification on the standard navy handgun qualification COF was administered to the control group to establish a baseline of their current level of marksmanship performance and score. Their baseline qualification score and the information on the demographic survey from day 0 were used to block participants into

the control and experimental groups. The standard navy handgun qualification COF procedure was checked by a subject matter expert (SME) in order to ensure that the proper instruction was given.

(Day 2) The control group received current naval marksmanship training, which involves handling a simulated 9mm Berretta, practicing proper techniques for standing, breathing, and doing dry fire. ISMT qualification on the standard Navy handgun qualification COF was administered to determine the main effects of the training on the control group's marksmanship performance and score. The current naval marksmanship training was checked by a SME in order to ensure that the proper training was given.

(Day 3) The ISMT qualification on the standard navy handgun qualification COF was administered to the experimental group to establish a baseline of their current level of marksmanship performance and score. Their baseline qualification score and the information on the demographic survey from day 0 were used to block participants into the control and experimental groups. The standard navy handgun qualification COF procedure was checked by a SME in order to ensure that the proper instruction was given.

(Day 4) The experimental group received simulation-based marksmanship training in the ISMT. This training involves handling a simulated 9mm berretta, practice proper techniques for standing and breathing. These participants also had the opportunity to fire practice shots at simulated targets, analyze their trace profiles and shot groups. The immediate feedback provided by ISMT was the only aspect of the training that was different from the control group. ISMT qualification on the standard Navy handgun qualification COF was administered to determine the main effects of the training on the experimental group's marksmanship performance and score. The simulation-based marksmanship training was checked by a SME in order to ensure that the proper training was given.

(Days 5–8) No additional training was provided.

(Day 9) ISMT qualification on the standard navy handgun qualification COF was administered to the control group. This determined how much marksmanship training the participant had retained.

(Day 10) No additional training was provided.

(Day 11) ISMT qualification on the standard navy handgun qualification COF was administered to the experimental (simulation) group. This determined how much marksmanship training the participant had retained.

During all training and qualification assessments, data regarding participants' performance score, diameter of shot groups, and trace profiles were collected. After the participants had left the ISMT lab, a digital camera was used as backup to collect performance and score data that was projected on the screen. The participants were not video or audio recorded at any time.

C. EQUIPMENT

This section describes the ISMT and how it works. The ISMT enclosure holds the computer processing unit (CPU), amplifier and a flip up monitor attached to a keyboard. The following components are also a part of the ISMT suite; two speakers, projector, projector screen, hit camera, simulated M9 Berretta and a CO^2 tank. The CPU synchronized all the components in order to run the simulator. The ISMT lab for this thesis utilized an additional computer monitor and keyboard so that ISMT can be controlled from multiple stations. The CPU sent video data to the projector that projected an image on the screen mounted against the wall ahead. The participant fired a round at a target on the screen with a M9 pistol that is connected to the CPU and a carbon dioxide (CO^2) tank. The CO^2 tank released gas that was used to simulate recoil in the pistol. The pistol sent an infrared beam out of the barrel and that signal was received by a hit camera that is connected to the CPU. The CPU sent an audio signal to the amplifier which is connected to two speakers located on the floor, to the right and left of the screen. The speakers simulated the sound of a M9 pistol being fired. The CPU calculated the shot fired based on the information received from the hit camera and presented the marksmanship performance data at the end of the qualification. Refer to Figure 6 for a picture of the ISMT major components. The labels were added to the picture to assist identifying components.

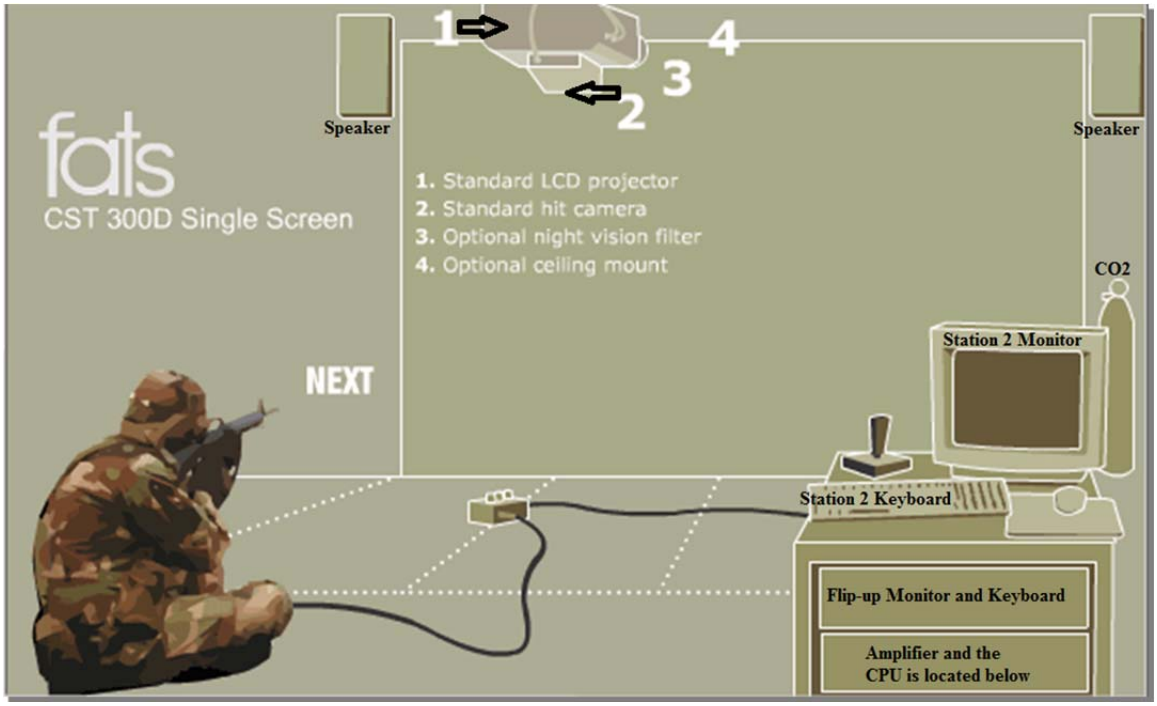


Figure 6. ISMT Major Components (after Schwetje, 2009)

1. Building Scenarios

The ISMT used in this experiment was the Marine Corp version. All the preinstalled training programs were within the Marine Corp standards. Therefore, the author programmed the ISMT to establish the navy handgun qualification standards. The following paragraphs will describe each of the scenarios and its purpose.

a. Zero Scenario

The zero scenarios for each of the three, seven and 15-yard lines were created. In real life, a pistol does not get zeroed like a rifle because the sights do not move. But these scenarios ensured the accuracy of the simulated pistol, thus the zero scenarios were used. The zero scenarios were also used for quick operational test of the M9 Berettas, which assisted with trouble shooting replacement pistols to ensure their integrity during the experiment. All zero scenarios have no time limit and have only one magazine of three rounds. Refer to Appendix B, C and D for screen captures of every setting to recreate the three, seven and 15 yard line zero scenarios.

b. Qualification Scenario

The qualification scenario was the most important because all the data collection would come from the results of the qualification at the end of the scenario. After a few trials the author determined it was best to have a target to represent the distance of three, seven and 15-yard line. The targets would not appear until the recorded COF introduction instructions were completed. Then the targets appeared prior to the first shot of that particular stage of fire. The targets disappeared after the last cease-fire instruction was completed per stage. This allowed the participants to focus on the instructions versus the target. Refer to Table 7 for a complete list of all the stages and required sequence of fire.

Navy Handgun Qualification Course			
Yard Line	Sequence	Time Limit	Remarks
3 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
3 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
3 Yards	Draw and fire 2 rounds, reload and fire 2 rounds	10 seconds	Strong Hand Supported
3 Yards	Draw and fire 4 rounds	8 seconds	2 rounds Strong Hand, 2 rounds weak Hand supported
7 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
7 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
7 Yards	Draw and fire 2 rounds, reload and fire 2 rounds	10 seconds	Strong Hand Supported
7 Yards	Draw and fire 4 rounds	8 seconds	2 rounds Strong Hand, 2 rounds weak Hand supported
15 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
15 Yards	Draw and fire 2 rounds	4 seconds	Strong Hand Supported
15 Yards	Draw and fire 4 rounds	8 seconds	Strong Hand Supported
15 Yards	Draw and fire 4 rounds, reload and fire 4 rounds	20 seconds	Strong Hand Supported
15 Yards	Draw and fire 8 rounds	20 seconds	Strong Hand Supported

Table 7. Navy Handgun Qualification COF

The qualification scenarios provided the participant with two magazines (six rounds in each magazine) for the three and seven yard line COF. The 15-yard line had two magazines with 12 rounds in each magazine. The recorded navy handgun qualification COF commands were used to administer the qualification. The scene selected for this scenario was a picture the author took of a flight deck looking out at sea. The image was imported into ISMT and the intention was to help the participant develop a navy centric experience of a handgun qualification out at sea. Refer to Appendix E for screen captures of every setting in the qualification scenarios.

c. Unlimited Practice Scenario

The unlimited practice scenario was created so that all participants could practice with an unlimited amount of time. The participants were presented with a three, seven and 15-yard line targets on the screen to take practice shots. The control group utilized this scenario to conduct dry fire training and practice taking aim at the targets. The pistol was disconnected from the ISMT and the CO^2 tank. This procedure ensured that the participants in the control group did not receive any immediate feedback from the ISMT. The control group only received immediate feedback from the instructor. The instructor paid close attention so that a pistol is connected or disconnected based on the training phase or if the participant was in the control group versus the experimental group.

This scenario provided an unlimited supply of magazines to the experimental group. ISMT does not account for an unlimited supply of magazine but provided the maximum allotted magazines with six rounds in each magazine. The author decided that in order to maximize training, the magazines should have six rounds instead of 12 rounds because it forced the participants in the experimental group to reload the pistol frequently. The scenario provided instant feedback to the participant in the experimental group. Experimental group participants were able to view a silhouette of the targets in a blue box at the top of the projection screen. If the participants in the experimental group had a hard time seeing a target silhouette to track the position of the shots fired, they were allowed to look at the instructor's computer monitor. The monitor displayed the same information but with a zoomed in view.

All the participants were asked to square their shoulders to the target by shuffling to the right or left. This adjustment ensured that the targets were centered in front of the participant when they practiced firing the pistol. The author did not want to risk any negative training with the participants by allowing them to stand in one place and shoot at a target offset or not directly in front of the shooter. If the instructor allowed the participant to aim at a target off to the side rather than directly in front, the participant looked at an improper sight picture and sight alignment. In order to ensure the continuity of good sight picture and sight alignment, the participants needed to see the same thing

every time. Refer to Appendix F for screen captures of every setting to recreate the unlimited practice scenario.

d. Practice Qualification Scenario

The practice qualification scenario was almost identical to the qualification scenario except there were pauses between the three, seven and 15-yard line. This scenario had two more sub serials than the qualification scenario. Refer to the ISMT manual and Appendix G for information on sub serials. The scenario provided a view of the target's silhouette in a blue box for the experimental group. These targets were located at the top of the projection screen the above the actual target that the participants fired at. If the participants had a hard time seeing the silhouette to keep track of the position of the shots fired, they were allowed to look at the instructor's computer monitor that displays the same information but with a zoomed in view. The control group also used this scenario but the pistol was disconnected from the ISMT and the CO^2 tank. The instructor paid close attention so that a pistol is connected or disconnected based on the training phase or if the participant was in the control group versus the experimental group. The same amount of magazines and rounds in the qualification scenario applied to the practice qualification. The recorded navy handgun qualification COF commands were used to administer the qualification. Refer to Appendix G for screen captures of every setting of the practice qualification scenario.

2. Voice Recording Instructions

The author decided that it was imperative the participant received their basic training, control group stimulus training or experimental group stimulus training, and instructions for the standard navy handgun qualification COF from a recording. The author planned on having 30 participants and each participant had to qualify three times each. He felt that he would not be able to deliver the instructions and training the exact same way throughout the entire data collection period. Special care was required in the creation of the media files and timing the ISMT scenarios so that the targets appeared and disappeared in a timely manner.

3. Lab Setup

The ready line and firing line was established by laying duct tape for the firing line and masking tape for the ready line. The instructor also posted a copy of the four general safety rules so that participants viewed and referenced them at all times. It was important to have a separate laptop connected to speakers so that the instructor played the playlists independently of the ISMT. Before the experiment began, special care was taken with ISMT preparations by calibrating the hit camera after the system startup. After the system was up and running and the system calibration was complete then the M9 Berretta went through a weapon registration and weapon calibration. At this point the instructor began to collect data. Every participant went through a shooter registration in ISMT to help keep track of the participants' four-digit identification.

4. Data Recording

Based on lessons learned in a class project, the author decided it was best to have several backup systems for data collections. Pictures were taken at the completion of every qualification. The instructor took pictures of the results page, all the shot groups, all the MPI to CZP groups and all 48 trace profiles for every shot fired in the qualification. An Excel spreadsheet also was used to collect data and conduct statistical analysis. The instructor printed out the results data after the pictures were taken and the data was transferred to Excel. The print outs were filed in case any electronic files became corrupted or lost.

D. MAIN MEASURES

The main measures for this experiment were the various marksmanship performance data that ISMT provided at the end of each qualification and a post experiment survey. This section lists each of the performance measures used. It also provides a description of how they were scored and indicates whether higher or lower scores were better.

1. Scores on the Standard Navy Handgun Qualification COF

These scores are based on points earned depending on which region of the target was hit. The more points a participant received for a qualification, the better. Marksmanship improvement with this measure was determined when participants received higher scores on training (second) qualification than the baseline (first) qualification. The same determination was made when a participant received higher scores on the retention (third) qualification than the training (second) qualification. Thus, positive difference scores (e.g., training scores—baseline scores) indicate improvement. Transtar II targets were used for this experiment and were in accordance with small arms training and qualificaiton instruction, enclosure seven, section 1A (Chief of Naval Operations, 2009). The target was split up into six regions. Region one was worth zero points, region two was worth two points, region three was worth three points, region four was worth four points, region five and six were worth five points. Refer to Figure 7 for a picture of a transtar II target. The image also identifies the regions of the target.

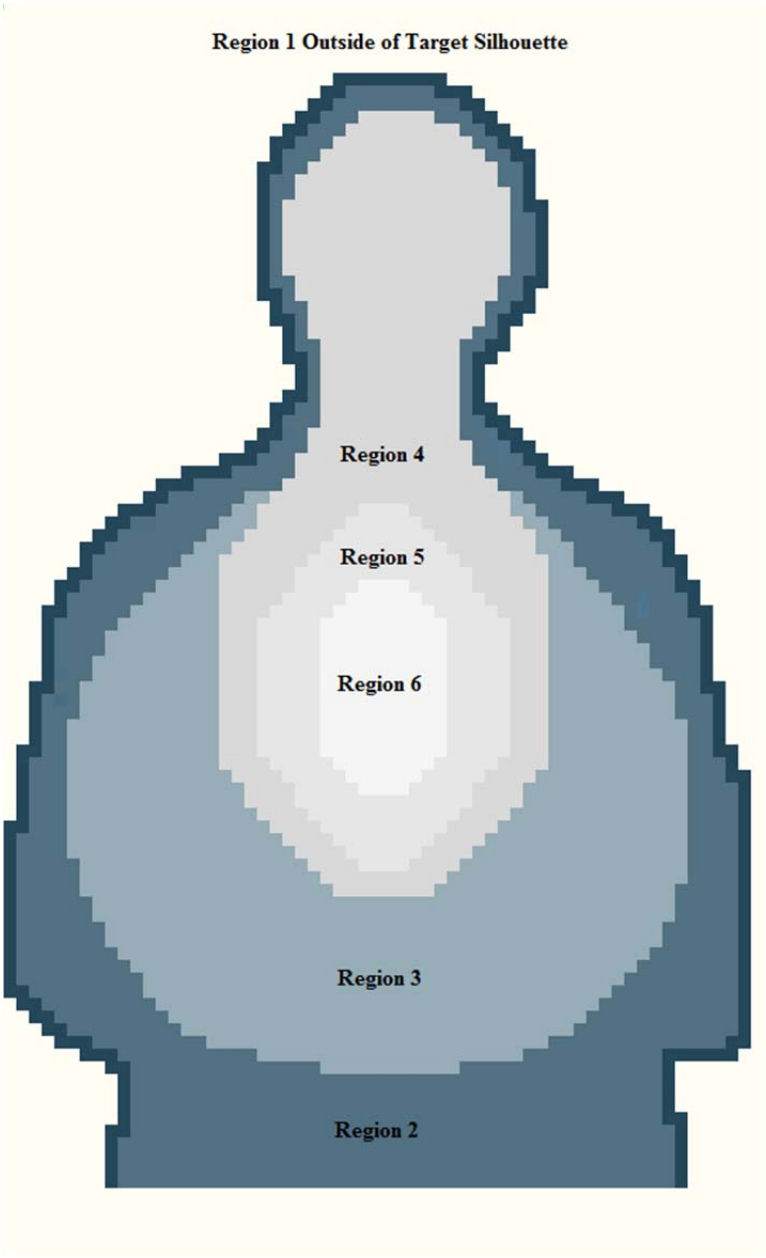


Figure 7. Transtar II Target with Region Labels

2. Diameter Size of the Shot Group

Marksmanship performance was measured by the diameter size of the three, seven and 15-yard line shot group. Diameter size measures variability in shot consistency. All shot group size diameters were measured in centimeters and a participant showed improvement when the diameter decreased over time. Therefore, negative difference

scores (training scores - baseline scores) indicate improvement from baseline to training. Special consideration determined it was best to only use three targets that represented the three, seven and 15-yard line. The scenarios could not use a new target for every step during the COF because ISMT cannot determine a shot group diameter with only two rounds. Therefore, the three and seven yard line targets received 12 rounds each, while the 15-yard line target received 24 rounds.

3. Average Shot Group

Average diameter size measures variability in shot consistency. All shot group size diameters were measured in centimeters and a participant showed improvement when the diameter decreased over time. Therefore, negative difference scores (training scores - baseline scores) indicate improvement from baseline to training. Thus, as in the diameter size of shot groups, negative difference scores in the average shot group indicate improvement.

4. MPI to CZP

The length of mean point of impact to center zeroing point (MPI to CZP) measures the average distance of the shot fired to a fixed point on the target. The fixed point on the target was determined by the author when he placed it in the center of region six, during the creation of all the targets. MPI to CZP was measured for the three, seven and 15-yard line. The length of MPI to CZP also was measured in centimeters and a participant showed improvement with accuracy when the length decreased over time.

5. Demographic Survey

The demographic survey was administered in order to block participants into the control and experimental groups. It contained questions that asked about the participants' characteristics, marksmanship skill level and experience.

6. Post Experiment Survey

After completing the experiment, participants were asked four open ended questions to determine their thoughts about the experiment, how they felt about

simulators and if they were willing to replace real marksmanship practice with simulated marksmanship practice. Refer to Appendix I for a copy of the post survey. The data cannot determine if an improvement occurred in the participant's opinion because a preliminary open-ended survey was not administered.

III. RESULTS

A. DATA PREPARATION AND PRELIMINARY ANALYSES

This chapter will report results from hypothesis testing for this thesis. The data was recorded using Excel and all statistical analysis was conducted using the data analysis feature for Excel. This section describes data preparation and preliminary analyses.

1. Data Preparation

The data preparation for this experiment consisted of calculating the difference scores on all the main measures. Three sets of difference scores were calculated: (1) the difference between baseline and post training performance (baseline - post training) to test hypothesis one; (2) the difference between post training and post retention scores (post training—post retention) were calculated to test hypothesis 3; (3) the difference between baseline and post retention scores (baseline - post retention) also were calculated to explore whether group differences would be stronger after a longer time frame. Two sample *t*-tests of these difference scores were used to determine if there were group differences in improvement. Prior to performing the two sample *t*-tests, *F*-tests were used to check equal variance assumption for all comparisons. When the *F*-test indicated that the equal variance assumption was met, the two-sample *t*-test assuming equal variances was used; otherwise, the two sample *t*-test assuming unequal variances was used. The two-sample *t*-test assuming equal variances was used for all main measure except two. The three-yard line score and the three-yard line MPI TO CZP did not meet the equal variance assumption between the retention (third) qualification and the training (second) qualification. For these two cases, the two-sample *t*-test assuming unequal variance was used. The normality assumption also was checked. Non-parametric tests (Wilcoxin Rank Sum Test) were used when the normality assumption was violated. The results from all non-parametric tests had the same pattern as two sample *t*-tests. Therefore, only two sample *t*-test results are described. For all tests, an alpha of .05 one tailed was used.

2. Preliminary Analyses

Before conducting hypothesis testing, the author first wanted to check that the control and experimental groups performed similarly at baseline. A two sample *t*-test assuming equal variance was conducted on the baseline final qualification scores (0–240 possible points) between the control group and experimental group. Results indicate that there is no significant difference between the control and experimental group in baseline performance (see Table 8). Therefore, even though there was a group difference in the distribution of self-reported marksmanship experience, this result indicates that on an objective measure of performance, the groups were evenly matched in ability.

The next section will take a closer look at marksmanship performance.

t-Test: Two-Sample Assuming Equal Variances		
Baseline Scores = Week 1		
	Control	*Sim*
Mean	209.4	201.8666667
Variance	422.2571429	981.4095238
Observations	15	15
Pooled Variance	701.8333333	
Hypothesized Mean Difference	0	
df	28	
t Stat	0.778754951	
P(T<=t) one-tail	0.221328073	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.442656145	
t Critical two-tail	2.048407115	
NO SIG DIFF between Control and Sim Group with P(T<=t) one-tail		
NO SIG DIFF between Control and Sim Group with P(T<=t) two-tail		

Table 8. Baseline Scores Two Sample Assuming Equal Variance *t*-Test

This section will provide the means and standard deviations for the baseline, training and the retention phase of the experiment. The purpose for reviewing the descriptive statistics during each phase was to gain some preliminary determination of the progress on each group's performance. Therefore, formal statistical testing was not

conducted in order to keep type II error low. Refer to Table 9 for the descriptive statistics during the baseline phase.

Descriptive Statistics								
Baseline	Scores	Ave Shot Group Size	3 Yard Shot Group Size	3 Yard MPI to CZP	7 Yard Shot Group Size	7 Yard MPI to CZP	15 Yard Shot Group Size	15 Yard MPI to CZP
Control Group Mean	209.40	9.77	10.69	2.90	19.91	5.81	50.61	9.76
Control Group SD	20.55	4.20	6.43	1.15	6.46	3.28	27.77	5.19
Experimental Group Mean	201.87	12.02	13.57	2.81	27.18	7.45	54.32	8.73
Experimental Group SD	31.33	5.92	8.35	1.76	15.10	4.01	32.50	4.01

Table 9. Baseline Descriptive Statistics

All of the data collected are measured in centimeters with the exception of the scores. The baseline descriptive statistics suggested that the control group was performing slightly better than the experimental group, but note the large standard deviations. The control group has a higher score and appears to have a smaller shot group. The experimental group appears to be slightly more accurate on the three- and 15-yard line based on the MPI to CZP. Refer to Table 10 for the descriptive statistics during the training phase.

Descriptive Statistics								
Training	Scores	Ave Shot Group Size	3 Yard Shot Group Size	3 Yard MPI to CZP	7 Yard Shot Group Size	7 Yard MPI to CZP	15 Yard Shot Group Size	15 Yard MPI to CZP
Control Group Mean	227.60	6.75	6.74	1.91	15.12	4.13	35.37	7.19
Control Group SD	7.26	1.82	2.25	1.08	5.52	1.73	12.37	2.89
Experimental Group Mean	225.53	7.11	7.91	1.57	15.93	2.89	33.23	5.50
Experimental Group SD	19.97	2.74	3.29	1.00	5.73	2.86	16.26	3.49

Table 10. Training Descriptive Statistics

The training descriptive statistics suggest that the control group and the simulation group performed at similar levels. The descriptive statistics suggest that as the distance from the target increased, the experimental group decreased their shot group size. The control group did not appear to be as accurate as the experimental group based on the length of the MPI to CZP on the three-, seven- or 15-yard line. The experimental group had more variability on the scores, indicating wider range in participant performance. Refer to Table 11 for the descriptive statistics during the retention phase.

Descriptive Statistics								
Retention	Scores	Ave Shot Group Size	3 Yard Shot Group Size	3 Yard MPI to CZP	7 Yard Shot Group Size	7 Yard MPI to CZP	15 Yard Shot Group Size	15 Yard MPI to CZP
Control Group Mean	222.07	7.21	7.84	2.41	16.49	5.97	33.48	7.63
Control Group SD	19.14	2.86	3.82	1.21	8.38	3.39	14.71	3.90
Experimental Group Mean	223.53	7.41	8.69	2.28	15.66	4.33	34.45	8.18
Experimental Group SD	17.63	2.56	3.91	1.71	5.72	2.59	3.52	4.71

Table 11. Retention Descriptive Statistics

The retention descriptive statistics suggest that the control group and the simulation group have similar marksmanship performance levels. The measurements for the shot groups and MPI to CZP are very close but the control group has a larger standard deviation for the 15-yard line shot group size.

3. Results from Hypothesis Testing

This section addressed results from each of the three hypotheses.

a. Hypothesis One

H0: There will be no change in the participants' marksmanship performance and scores in the Standard Navy Handgun Qualification Course of fire (OPNAVINST 3591.1F, 2009) from the baseline performance to training phase.

HA: Participants who receive simulation-based training in ISMT will have a greater improvement in marksmanship performance and scores in the standard Navy Handgun Qualification Course of fire (OPNAVINST 3591.1F, 2009) from the baseline performance to the training phases than participants who received current naval marksmanship training.

There were no significant differences in improvement between the control and the experimental group for the average shot group size, three-yard line shot group size, three yard line MPI to CZP, 15–yard line shot group size and 15-yard line MPI to CZP. Therefore, the null hypothesis was retained for these variables.

There were significant differences in the seven yard line shot group size (p = .007) and seven yard line MPI to CZP (p = .048). Refer to Tables 12 and 13 for the results of the seven-yard line shot group size and seven-yard line MPI to CZP. A negative

score indicates more accurate shooting. For both variables, the experimental group improved more than the control group.

t-Test: Two-Sample Assuming Equal Variances		
7 Yard Line Training-Baseline Group Size		
	Control	*Sim*
Mean	-4.793333333	-11.25333333
Variance	63.81780952	146.0240952
Observations	15	15
Pooled Variance	104.9209524	
Hypothesized Mean Difference	0	
df	28	
t Stat	1.727157877	
P(T<=t) one-tail	0.047578559	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.095157118	
t Critical two-tail	2.048407115	
SIG DIFF between Control and Sim Group with P(T<=t) one-tail		
NO SIG DIFF between Control and Sim Group with P(T<=t) two-tail		

Table 12. Hypothesis One, Seven Yard Line Shot Group Statistics

t-Test: Two-Sample Assuming Equal Variances		
7 Yard Line Training-Baseline MPI to CZP		
	Control	*Sim*
Mean	-1.68	-4.553333333
Variance	9.991714286	7.724095238
Observations	15	15
Pooled Variance	8.857904762	
Hypothesized Mean Difference	0	
df	28	
t Stat	2.643937225	
P(T<=t) one-tail	0.006637884	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.013275767	
t Critical two-tail	2.048407115	
SIG DIFF between Control and Sim Group with P(T<=t) one-tail		
SIG DIFF between Control and Sim Group with P(T<=t) two-tail		

Table 13. Hypothesis One, Seven Yard Line MPI to CZP Statistics

b. Hypothesis Two

H0: Among those who do not meet the qualification standard in the standard Navy Handgun Qualification Course of fire (Chief of Naval Operations, 2009) at baseline, there will be an equal number of participants in each group who do not meet the qualification standard after training.

HA: Among those who do not meet the qualification standard in the standard Navy Handgun Qualification Course of fire (Chief of Naval Operations, 2009) at baseline, a greater number of participants in the experimental group will reach qualification standard after simulation-based training than in the control group.

There were only three people in each group that failed during the baseline qualification. Three per group is insufficient to conduct a statistical test of any significance. Therefore, only descriptive statistics are provided. Refer to Table 14 for a percentage failures during the entire experiment.

Failure Stats	Base	Training	Final
Percent of Failures for Control	0.13	0.00	0.07
Percent of Failures for Sim	0.13	0.07	0.07

Table 14. Percentage of Failures

A closer look at scores for all the failed participants using descriptive statistics suggests that this hypothesis should be tested in a future study with appropriate sample size. Refer to Figure 8 for a graphical depiction of the mean differences in score during the training and retention qualification among those participants who failed at baseline. Positive values indicate improvement in performance.

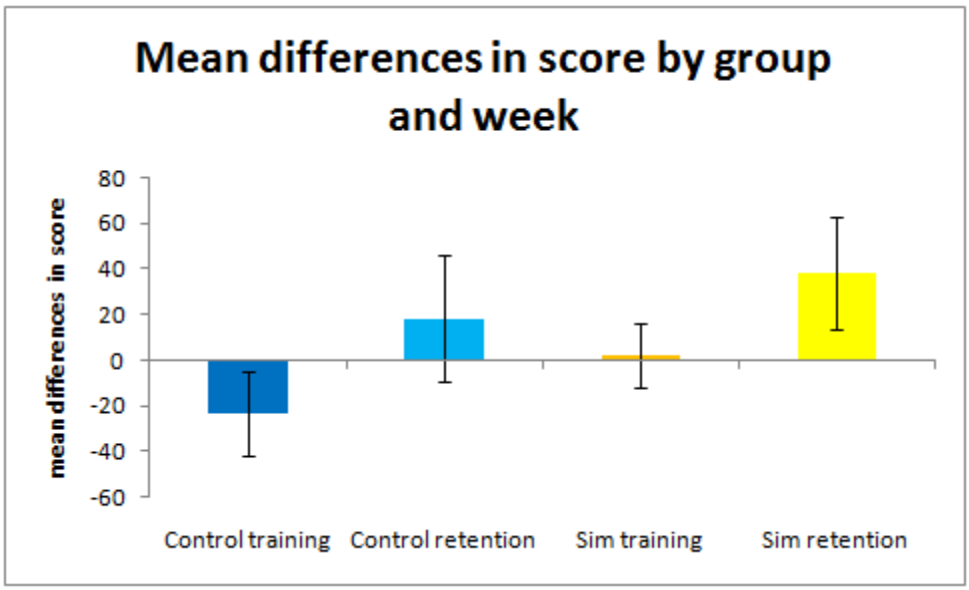


Figure 8. Hypothesis Two Mean Difference in Scores by Group and Week

The participants that failed in the experimental group performed higher than the control group both after training and after retention. These descriptive statistics suggest that the experimental group enhanced their marksmanship skill to a higher degree with simulation-based marksmanship training program. It also suggests that they were able to retain more knowledge and ability over a one-week period of time with no training.

To explore if improvement among participant who failed at baseline was focused on particular performance measures, descriptive statistics on the individual performance measures were examined. These exploratory analyses indicated that the greater improvement in the experimental group is seen in the seven-yard line measures. Refer to Figure 9 for a bar graph of the seven-yard line improvement from the baseline qualification to the training qualification.

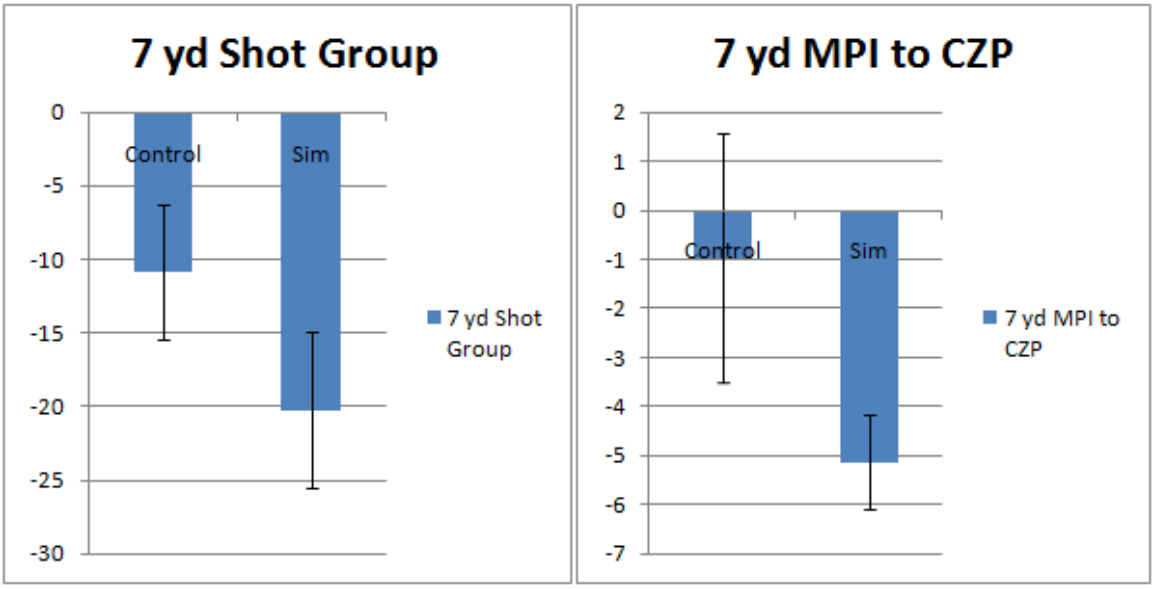


Figure 9. Hypothesis Two Mean Difference in Seven-yard Line Performance from baseline to post training.

The descriptive statistics did not indicate that the participants that failed in the experimental group were able to retain more marksmanship skills then the participants that failed in the control group, after a week of no further training. This may indicate that a one-week period of time is not long enough to make that determination. Another, analysis using descriptive statistics was done comparing the marksmanship performance between the baseline qualification and the retention qualification. The seven-yard line seems to indicate that the participants that failed in the experimental group improved more than the participants that failed in the control group. Refer the Figure 10 for a bar graph of the seven-yard line improvement from the baseline qualification to the retention qualification.

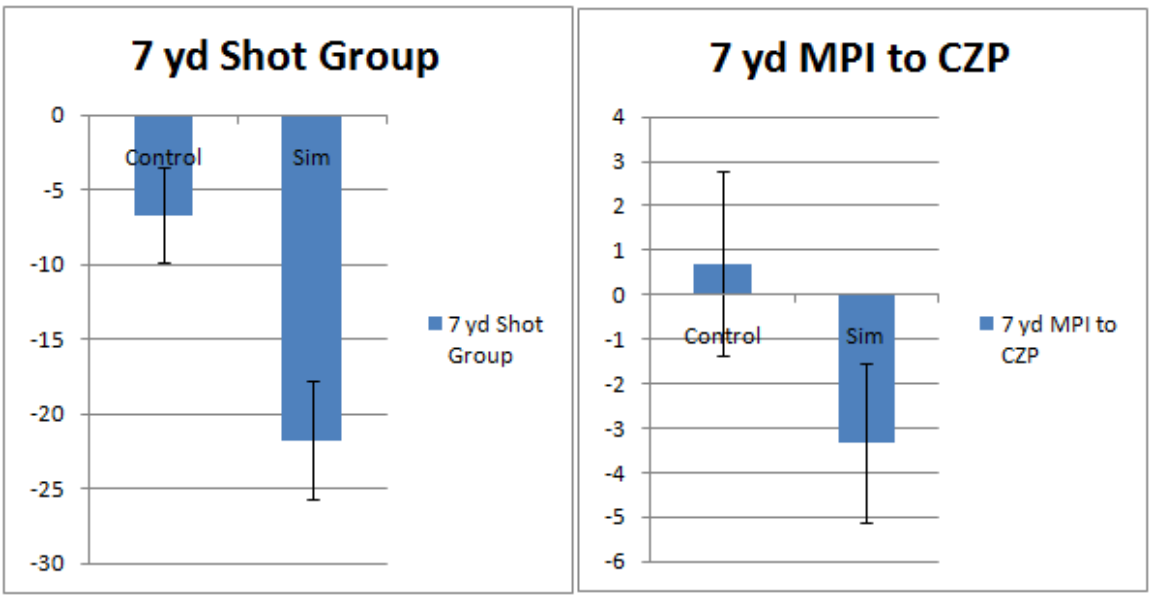


Figure 10. Hypothesis Two Mean Difference in Seven-yard Line Performance.

The best example of all the participants that failed was in the experimental group. This participant failed the baseline qualification with a low score of 118 points. The participant failed the baseline and the training qualification and finally passed the retention qualification toward the end of the experiment with 192 points. It is important to remember that no significant statistical information can be determined with only one person, but the level of improvement is noteworthy. Refer to Figure 11 for a graphical representation of this participant's performance over time. The scale for the scores is based on points; more points over time indicated better performance. The scale for all other marksmanship performance data is in centimeters and smaller measurements over time indicate better accuracy.

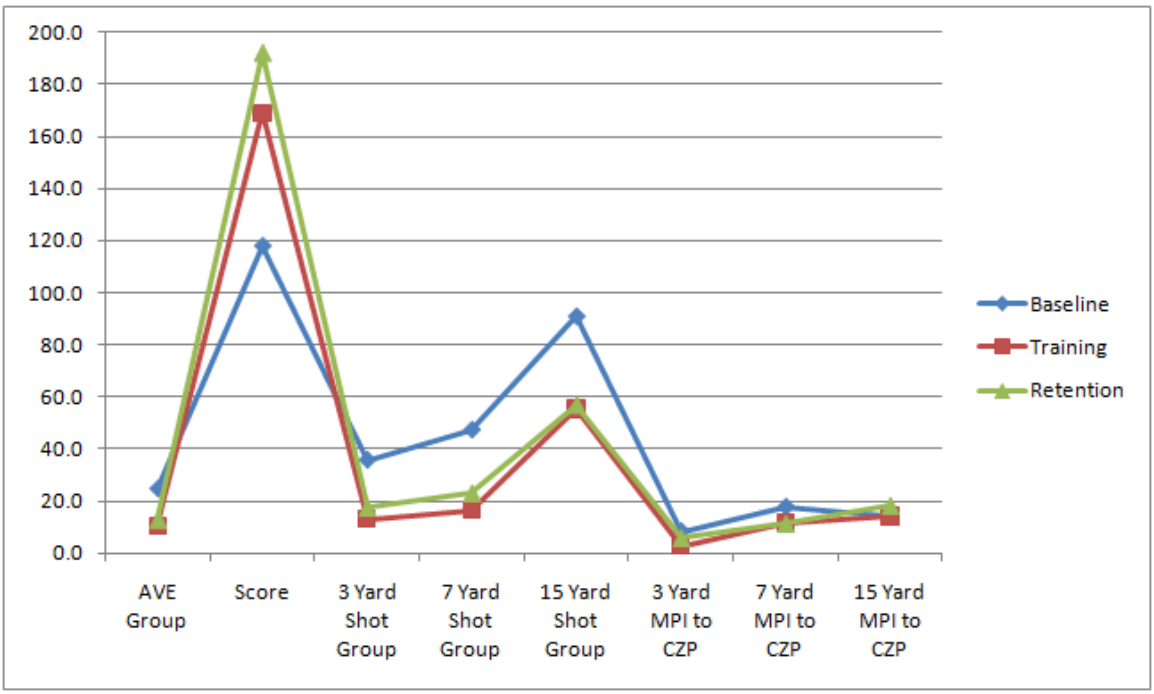


Figure 11. Most Improved Participant

c. Hypothesis Three

H0: Participants in each group will be equally likely to maintain their marksmanship performance and scores on the standard Navy Handgun Qualification Course of fire (Chief of Naval Operations, 2009) one week after the training day.

HA: Participants in the experimental group will be more likely than those in the control group to maintain their marksmanship performance and scores on the standard Navy Handgun Qualification Course of fire (Chief of Naval Operations, 2009) one week after the training day.

There was no significant difference between the control group and experimental group based on their performance from the training qualification to retention qualification. This experiment failed to reject the null hypothesis three.

4. Exploratory Analyses

One week with no further training may not be enough time to determine any loses of marksmanship performance. According to the qualification criteria for pistols found in

Enclosure three, section five, paragraph A of the small arms training and qualificaiton instruction (Chief of Naval Operations, 2009) a sailor can go as long as 30 day after training before a qualification; "The period of time between the marksmanship/safety/weapons familiarization training and live fire qualification should not exceed 30 days." (p. 2)

To explore whether group differences in improvement occurred between baseline and the retention phase, two sample *t*-tests assuming equal variances were conducted on the difference scores for each performance measure. Significant group differences in improvement on the seven-yard line shot group (p = .02) and seven-yard line MPI to CZP (p = .003) were significant. The lower the diameter in the shot group, the more consistent the participant became over time. The lower the length of MPI to CZP the more accurate the participant became over time (refer to Table 15). Thus, for both variables, negative scores indicate improvement. In both cases, the experimental group improved to a greater extent than the control group.

t-Test: Two-Sample Assuming Equal Variances		
7 Yard Line Retention - Baseline Group Size		
	Control	*Sim*
Mean	-3.42667	-11.52
Variance	93.54495	125.6746
Observations	15	15
Pooled Variance	109.6098	
Hypothesized Mean Difference	0	
df	28	
t Stat	2.117061	
P(T<=t) one-tail	0.021635	
t Critical one-tail	1.701131	
P(T<=t) two-tail	0.043271	
t Critical two-tail	2.048407	
SIG DIFF between Control and Sim Group with P(T<=t) two-tail		
SIG DIFF between Control and Sim Group with P(T<=t) two-tail		

t-Test: Two-Sample Assuming Equal Variances		
7 Yard Line Retention - Baseline MPI to CZP		
	Control	*Sim*
Mean	0.16	-3.11333
Variance	10.01829	7.511238
Observations	15	15
Pooled Variance	8.764762	
Hypothesized Mean Difference	0	
df	28	
t Stat	3.027965	
P(T<=t) one-tail	0.002621	
t Critical one-tail	1.701131	
P(T<=t) two-tail	0.005241	
t Critical two-tail	2.048407	
SIG DIFF between Control and Sim Group with P(T<=t) two-tail		
SIG DIFF between Control and Sim Group with P(T<=t) two-tail		

Table 15. Exploratory Analyses for the Seven Yard Line

The results of this test suggest that at least two weeks of time is needed to detect group differences in improvement.

B. SUBJECTIVE REPORTS OF THE ISMT EXPERIENCE

This section reviews input provided by the participants of the experiment, after the retention qualification was complete. Every participant was instructed to fill out a

post experiment open-ended survey. This survey was an opportunity for the author to get a good understanding of how the participants felt about the study and marksmanship simulators. Not every participant submitted a post survey and not every participant that submitted a post survey had much value, if any, toward comments on their experience in the experiment. The quotes that are posted in this section are their own thoughts. In an attempt to protect the identity of the participants in the experiment no names shall be used in the section. Refer to Appendix I for a copy of the post survey used in this experiment.

1. Comments on the Value of Simulation

- Without any reservation, I fully believe in the effectiveness of the ISMT in helping train and dramatically improve marksmanship performance… I think the SMT's/EST-2000's are fantastic, especially their ability to simulate training scenarios for MP's, gate guards, etc. I've never seen any study proving beyond a doubt that these systems improve marksmanship "X percent," but I have no doubt they're worth the investment.
- In my personal experience, I have had several occasions in which watchstanders had to stand extra watches to cover new shipmates who could not get qualified on a weapon due to being deployed.
- I whole heartedly believe that the ISMT is a useful tool for marksmanship training. The Sailor can get instant feedback with deficiencies on their fundamentals of marksmanship and correct them on the spot.
- I feel these types of simulators are extremely useful in areas like marksmanship training. This is a low cost (over time) effort that can be used immediately, unlike live fire ranges that have higher resourcing requirements.
- *Extremely useful, if for nothing else for the money that would be saved and for the valuable information and feedback that trainees receive from the simulator.*
- ISMT is very useful for a variety of marksmanship training. First, it should be used to teach novice shooters before handling a weapon and "wasting" live ammunition to familiarize themselves with the "feel" of recoil and mechanics of a pistol. Second, sustainment training should utilize the ISMT. Even if someone is a good shot, skills deteriorate with time. Using the ISMT gets those skills back up to standard before moving to a live range for qualification. Finally, shooters of all levels can benefit from the feedback provided by the ISMT. Expert performance can be evaluated and emulated by others seeking to perfect their abilities.

- Use a shock belt to keep the user in a scared mindset…for example if the weapon is condition 1 and safety off but pointed in an unsafe direction, or if the weapon is holstered with the safety off, etc. Also it felt as if the pause between instruction and commencement of firing was too long and can affect the results.
- Very useful. My score improved greatly. There is very little marksmanship training in the Navy for the typical sailor so it would be a needed addition to the force.
- Extremely useful. They would cut down on costs dramatically, allow commands to tailor a program suited for their members' needs, and allow a safer environment to train new shooters and re-qualify experienced shooters while maintaining the fundamentals of marksmanship… Shooters will need to feel some of the aspects of shooting that cannot be simulatedweapons failures, the shock of a weapon actually firing, and some other intangible factors of shooting. However, simulated training can drastically improve the efficiency of real training and allow trainers to focus on the areas that shooters are struggling on.
- Highly useful. The fleet needs to train on them prior to wasting ammo. The usefulness of being able to step back and evaluate your muzzle control in invaluable... not to mention I'm sure cost effective… This is a great concept that should be used in the fleet. It will allow more bullets to go to the "fight" and allow for a more cost effective way to train... and one that will be much easier to get beneficial training.
- The indoor simulator is a must have. It allows the shooter to work on his abilities and for the instructor to have a real world critique of the errors that the shooter is making.
- Yes, because it's cheaper and it allows for real caption of what a shooter is doing wrong.
- I believe that this program is needed for the issuing of a firearm to civilians as well as military training. The better laws we have and training for users of firearms the less injuries we would see. There are too many Novice shooters that are more harm to themselves and the innocent then they are to their targets.
- I think that using the simulated trainer will be very useful for training. It is a training resource that can be utilized frequently simply due to the fact that it does not require travel to a range. The data that is collected provides useful feedback for the user in terms of what errors are being made and at what point in the firing process they need to make corrections.
- Simulated Marksmanship training would be very useful in providing instruction to personnel in areas/units that have a lower need for live fire

exercises. Simulation can also provide a safer and less stressful training environment for inexperienced shooters.

- I believe that the simulators have a place for training and proficiency. For requals, they would be good as well.

2. Comments of Real Versus Simulated Training

- Simulators can be used for training, but at some point the real object must be handled. Maybe not every qual, maybe every other or every third requal. However, I believe that with the simulators the ability exists that training is conducted more often, so instead of yearly requals, they can be conducted every 6 months, on that time frame every fourth requal should be live-fire, while the other three can be simulated.
- Training using this simulation could be provided before the real training, giving trainees the opportunity to absolutely understand the subject and perform better and safer when they are exposed to the real training.
- I do not believe that simulated training will ever replace 100 percent the real training and also to my mind simulation should not replace the real training. It can only be a supplementary tool especially before the real training. To my mind, reality contains such unpredictable factors that no simulation can predict and simulate them.
- It is clear to me that the Navy would be afraid to replace real training with a sim and that is unfortunate because with technology the way it is now, the ISMT is <u>better</u> than real range training as it provides immediate feedback based on real data not just opinion.
- Although I believe there is a great deal of value added to using the simulator. The real training is still that.. 'real'. I believe that an individual still needs to experience the feel of a real weapon. Simulated training however could reduce the amount of real training.
- If they can be used consistently, I believe they can be very useful. Seemed very realistic, minus wind, the smell of the powder, and the burn of the casings landing on my arms.
- No, because you can never fully simulate the real thing. A shooter will always need to practice their shooting ability on the range with live rounds. This allows for a true test of the changes made to improve the shooters ability using the simulator.
- If the exact conditions of "real" training were able to be duplicated (recoil, sound level, etc.) then I would say that, yes, simulated training might be used to replace the range training. Never having fired guns under the "real" conditions, I have nothing to compare the simulated training to. I feel confident however that the simulated training would be a great tool to augment training methods already in place.

IV. CONCLUSIONS AND RECOMMENDATIONS

The question this thesis tried to determine is if the ISMT can be used for the purpose of improving participants' current marksmanship performance and score with the goal of meeting a qualification standard. A second question addressed was can ISMT be used to sustain an acceptable level of performance.

The concept is simple; until a person has received enough practice discharging rounds down range to improve accuracy and proficiency, it is not certain that they will be effective with firearms during an actual force protection crisis. To find the time to take an entire command to a firing range is difficult with the current ship schedule, unless it is for qualification purposes. If the command had a simulator onboard that could allow personnel to practice marksmanship skills on a regular basis, while in port or underway, then it is reasonable to believe that personnel can and will protect the ship during an attack.

Effective use of a firearm is the most important factor if a threat was detected. Personnel are trained to make the proper announcements to alert the crew and give the proper commands to an attacker, but if the watch standers cannot hit the target then they have failed. A worse scenario is if they miss the target and hit a civilian or friendly personnel. By providing the means to practice a perishable skill like marksmanship, the Navy may have less incidents or casualties. In this chapter, the author describes logical conclusions based on the results of the data collected during the experiment. Shortcomings of the experiment are identified, and recommendations on how to improve the study and marksmanship training in general are made. Finally, future works stemming from the results are suggested.

A. DISCUSSION

The results indicated that simulation training improves certain aspects of marksmanship performance, specifically, the seven-yard line. Hypothesis one addressed whether there was a difference in marksmanship performance when current naval marksmanship training was administered to the control group and simulation-based

marksmanship training was administered to the experimental group. Evidence for greater improvement in the experimental group than the control group was found for the seven-yard line performance measures. The experimental group continually showed greater improvement on the seven-yard line shot group size and the MPI to CZP length. The seven-yard line shot group size and seven-yard line MPI to CZP was able to reject the null hypothesis because the size of the target was much smaller than the three-yard line target. The seven-yard line was a more difficult task and recorded performance scores support the assumption that there was no ceiling effect.

Given these results, it was somewhat surprising that significant group results were not found for the 15-yard line. The 15-yard line shot group size and 15-yard line MPI to CZP should have been able to test the null hypothesis. In this experiment it was possible that the participants were able to get familiar with smaller targets from the seven-yard line target exposure. The participant may have been able to adjust their sight alignment and sight picture well enough from the three yard line target to the seven yard line target, that it did not make much of a difference when transition from a –seven-yard line target to a 15-yard line target. It was also possible that the study should be administered to a sample size of 30–60 participants to reduce the likelihood of type I error from the 15-yard line hypothesis testing.

Hypothesis two addressed whether there was a difference in marksmanship performance among those who do not meet the qualification standard when current naval marksmanship training was administered to the control group and simulation-based marksmanship training was administered to the experimental group. Although there was not adequate power to test hypothesis two due to insufficient sample sizes, the descriptive statistics suggest that simulation training may be more beneficial for poor shooters. The margin for improvement once a shooter was established as an expert was very small. Experts still showed improvement during the course of the experiment, but the novice shooters showed a substantial increase in marksmanship performance.

Hypothesis three tested addressed whether there was a difference in marksmanship performance after one week passed from the date the current naval marksmanship training was administered to the control group and simulation-based

marksmanship training was administered to the experimental group. The standards of the navy handgun qualification may have a lot to do with the inability to make a statistically significant differentiation in improvement between the control group and the experimental group. However, it is important to note that on average, participants in both groups showed improvement since the beginning to the experiment and displayed a trend indicative of higher qualification scores, tighter shot groups and smaller MPI to CZP lengths.

One possible reason for the lack of significant results for the three yard line may be due to the simplicity of the distance and the size of the target. A majority of the participants, regardless of training received, was able to hit the three yard target and score 60 of 60 possible points for the baseline, training and retention stage of the qualification (i.e., a ceiling effect for the three yard line occurred). If a participant did not gain all possible points then they were only a few points off. The shot group size and length of MPI to CZP would be better determinants of improvement; however a ceiling effect may occur with these performance measures as well. The margin of improvement for all measures on the three-yard line may not be enough to effectively test the null hypothesis.

The next section is recommendations for improving the experiment conducted in this thesis and identify possibilities of future work. Although results are promising, there were some limitations in this study: small sample size, ceiling effect, amount of time to test retention was too small and the marksmanship ship training was not as beneficial to experts. Future studies should repeat this experiment with a much larger sample size. The study may benefit from a different qualification with difficult tasks and more time should be allotted when testing for retention of marksmanship skills. A majority of the trends and results of this experiment indicate a study with only beginners and novice should provide a level of improvement to properly test all hypotheses.

Research question one did not have any significant difference in all categories except for the seven-yard line shot group size and the seven-yard line MPI to CZP. Another study should be administered with a bigger sample size. This thesis only used 30 participants and divided them up into two groups. A sample size of only 15 participants

in each group may not have been enough to make a clear distinction of the main effects of the different marksmanship training stimulus programs.

An analysis of the histograms for all marksmanship performance was conducted and using non-parametric results (Wilcoxin Rank Sum Test) in which the distributions were not normal gave similar pattern of results. It is reasonable to believe that if each group had 30–60 participants versus only 15 that the histograms would have looked more normal and possibly proved meaningful results. Future studies need much larger samples in order to correctly reject a false null hypothesis. The sample size in this thesis may have been too low and result in a high type II error rate, incorrectly retaining null hypothesis when it's actually false.

Because only three participants failed the baseline qualification, the author was unable to address research question two. Another study should be administered to participants that failed the baseline qualification in order to determine simulation training is more beneficial to poor / novice shooters than experienced shooters. Conducting the same study with beginners and failures at baseline will help avoid variability in learning curves with people that have not used a firearm in a while but have experience with firearms and formal marksmanship training.

Research question three failed to reject the null hypothesis. The retention qualification in this experiment was supposed to determine which group would be able to retain their marksmanship skills after a week of no training. Another analysis comparing the baseline qualification and the retention qualification may able to test the null hypothesis based on the results of the seven yard line shot group size and seven yard line MPI to CZP. This may indicate that another study should be administered in which the retention phase is longer than one week.

The navy regulation clearly stated that the time between the training and the live fire qualification should not exceed 30 days. Thirty days may be excessive and that a study of using navy pistol qualification standards should be conducted comparing a two week and one month time period of no marksmanship training. This type of future work should be able to determine if the duration of time between training and qualification

affect retention skill differentially based on the type of training. The next section will address all the software technical difficulties, system limitations, and pistol malfunctions experienced during this entire thesis.

B. TECHNICAL DIFFICULTIES AND RECOMMENDATIONS

1. Failed to Load Magazines and Provide Trace Profiles

The experiment met several challenges. For example, ISMT was unable to discard a round when the participants failed to shoot required rounds before "*cease fire.*" This action caused compounding technical difficulties: ISMT failed to load magazines with the proper amount of rounds.

ISMT failed to update the number of rounds per magazine if the participants failed to fire all required rounds. The three-yard line and seven-yard line required two magazines with six rounds. The 15-yard line required two magazines that had 12 rounds in each magazine. If a participant fired 11 of the 12 rounds required for the seven-yard line, then on the 15-yard line the ISMT would reload with a magazine of six rounds vice the required 12 rounds per magazine. The ISMT would not reload with a magazine of 12 rounds until the participant fired one more round at a target. This is a simple error that deals with the way ISMT keeps count of the number of shots fired.

An example of this type of error is when a participant failed to fire two rounds in four seconds when the recorded instruction said, "Cease fire." The ISMT was still waiting for one more round to fulfill the requirement of 12 rounds for the three and seven yard line. The system was not programed to count that missed round as a zero and continue to calculate the marksmanship performance data for the 11 of 12 rounds that were actually fired. ISMT also does not provide the simulation user a button to push or have some way to manually instruct the ISMT to continue the qualification and count the missing round as a zero for points. Surprisingly, when the participant fired all 12 rounds at the three or seven yard line target but at the 15-yard line only hit the target 23 of 24 times then ISMT would provide the needed marksmanship performance data at the end of the qualification.

2. Provide Trace Profiles

The experiment met several challenges first, ISMT was unable to discard a round when the participants failed to shot required rounds before *cease fire.* This action caused an inability to provide trace profiles on several occasions and the rapid-fire sequence was suspected to be the cause. The navy handgun qualification had a series of instructions that required the participants to shoot rapid fire from the holster. For example, the recorded instruction may tell the participant to shoot two rounds in four seconds. It was determined that ISMT was unable to track the barrel of the pistol effectively. The M9 Berretta was equipped with an infrared beam at the end of the barrel and the ISMT had a hit camera to trace where the pistol was pointed towards on the projector screen. Once the recorded instruction says fire, the participants quickly drew the weapon and fire two rounds. After the qualification was complete, the instructors collected the marksmanship performance data and noticed that the trace profile feature did not always work.

The ISMT had four different trace profile failures. First the trace profile would simply display no trace data. The second failure was when the trace profile did not display the green one second before shot and the purple .2 seconds before shot, but would display the blue one second after shot. The third failure was when the trace profile did not display the green one second before shot, but did display the purple .2 seconds before shot and the blue one second after shot. The last failure was when the trace profile did display the green one second before shot, but not the purple .2 seconds before shot and the blue one second after shot.

The author kept track of every time the trace profile had a malfunction. He recorded every observation in Excel and at the end of the experiment had 4,224 observations. A quick calculation indicated that the trace profile failed to work properly 17 percent of the time. The ISMT tracking system should be modified so that it can track the barrel sensor faster in order to help the instructor to train shooters while using the trace profile feature.

3. Qualification Scenarios

The creations of the qualification scenarios took several trials. The first trial had a separate target for each course of fire. For example, the first set of instructions on the three-yard line had the participant fire two rounds in four seconds. A target would appear before the recorded instructions said “Fire.” Then the target disappeared when the recoded instructions said “Cease fire.” A new target would appear for the next set of instructions. This scenario failed to provide any shot group size data at the end of the qualification because ISMT could not calculate a shot group with only two rounds for a target. This issue was fixed by creating a scenario that had only three targets representing the three, seven and 15-yard line. The targets would appear and disappear at the beginning and end of the assigned stage of the qualification. This method enabled instructors to record all marksmanship performance data that ISMT can provide.

4. Loss of Marksmanship Performance Data

Another issue was that the scenario would not provide marksmanship performance data if a participant failed to fire all required rounds for each stage of the qualification. The navy handgun COF required the participants to fire 12 rounds at the three-yard line target, 12 rounds at the seven yard line target and 24 rounds at the 15-yard target. If a participant only fired 11 of the 12 rounds required for the three-yard line target, then ISMT output would state invalid for shot group size and MPI to CZP. The instructor would observe invalid for performance measures if the same action occurred on the seven-yard line. Surprisingly, ISMT would provide marksmanship data if the same action occurred on the 15-yard line.

The author figured out a way to improve the scenario and take the limitations of ISMT under consideration. A future study should create a scenario exactly like the scenario created in the experiment except with a backup target on the side that is smaller and different looking from the main target. When the participant failed to fire required rounds within the standard time limit, then the instructor should instruct the participant to fire a round at the smaller and different looking target located off to the side. The instructor should keep track of which round was fired so that upon completion of the

qualification the instructor can drop that particular shot. ISMT would recalculate all the measurements for the shot groups and MPI to CZP data. However, ISMT will not recalculate the score and special measures should be taken to prevent participants from firing at the target after the command to cease fire.

5. Inability to Calculate Qualification Scores

It also was vital that the participant fired the round away from the actual target used for the qualification because ISMT would not update the score when the instructor dropped the shot upon completion of the qualification. For example, a participant only fired one round versus two in four seconds and the author told the participant to fire the round at the main target instead of the backup target. Then at the end of the qualification when the author drops that particular shot, ISMT will not subtract the points earned. This limitation will falsify the actual score that the participant should have earned in real life because the simulation was not smart enough to recalculate. It is important to have the actual and the backup targets look very different and located as far apart from each other as possible to ensure that the participants do not get confused with the instructions.

The author has not tried a second possible solution. Instead of having two separate targets, if the participant were instructed to fire a round pointed away from the projector screen, then ISMT may be able to continue with the qualification. The instructor should be able to drop the shot at the end of the qualification and have no problems with not being able to recalculate the score. Future experiments should try to implement these solutions in a pilot study before conducting their actual experiment.

To resolve this limitation in the experiment for this thesis, the author had to rely on previous marksmanship qualification experiences and consider this error as a technicality. The author did not derive these solutions until after the experiment had already began and did not have time to restart another experiment. The instructor considered this particular technicality as an alibi, which meant the participant was allowed to fire the round in a reasonable allotted time.

6. Error Messages

The author lost performance data from error messages while trying to print the average shot group results page. The author also lost performance data from error messages of which the cause was unknown. The error messages during the experiment only came at the end of a qualification and during data collection. The author was not sure what caused the first error message but took a picture for documentation purposes. It is important to note that when the instructor pressed the close button that all data was lost and irretrievable. Refer to Figure 12 to view the error message.

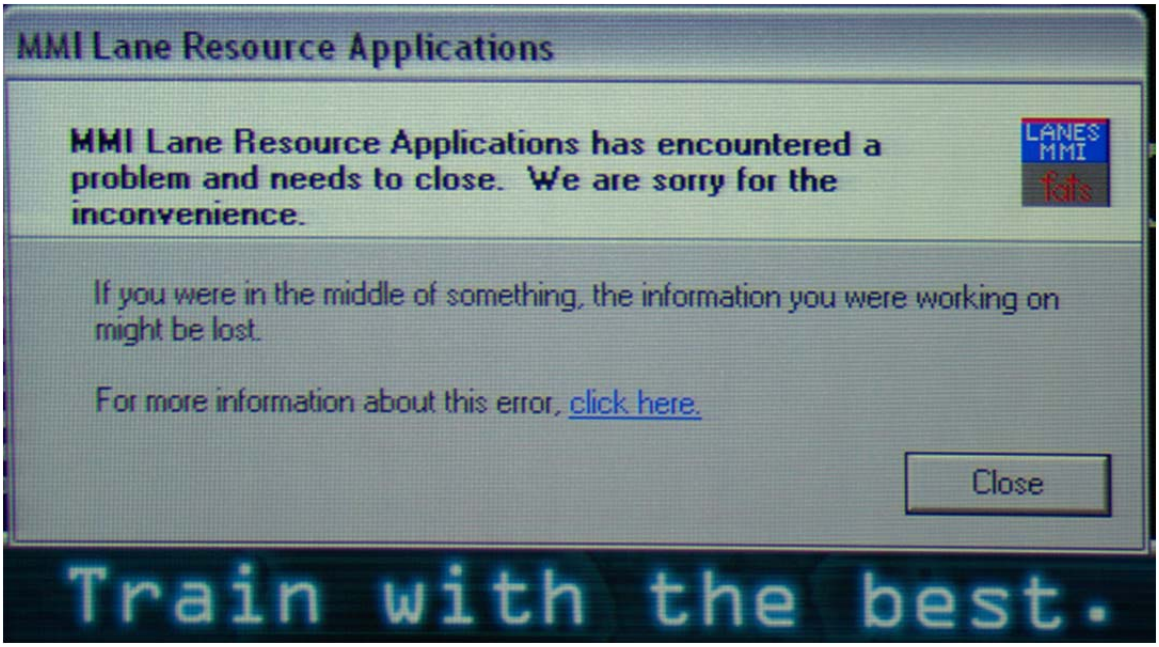


Figure 12. MMI Lane Resource Applications Error

ISMT also had printing issues that caused an error message, which resulted in loss of data. At the end of every qualification, the instructors would have to print out the marksmanship performance data as backup in case electronic soft copies were corrupted or lost. This particular ISMT failed to print the actual size of the average shot group size. ISMT at first always printed the average shot group size as 1.0 centimeters. The author manually wrote the actual size on the print out and filed it. This limitation continued until it was discovered that the ISMT would display an error message when the instructor tried

to print the average shot group results. The error message only gave one button to push and ISMT would exit the simulation screen and all data was lost. Refer to Figure 13 to view the LANEDX MFC Application error message.

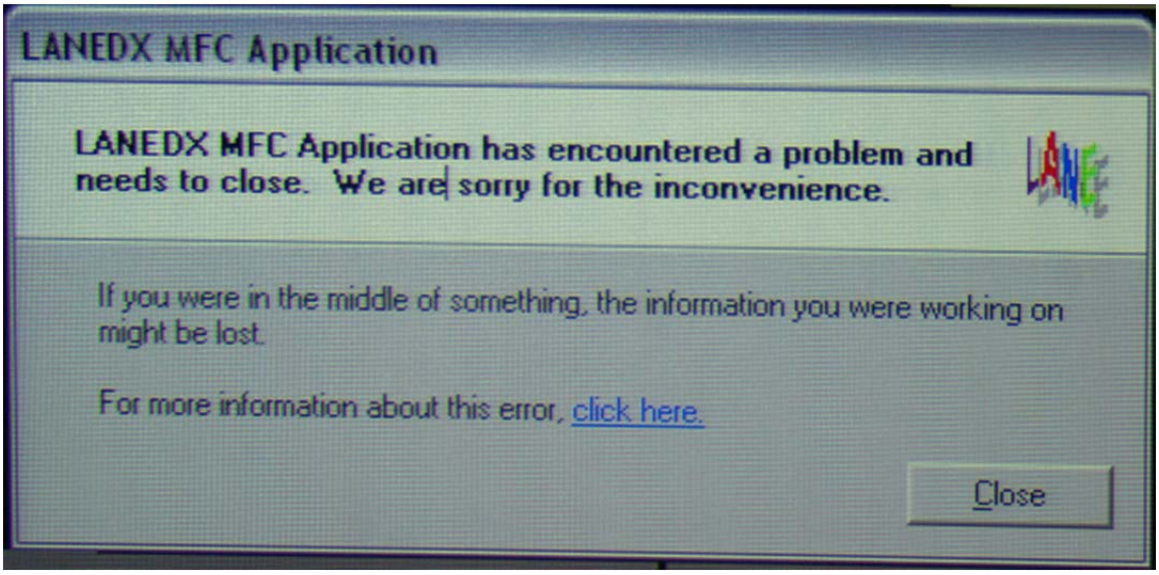


Figure 13. LANEDX MFC Application Error

The instructor decided to press click here versus the close button and another message came up. The author is not sure what the message means but took a picture for documentation purposes. Refer to Figure 14 to view the error signature message.

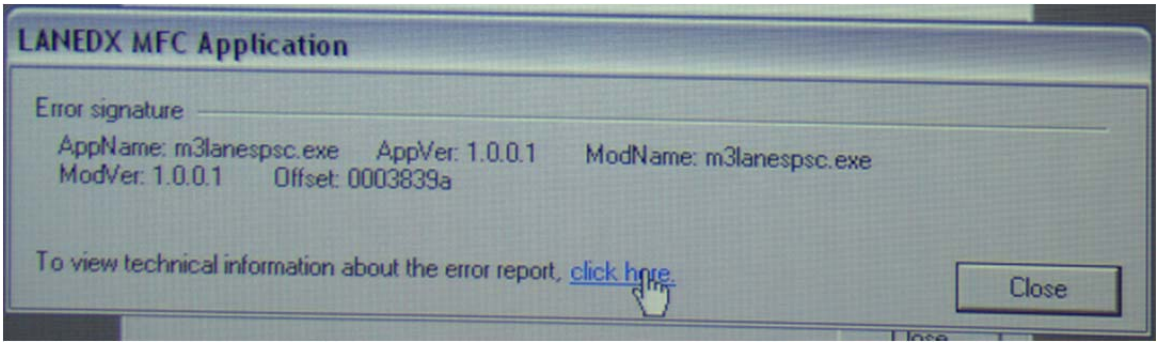


Figure 14. Error Signature Message

The instructor once again decided to press click here versus the close button and another message came up. The author is not sure what the message means but took a

picture for documentation purposes. Refer to Figure 15 to view the error signature message.

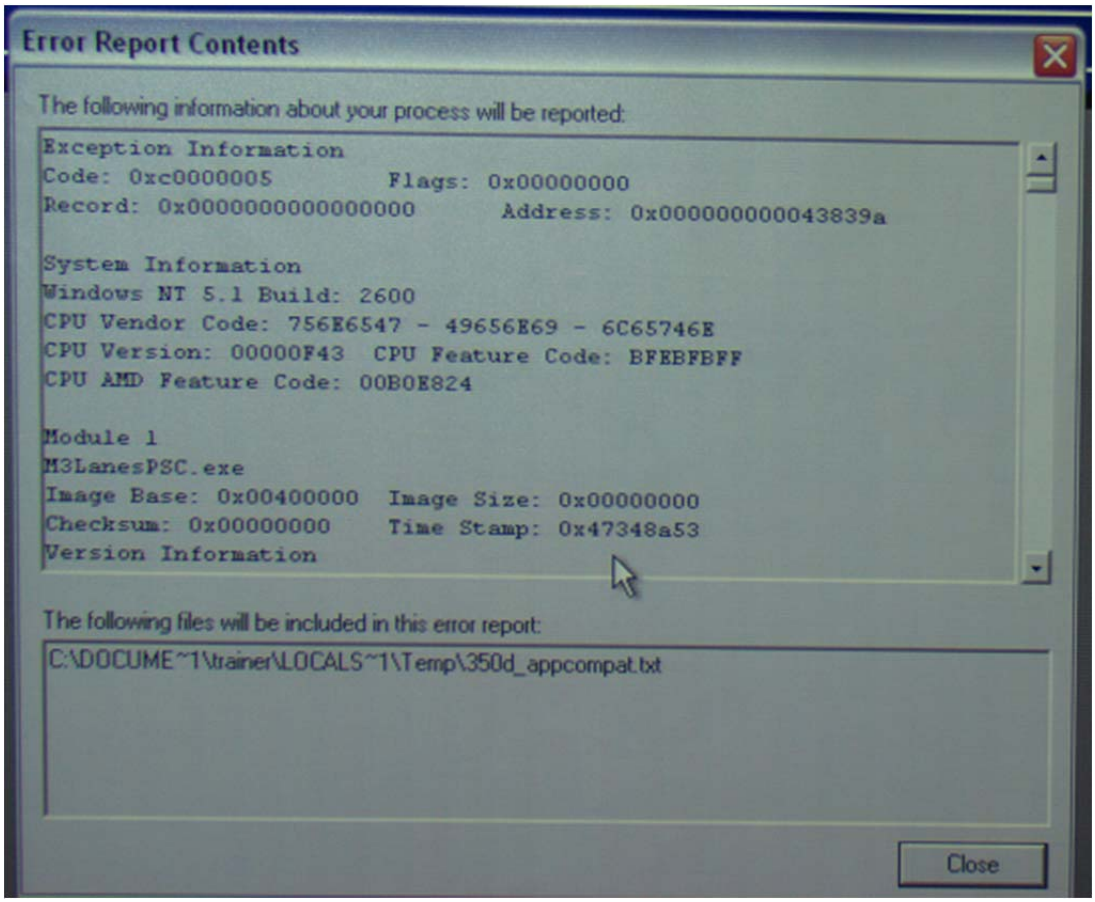


Figure 15. Error Report Contents

The author found no solutions for this error but came up with a policy that future thesis studies should consider. After completion of any qualification, the instructors should first record all data onto an Excel file and be extremely careful not to print anything out. The instructors should then take a picture of every data screen which includes the following; results page, average shot group size, shot group one (three-yard line), shot group two (seven yard line), shot group three (15-yard line), MPI to CZP group one (three-yard line), MPI to CZP group two (seven-yard line), MPI to CZP group three (15-yard line), and all 48 trace profiles. The author also required that all data

screens get printed with the exception of the average shot group page because it was the source of the error messages.

7. Menu Navigation

The next technical difficulty was caused by the instructor that ran the simulation. In order to navigate through the ISMT interface, the user had to either push enter or the letter Q in order to back out of a screen. The technical difficulty happens at the end of the qualification when the instructors are collecting data. If the user pushes the enter button and the simulation has "*Continue*" selected, then the ISMT will move to the next screen and discard all the marksmanship performance data. It is critical that all data is recorded in Excel, all pictures are taken and all data screens are printed out before the Continue option is selected and the enter button is pushed. There is no way to undo, or go back to previous screen to enable the instructors to collect data again. The same effect will occur if the simulation user pushes the Q button at any time. To avoid any loss of data, every instructor must be conscious of this limitation and aware of which option they are about to select on the screen.

8. Malfunction of the M9 Berettas

The last technical difficulty and the biggest issue for this thesis were the seven out of commission (OOC) M9 Berettas. The experiment started out with two M9 Berettas and only used one to conduct the experiment. The other was used as a prop to help the instructor demonstrate the functionality of the pistol to the participants. Given the number of participants and the length of each session, this was a lot of wear and tear on the pistols. Training sessions began at 0700 in the morning and the last training session ended at 1800 in the evening.

The first pistol with serial number BER4484182 had an automatic slide-lock activating mechanism break. This caused the pistol to not lock the slide to the rear when the magazine was empty. The second pistol with serial number BER441064Z had a safety-on sensor that was too slow. This caused the pistol to randomly and inadvertently fire if the hammer is in the single action position (in the full cocked position) and the safety was engaged to ride the hammer home. The ISMT still thinks that the safety level

was off because the safety-on sensor was too slow and the hammer reached the forward position before ISMT had a chance to catch up causing the pistol will fire a round. The pistol with serial number BER441064Z also fired a round when the participant was chambering a virtual round by pulling on the slide to the rear and releasing the slide forward.

The third pistol with serial number BER408276Z did not detect that the hammer had fallen and would not fire a round. The forth pistol with serial number BER422910Z had a slow safety-on sensor and exhibited the same symptoms as the pistol with serial number BER441064Z. The fifth pistol with serial number BER426414Z often mysteriously lost virtual rounds from the magazine without firing the pistol or without ejecting a round from the chamber. The simulation user watched the screen and witnessed the rounds in the magazine decrease while the weapon was not being fired.

The sixth pistol with serial number BER412636Z had an automatic slide-lock mechanism that would only partially engage. This would cause the pistol to release the slide forward with the slightest tap or rapidly moving the pistol in a forward motion and stopping. The pistol was an ineffective training tool because the participants never experienced the motion of have to press the slide release lever to close the slide since the pistol did that for them. The last pistol with serial number BER426445Z had a slow safety sensor-on sensor, which had the same symptoms as the previous pistols with the same malfunction and would not fire all rounds in the magazine.

In conclusion, based on the vast number of technical difficulties, the main recommendation for future work is to have several data backup systems in place and have as many pistols available as possible. Additional recommendations for future work should consist of studies that only focus on novice shooters and have much larger sample sizes. A study with a more challenging qualification than the one used in the experiment should be considered in order to avoid any ceiling affects.

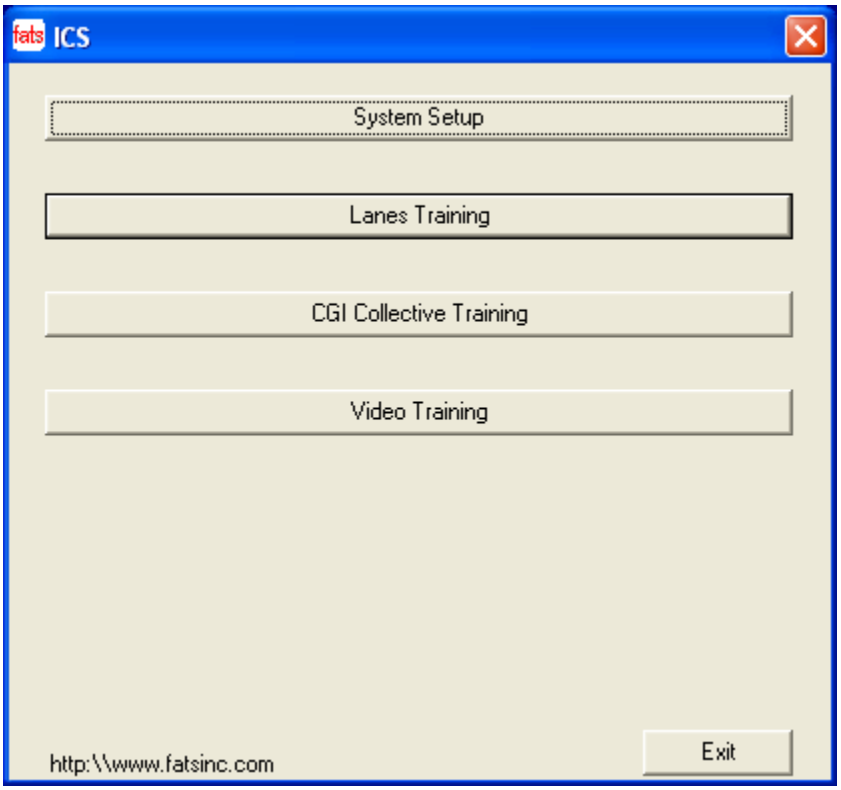
C. SUMMARY

This thesis found significant differences between the current naval marksmanship training program and a simulation-based marksmanship training program. The results

from the seven-yard line portion of the navy handgun qualification COF indicated that participants significantly benefited from the simulation-based training program more so than the current naval marksmanship training program. An exploratory analysis suggests that a time period of at least two weeks is necessary to detect group differences in retention of marksmanship skills. Additionally, an exploratory analysis indicates that the simulation-based training program may be most beneficial for poorer marksmen. Finally, responses from the post experiment survey indicated that the majority of participants in the experiment still had reservation about replacing real live fire training with simulation-based training, but established that there are benefits to having a marksmanship trainer available.

APPENDIX A. OPNAVINST3591.1F STAGE

The contents of this appendix are screen captures of the OPNAVINST3591.1F stage. These pictures are provided so that future thesis students can navigate to the stage used in this experiment. Readers may also reference the fats manual. The stage was named after the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification*.



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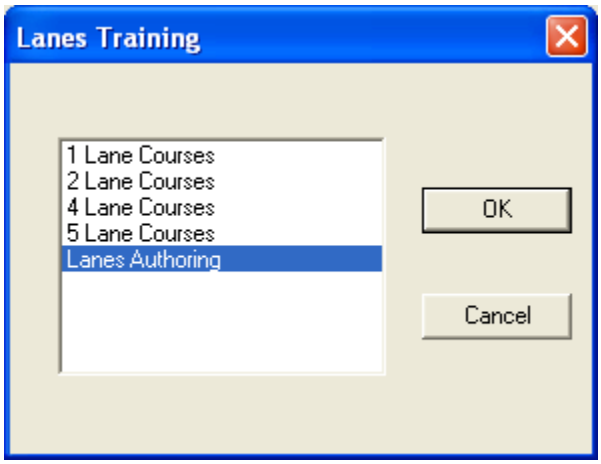
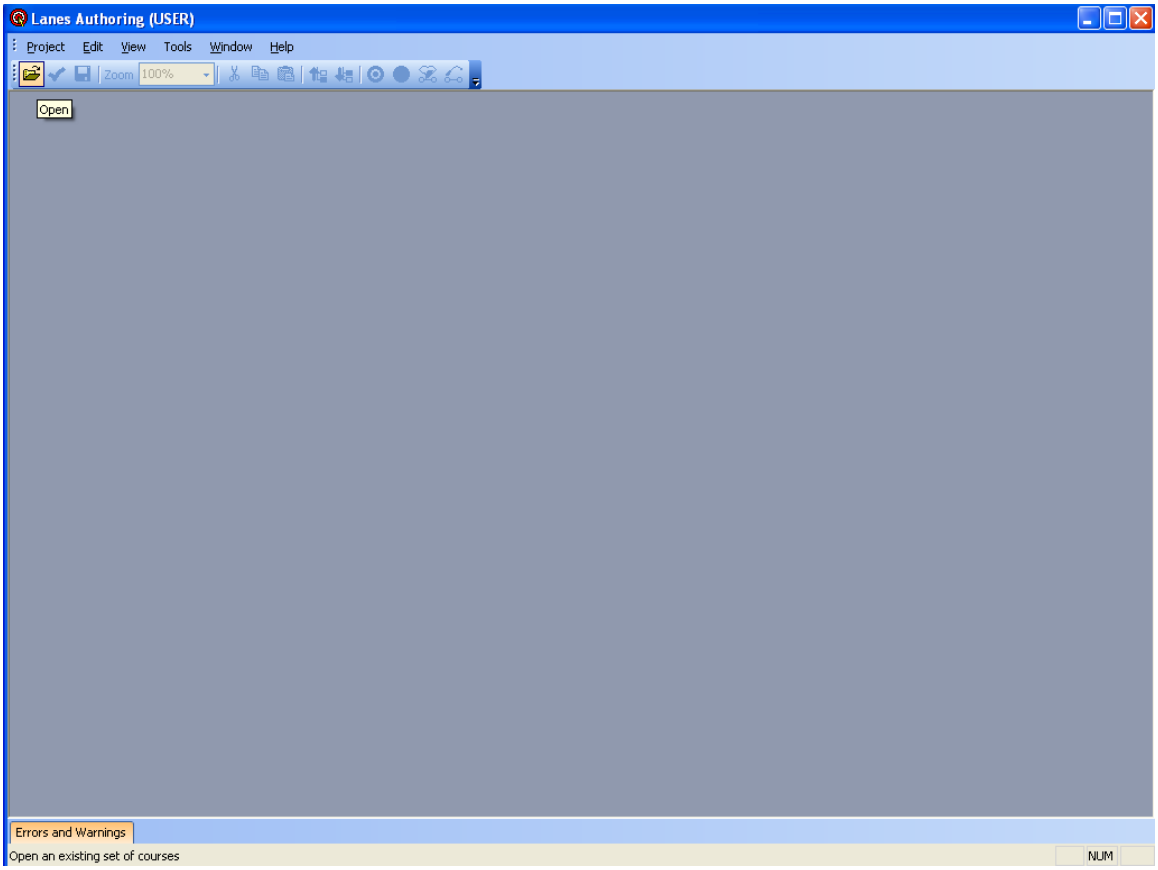
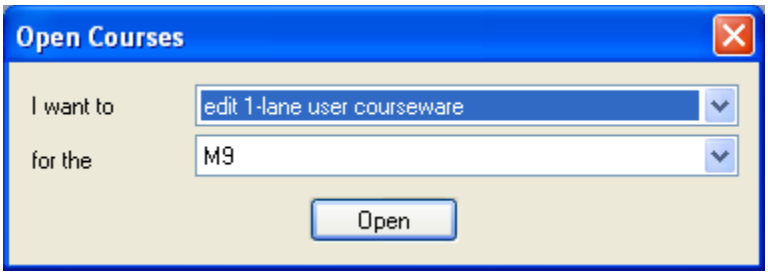


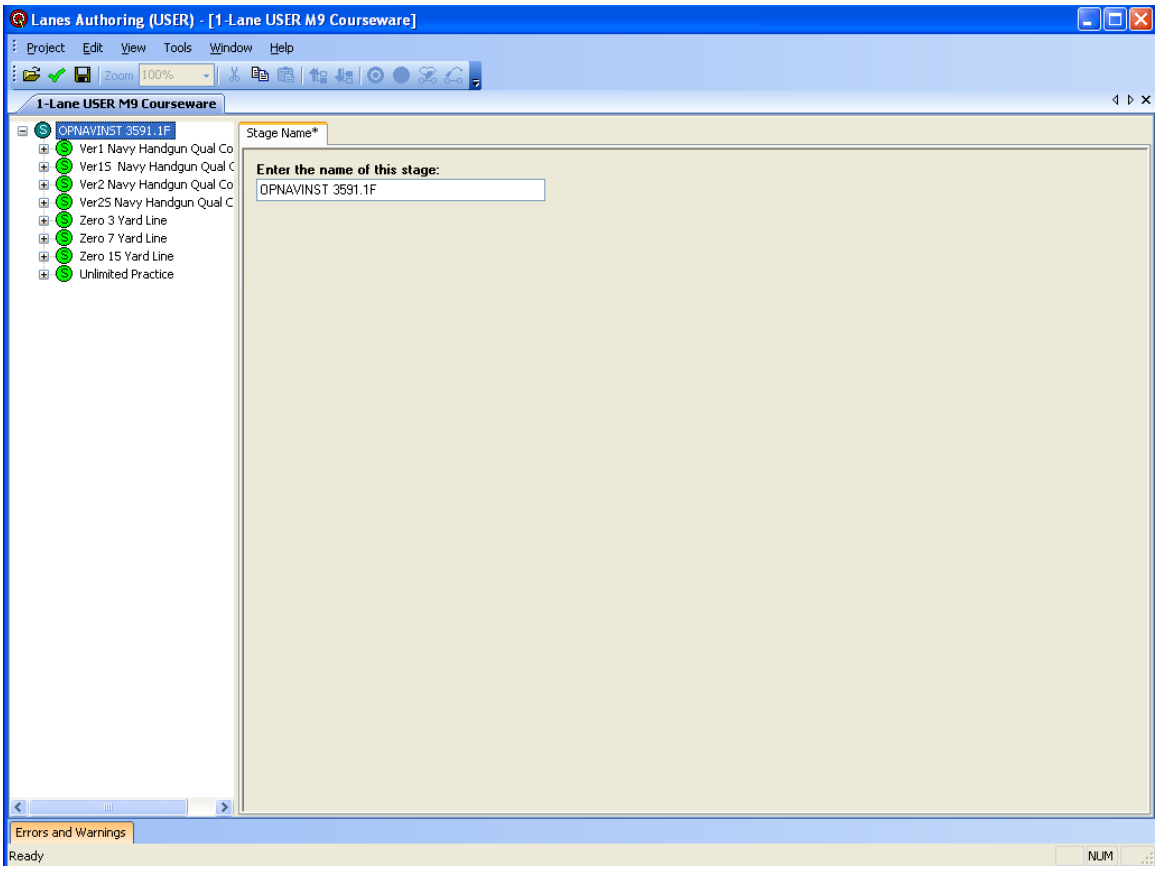
Lanes Authorizing



Open Courses Tab



Open Courses



OPNAVINST3591.1F Stage

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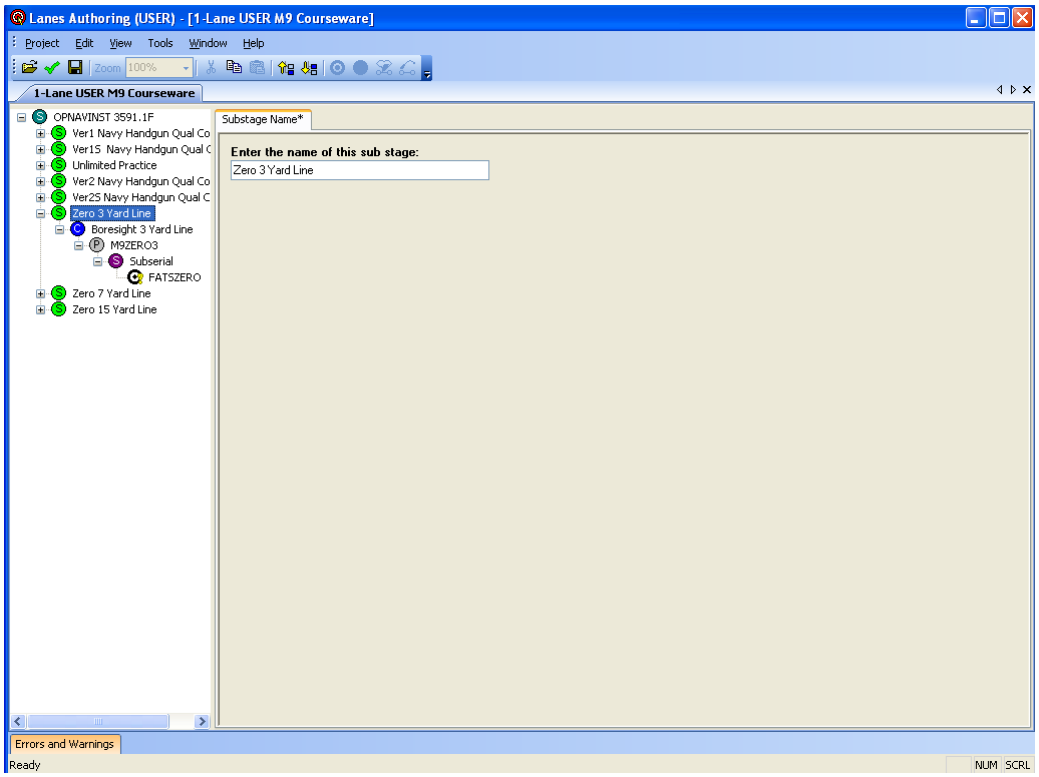
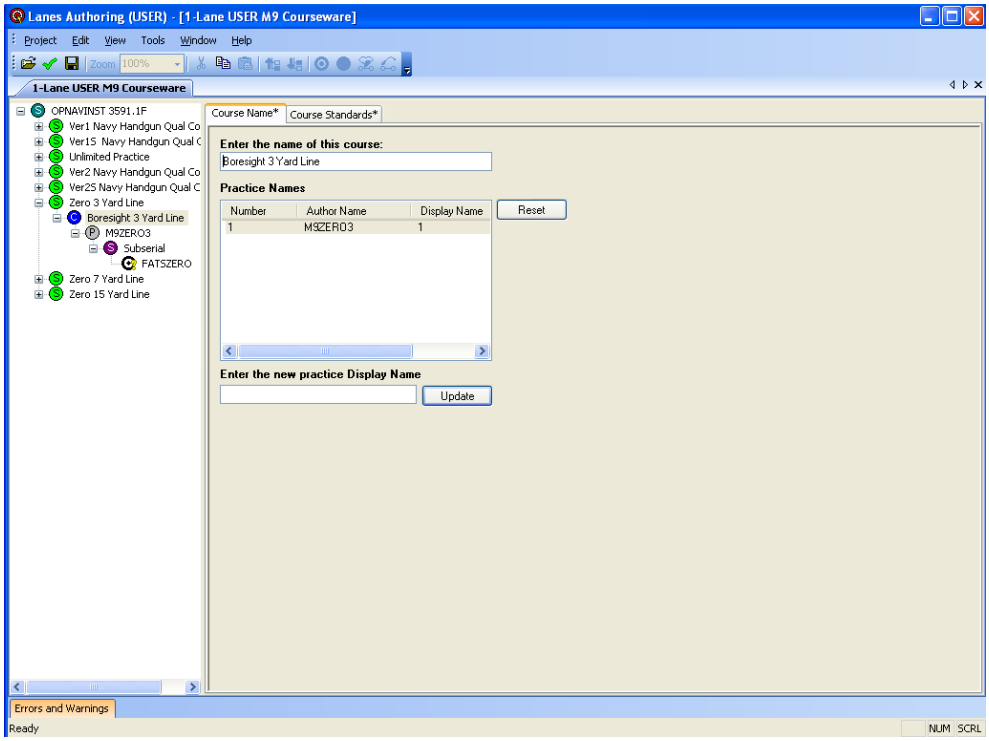
APPENDIX B. 3-YARD ZERO SCENARIO

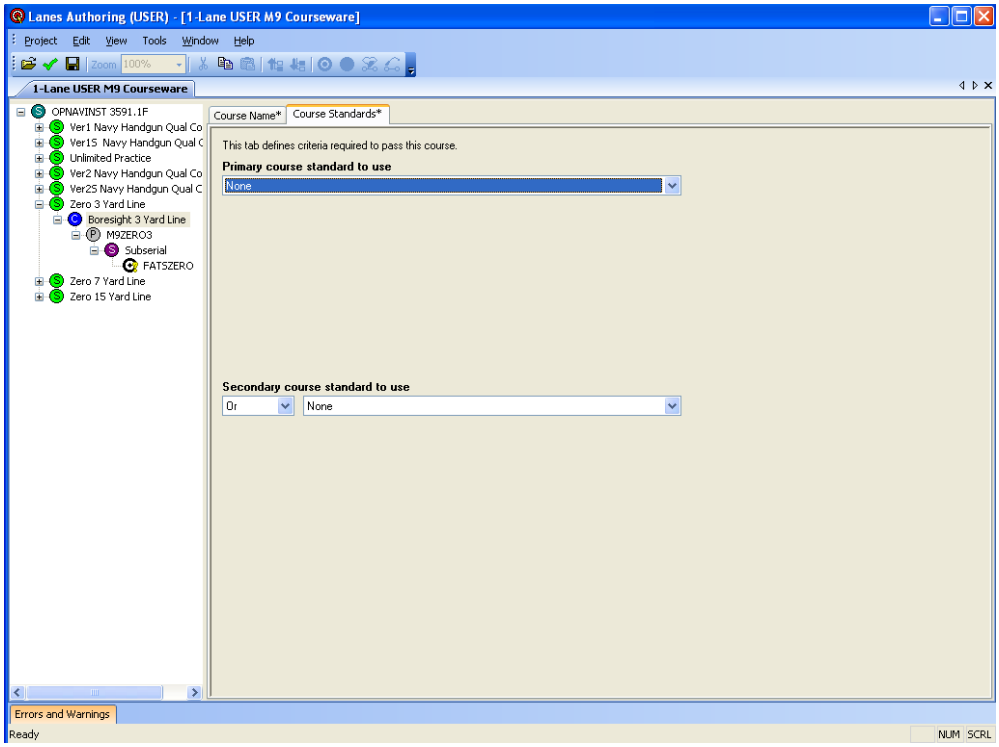
The contents of the appendix are screen captures of the 3-yard zero scenario. These pictures are provided so that anyone can recreate the course of fire used in this experiment. The scenario was established with respect to Navy Handgun Qualification Course found in the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification*.



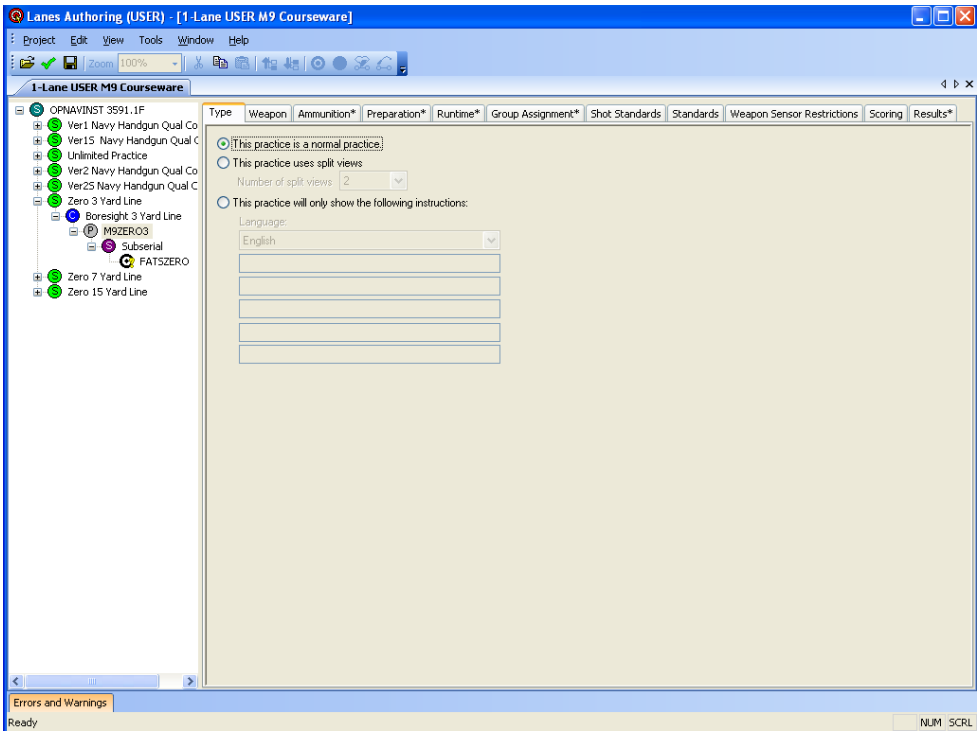
Sub Stage



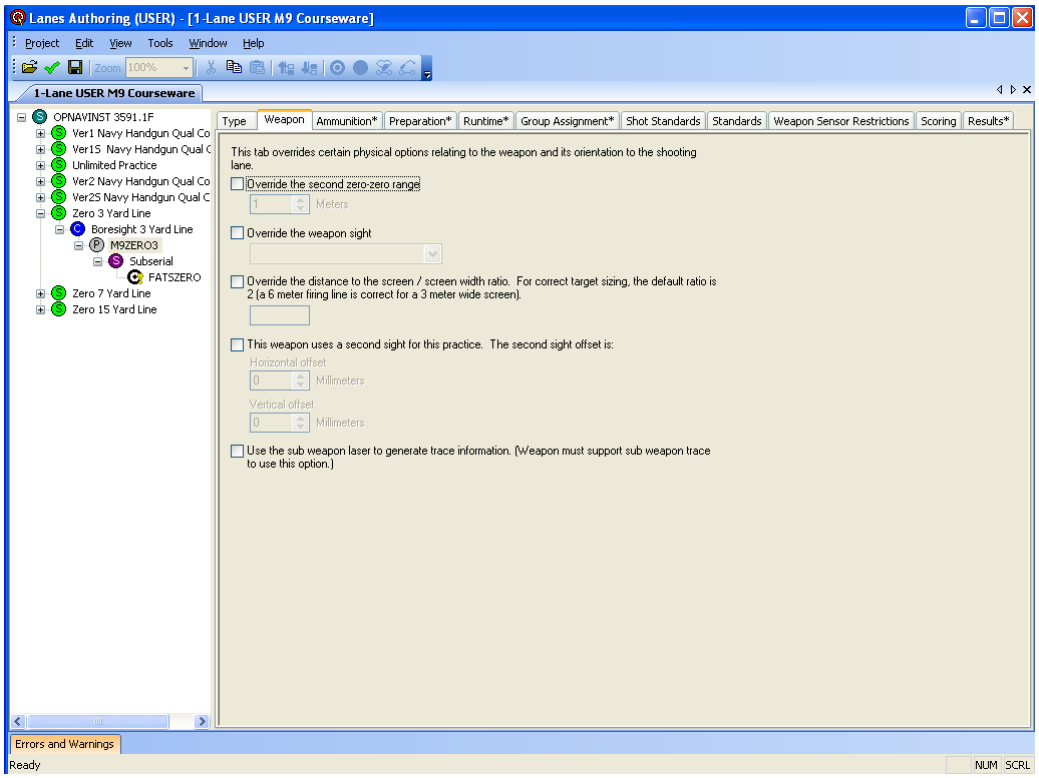
Course Name



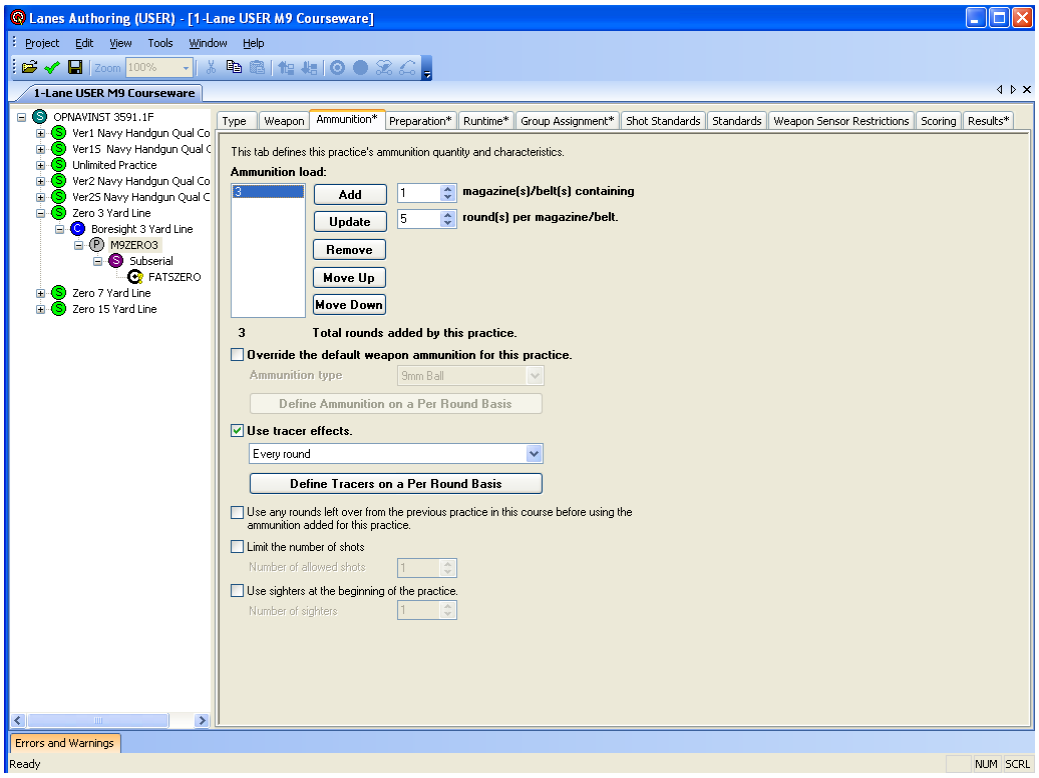
Course Standards



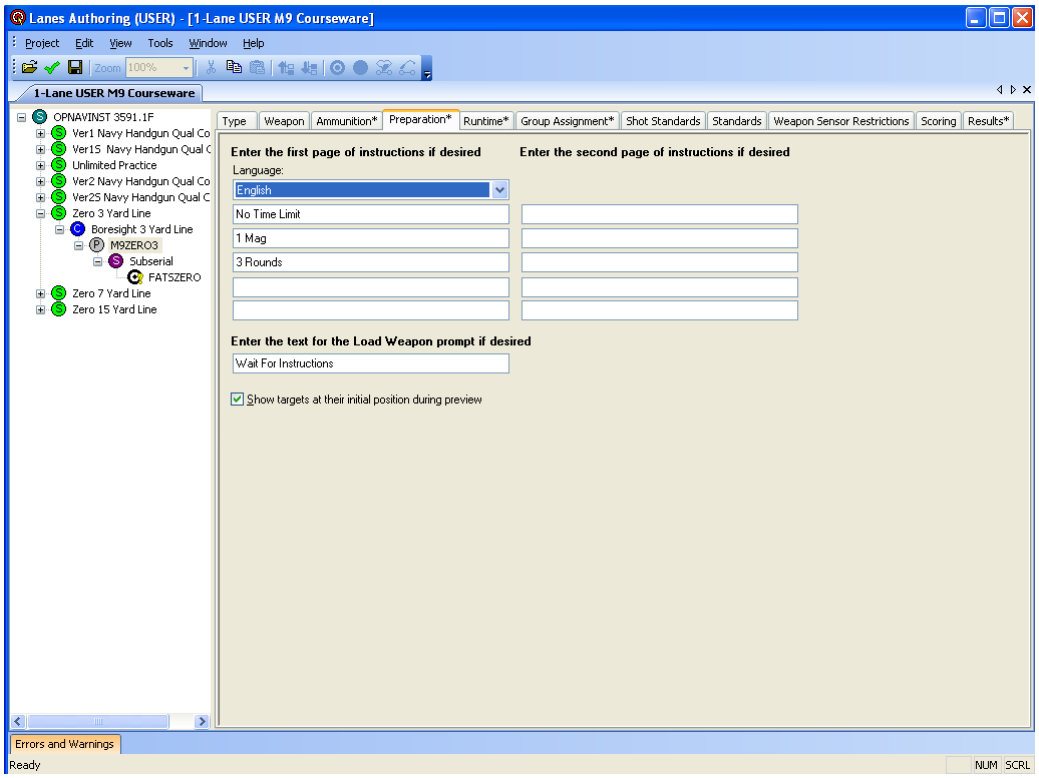
Practice Type



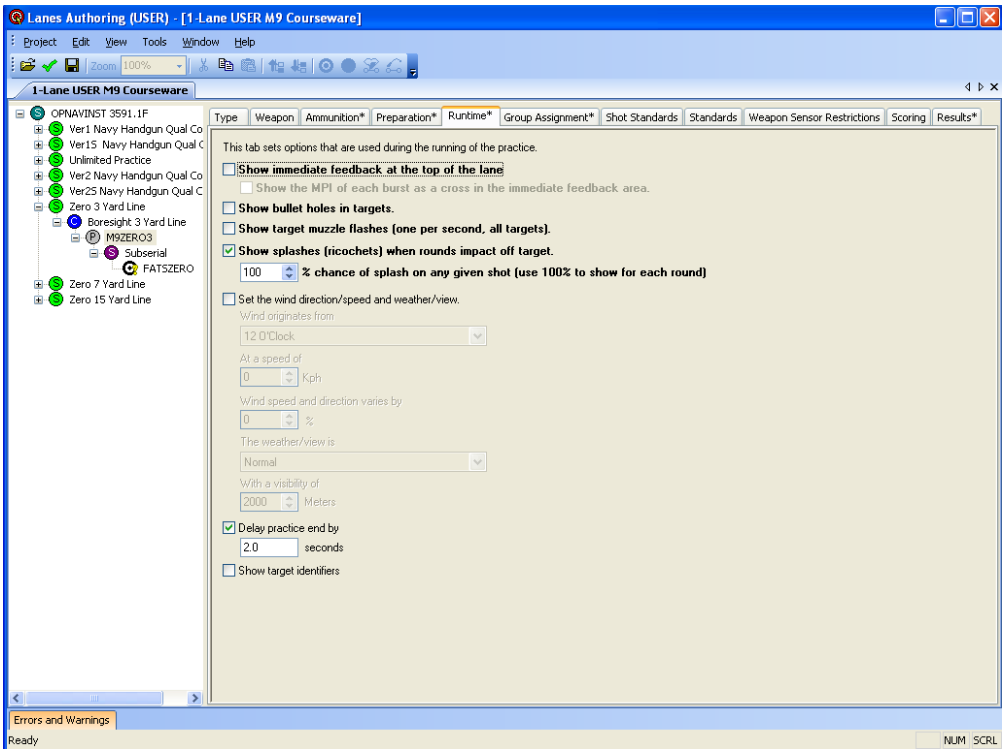
Practice Weapon



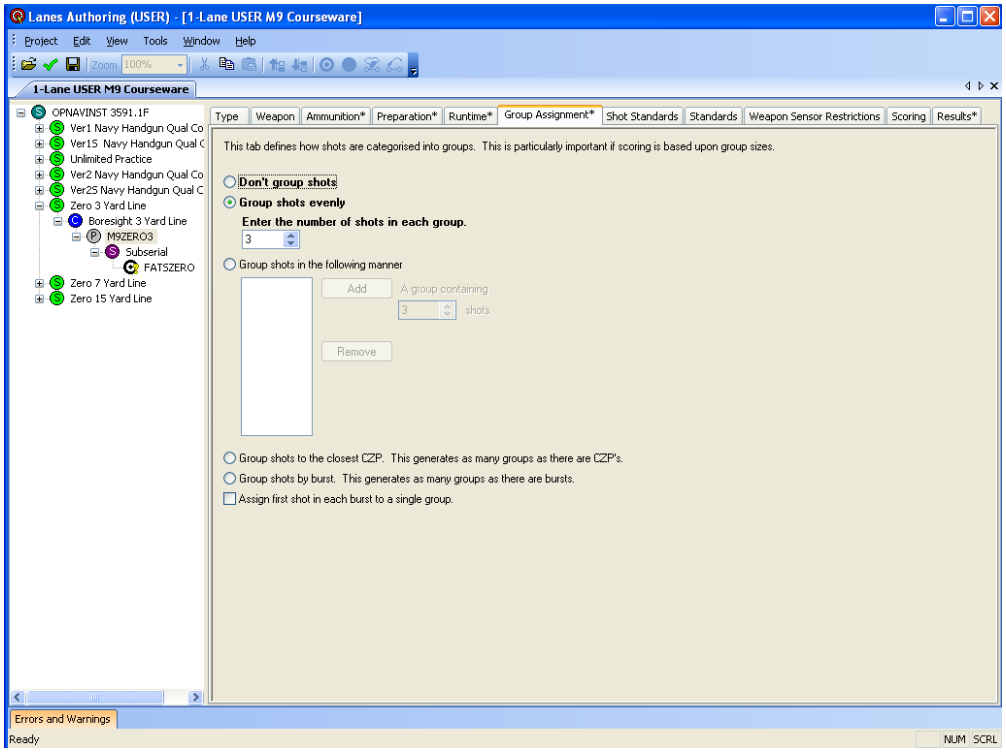
Practice Ammunition



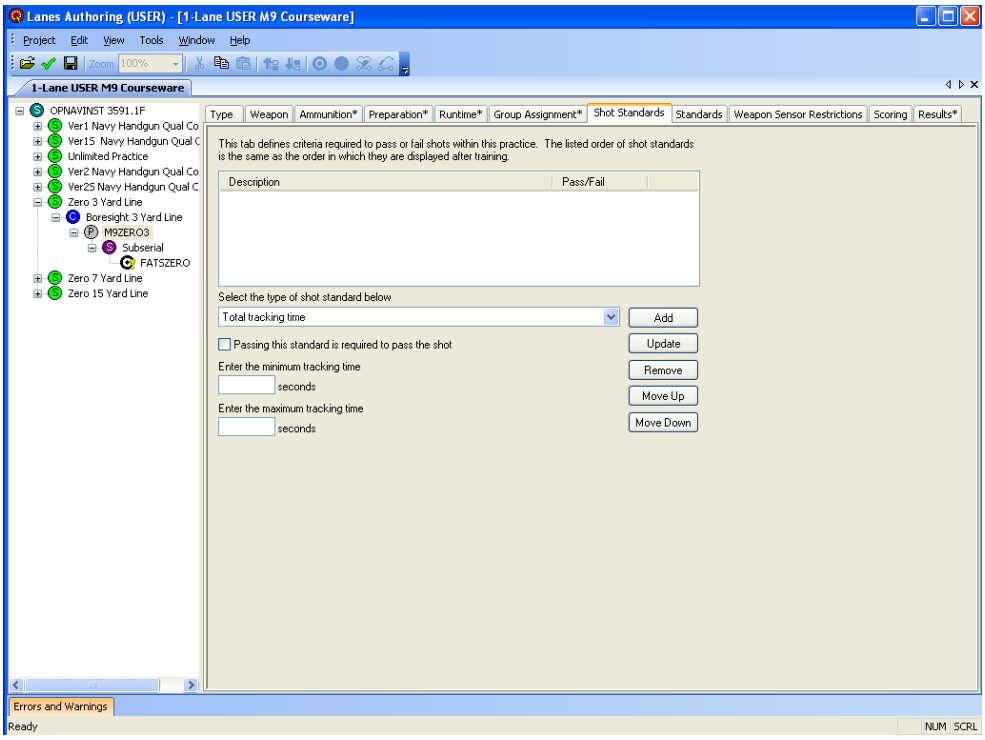
Practice Preparation



Practice Runtime



Practice Group Assignment



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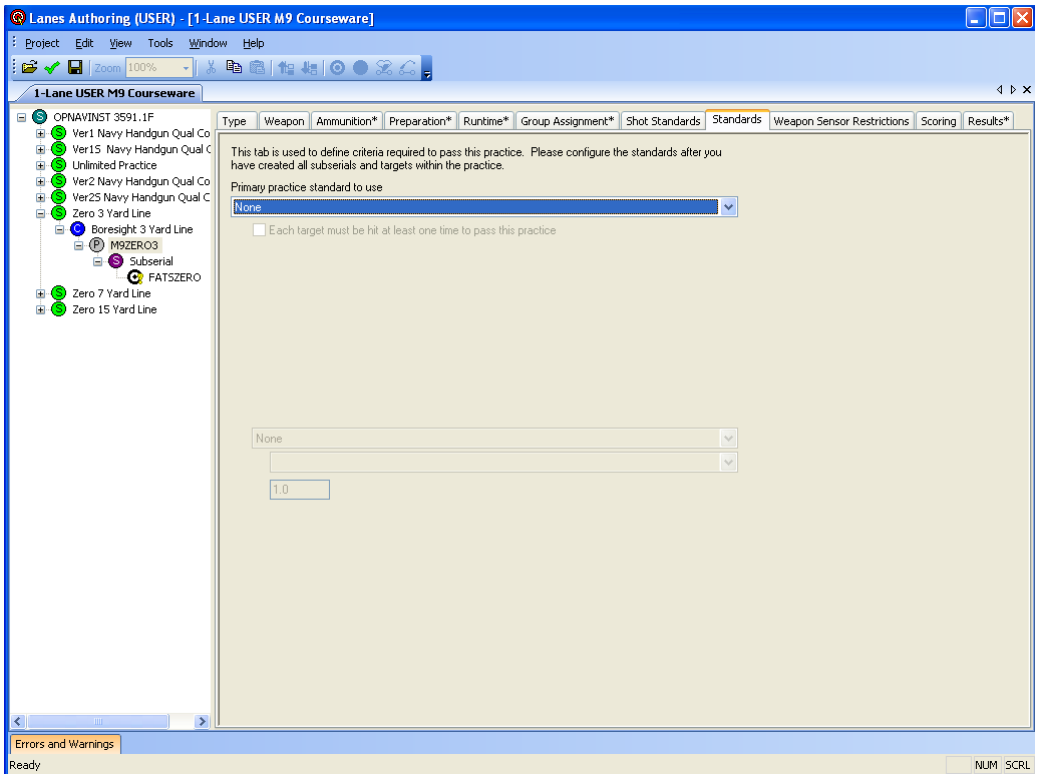

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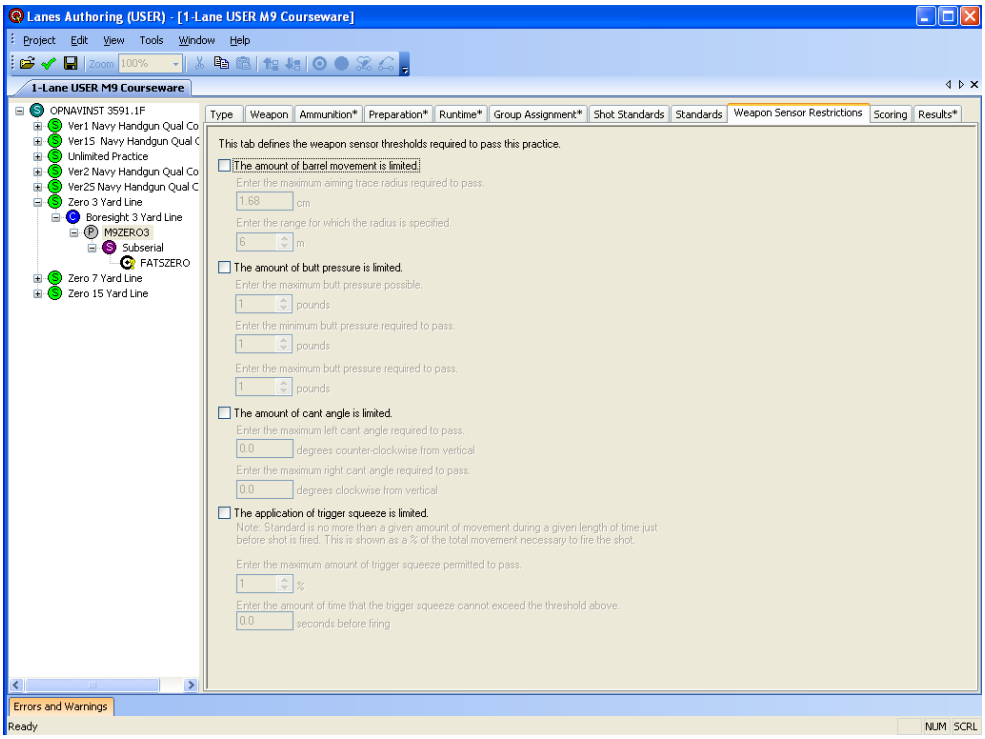
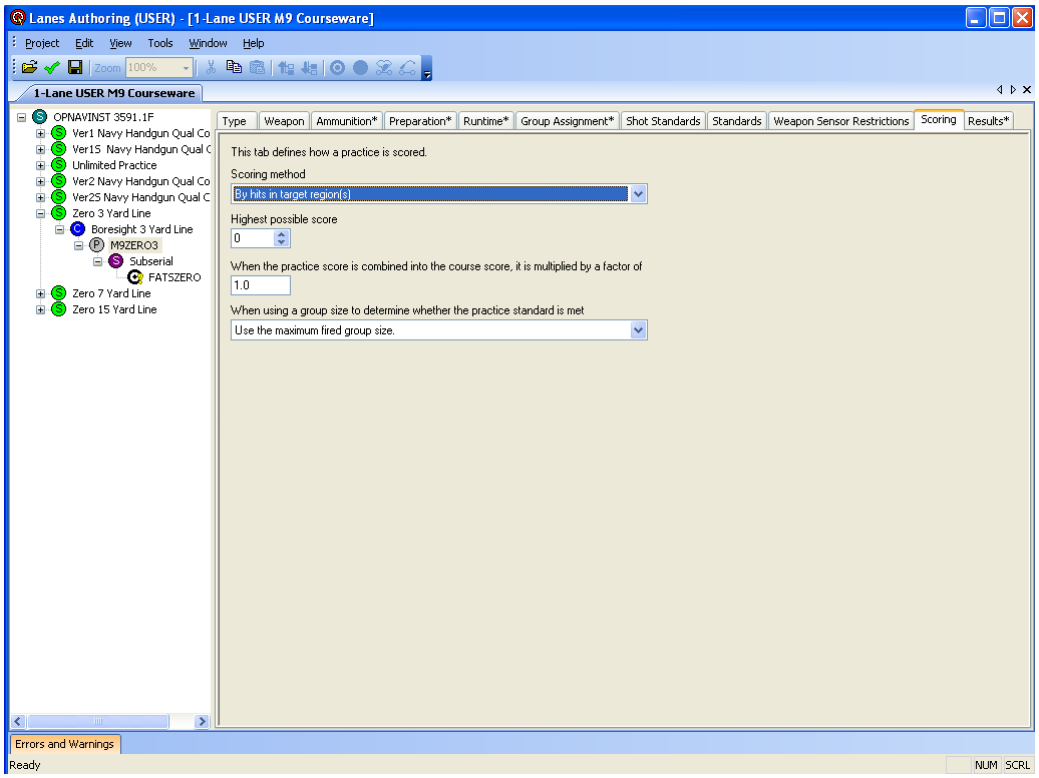


Practice Weapon Sensor Restrictions



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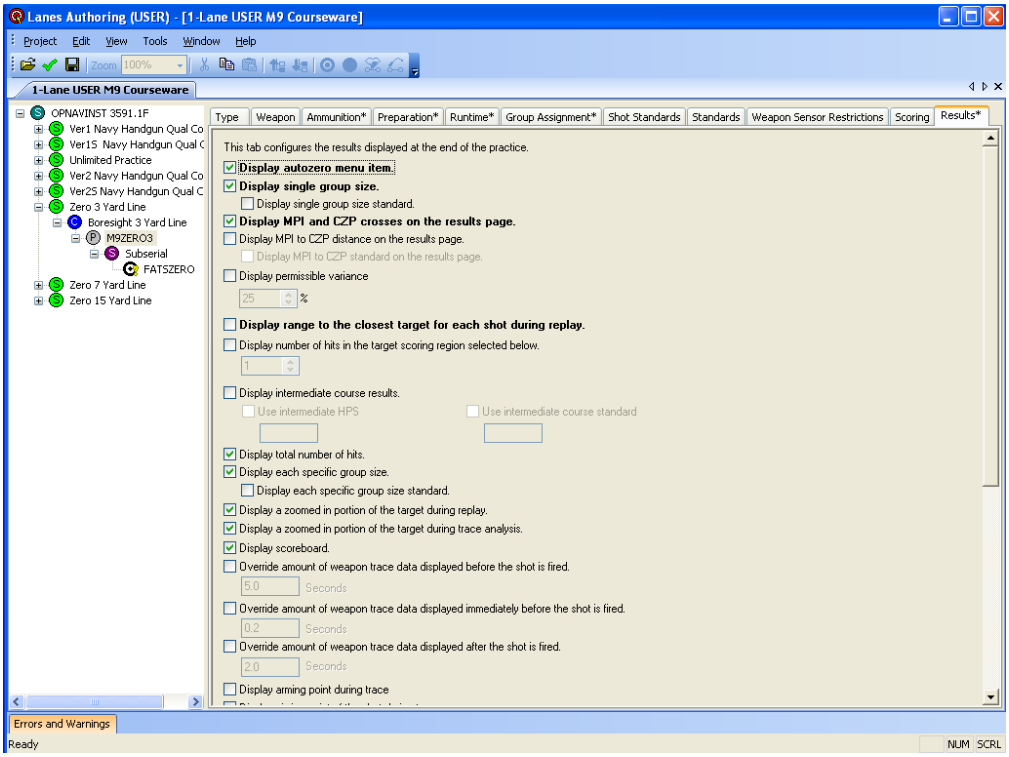
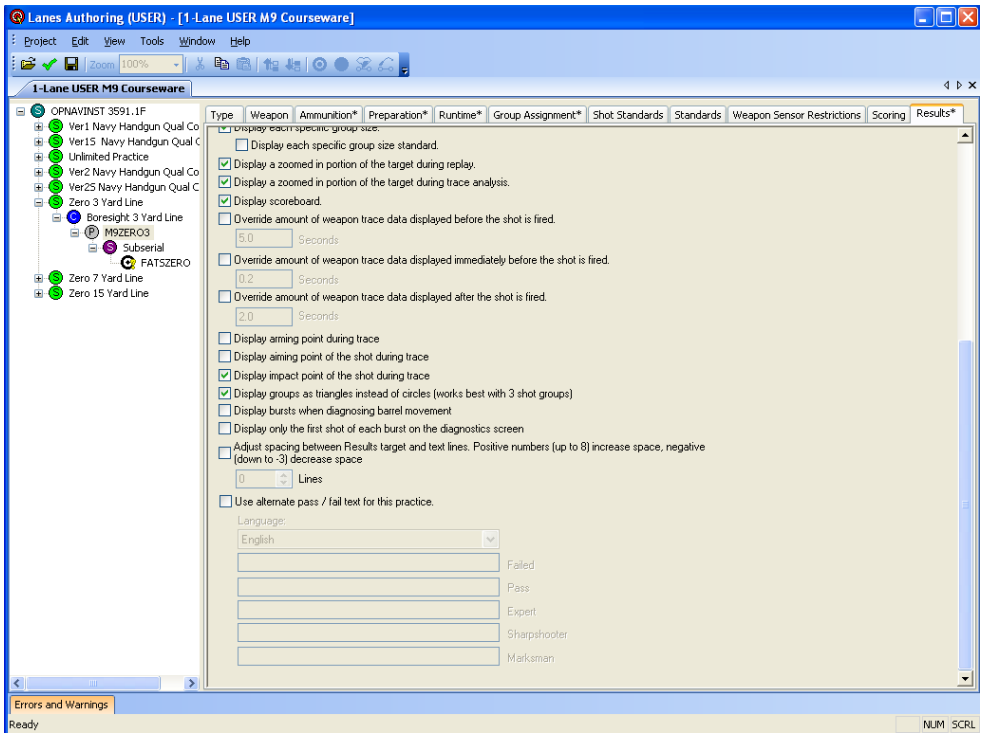
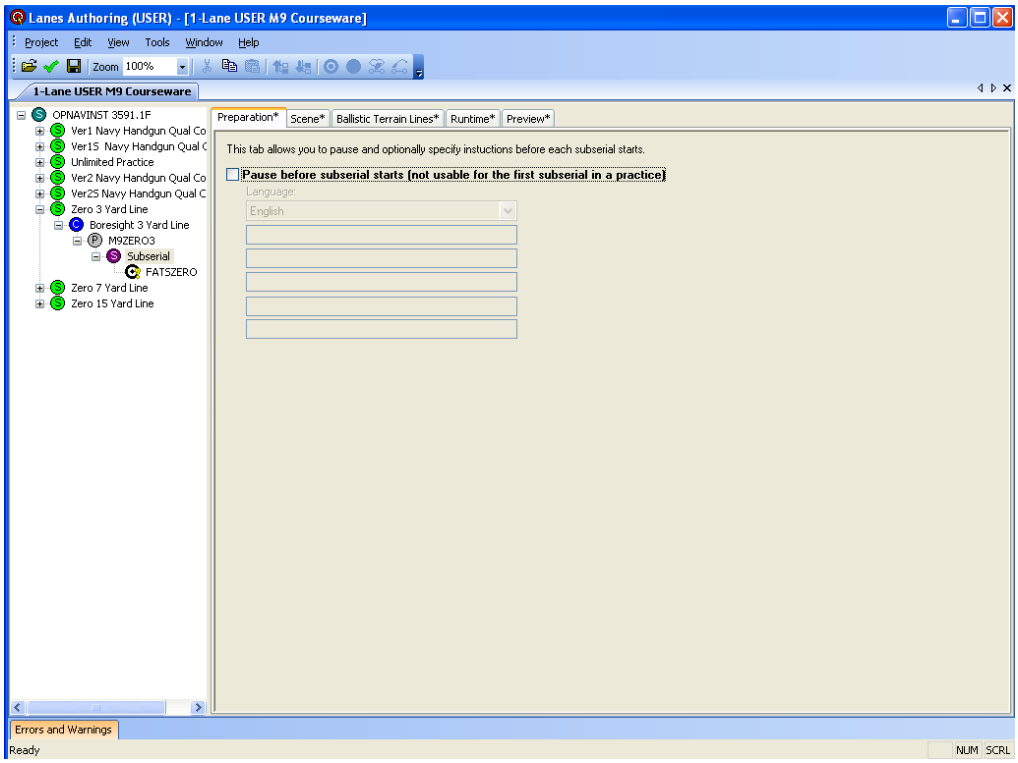


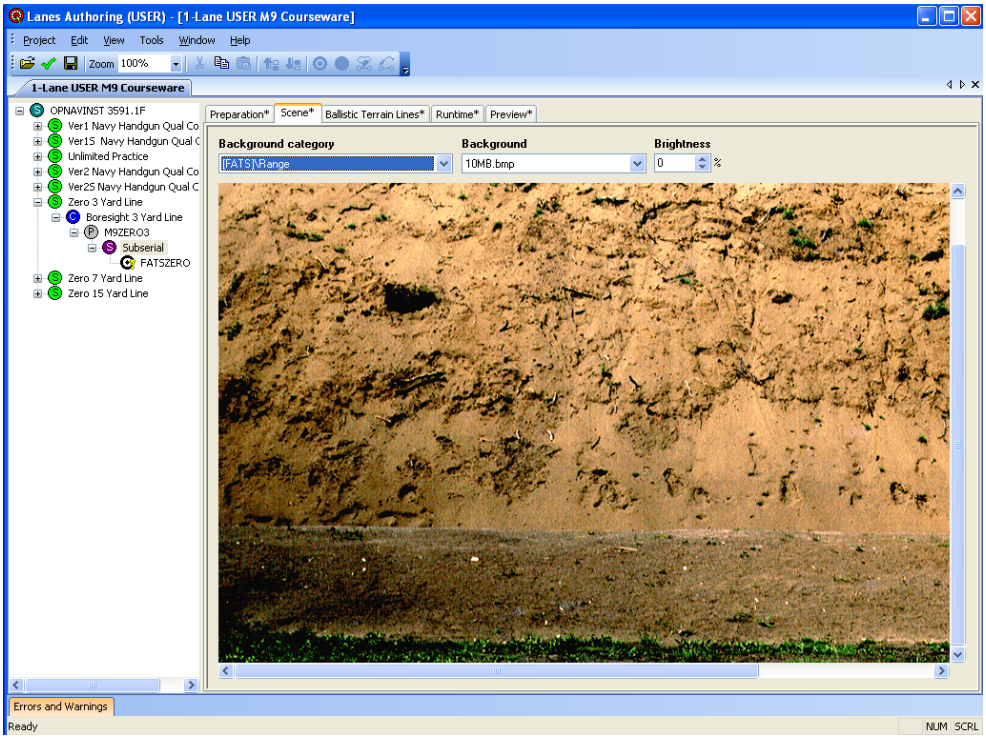
Practice Results Top



Practice Results Bottom



Sub Serial Preparation



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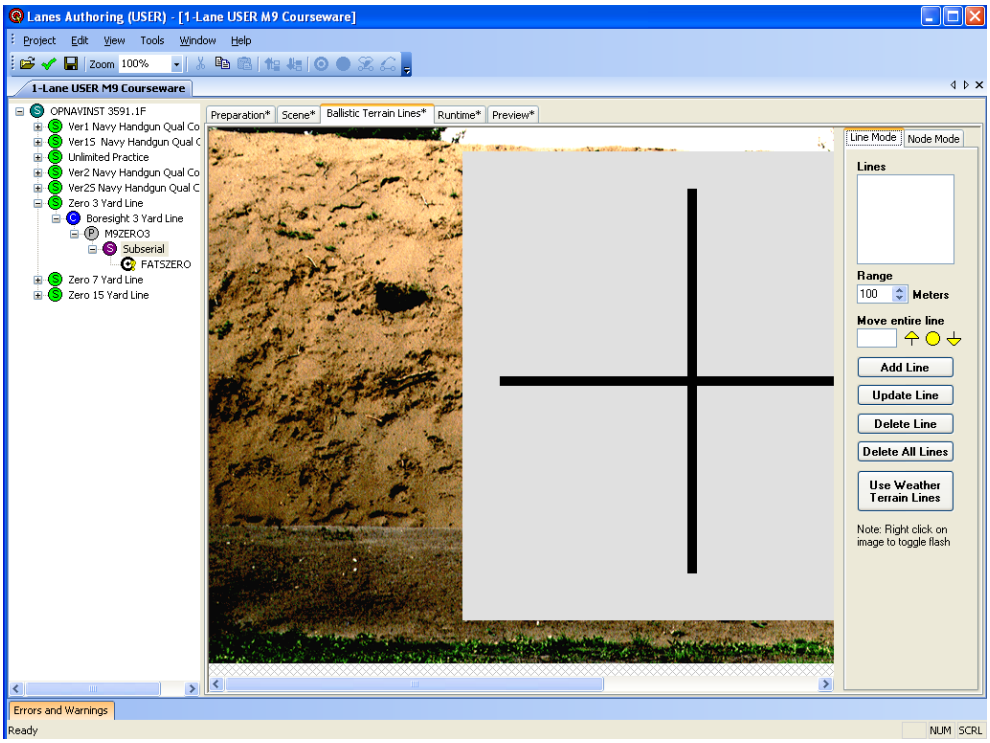
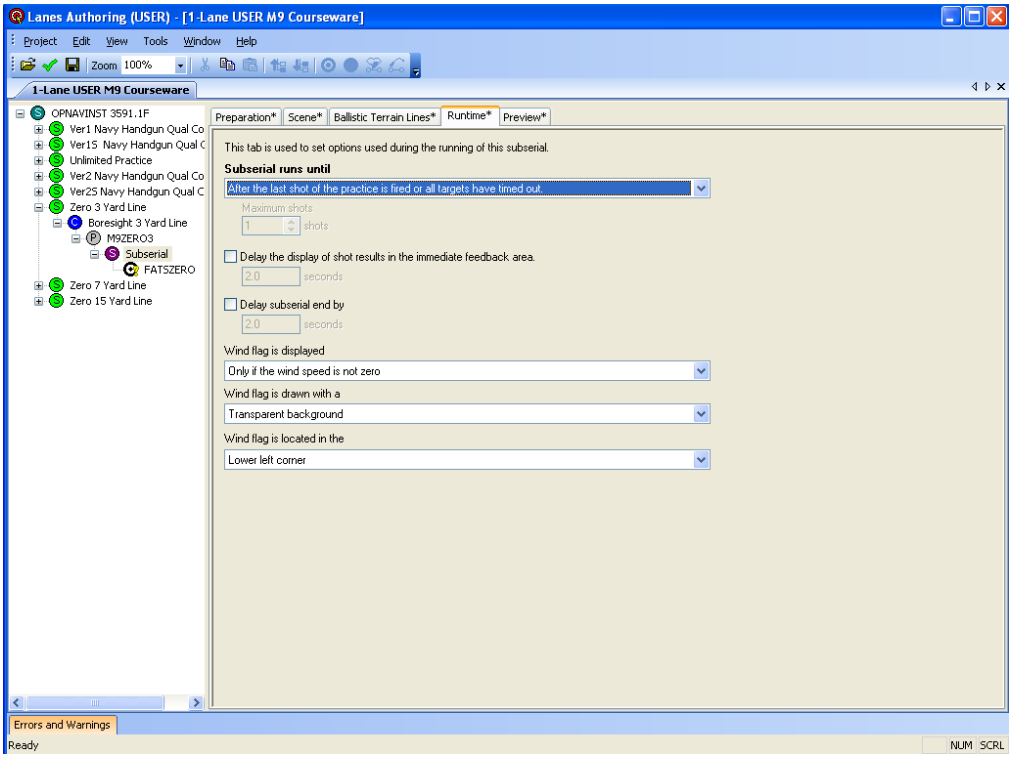
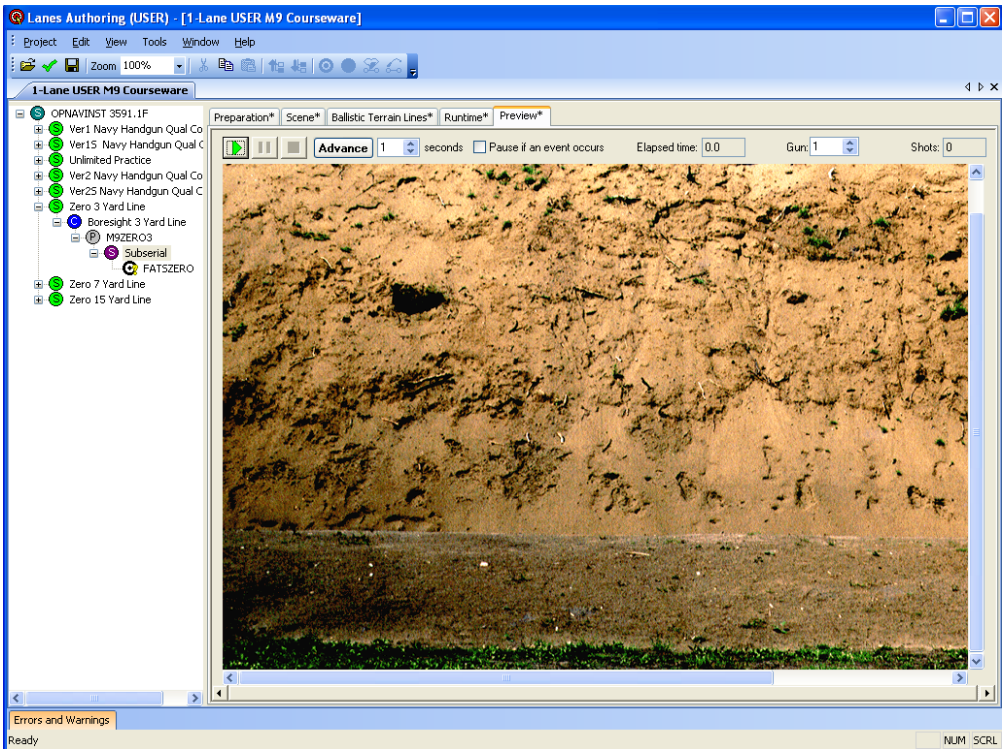


Sub Serial Ballistic Terrain Lines



Sub Serial Runtime



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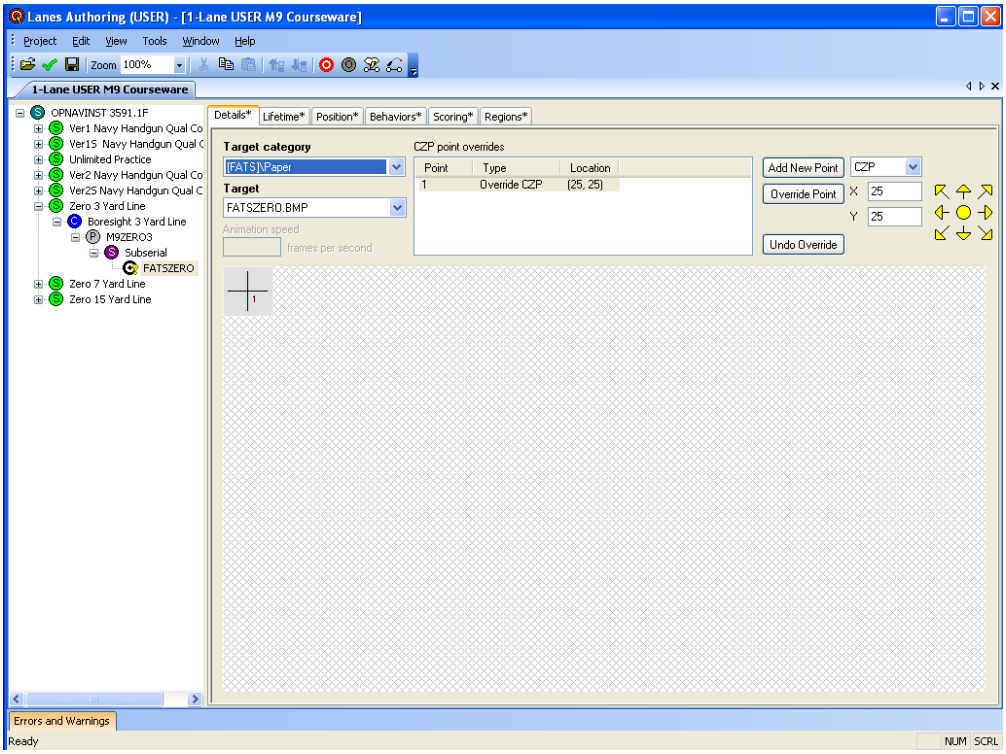
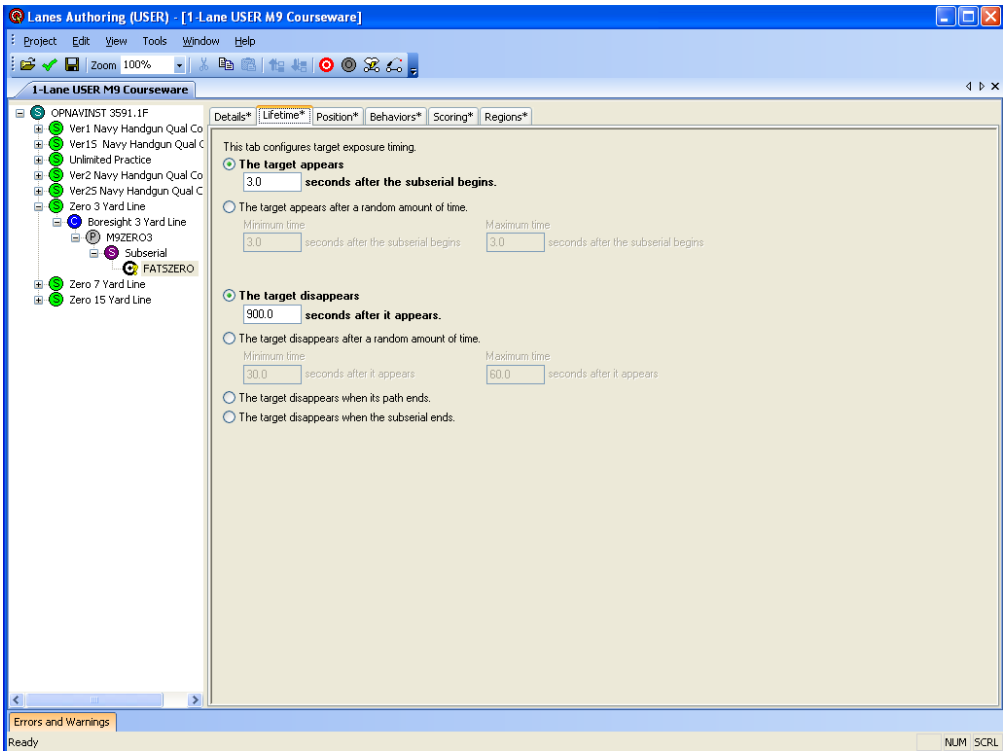


Target Details



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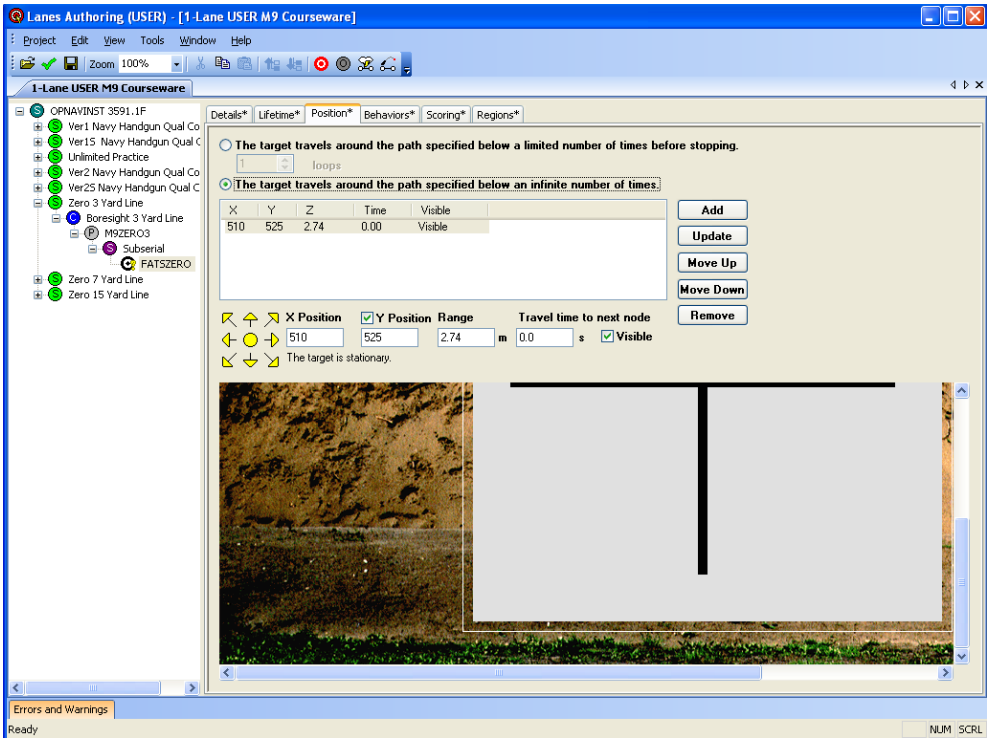
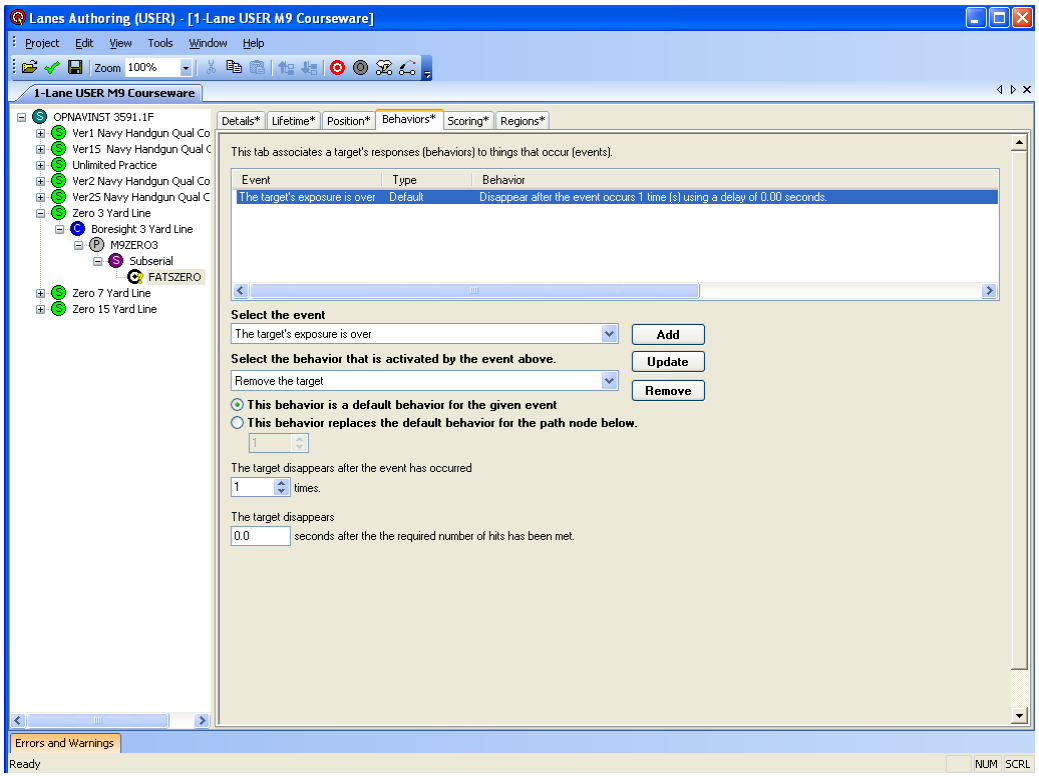
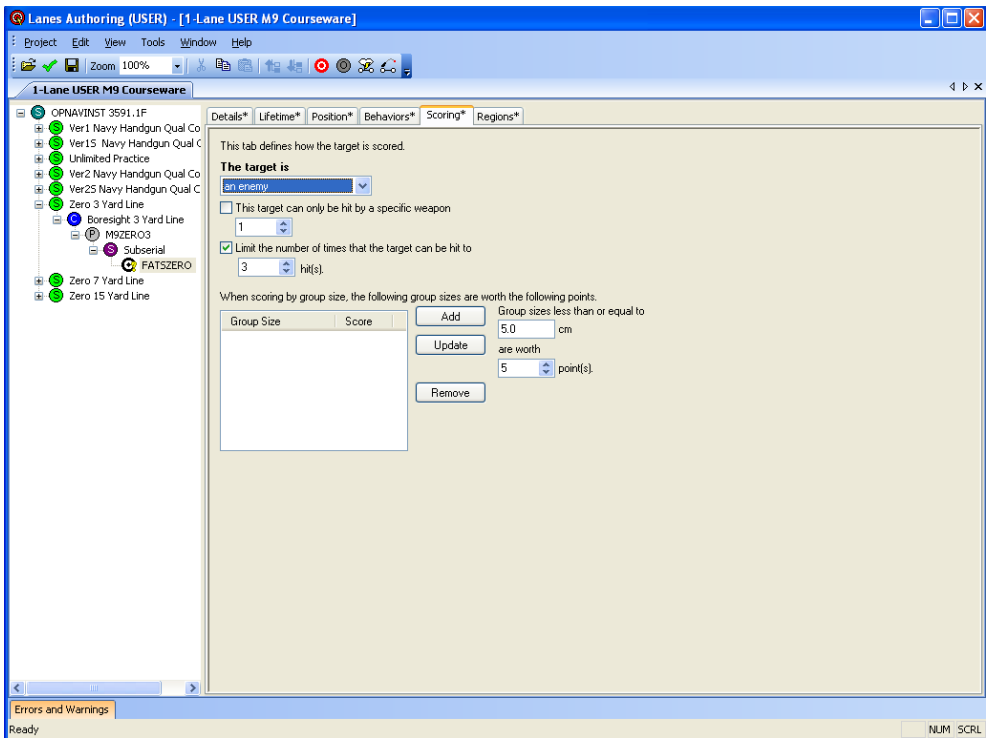


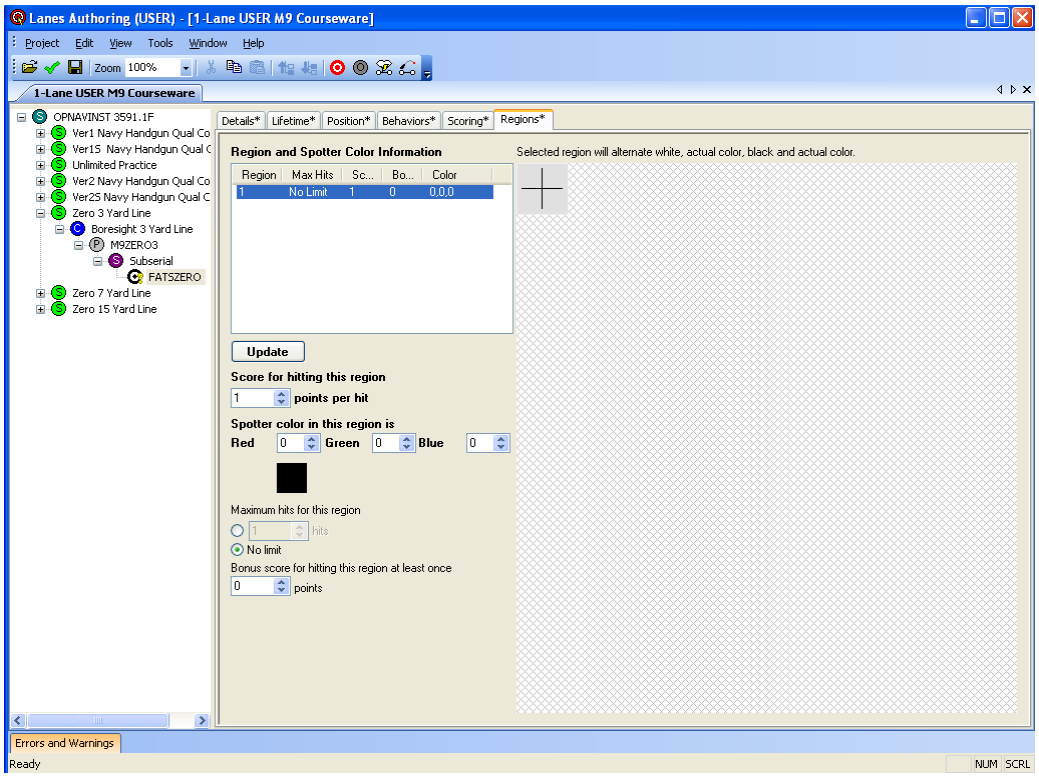
Target Position



Target Behaviors



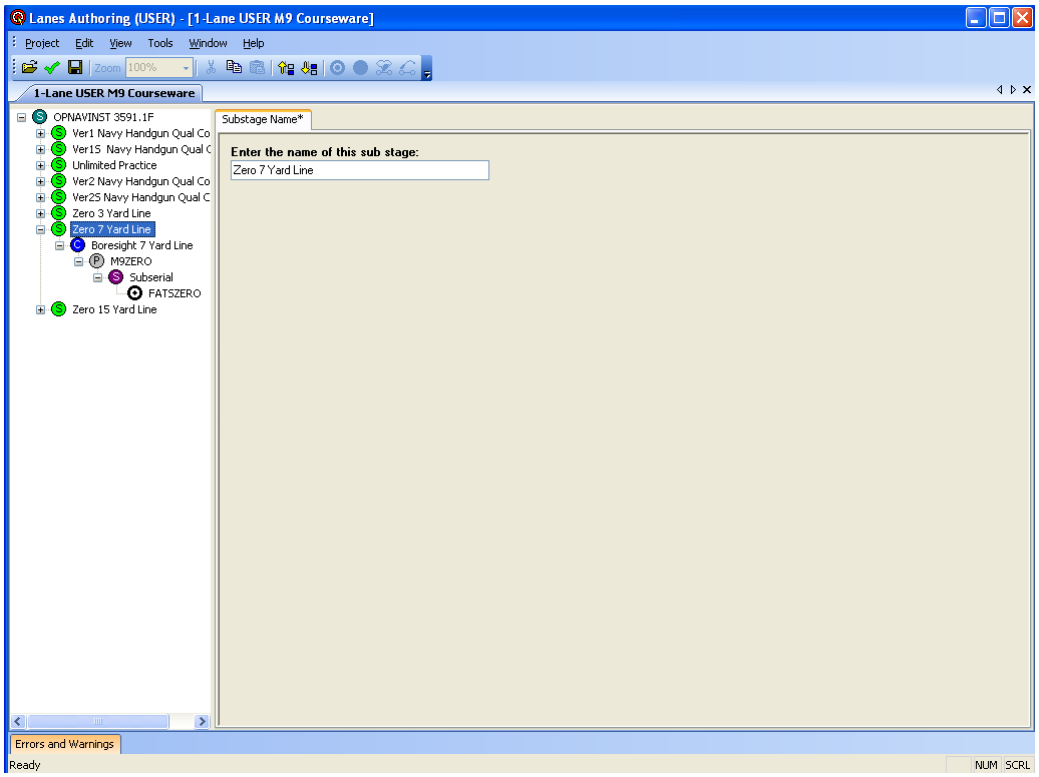
Target Scoring



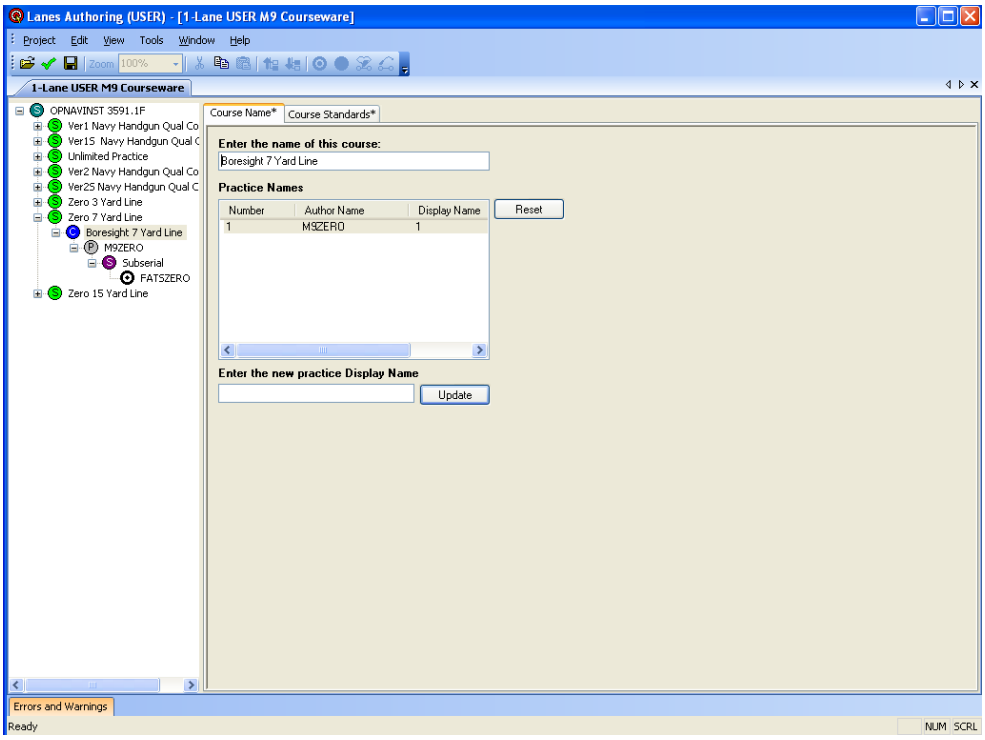
Target Regions

APPENDIX C. 7-YARD ZERO SCENARIO

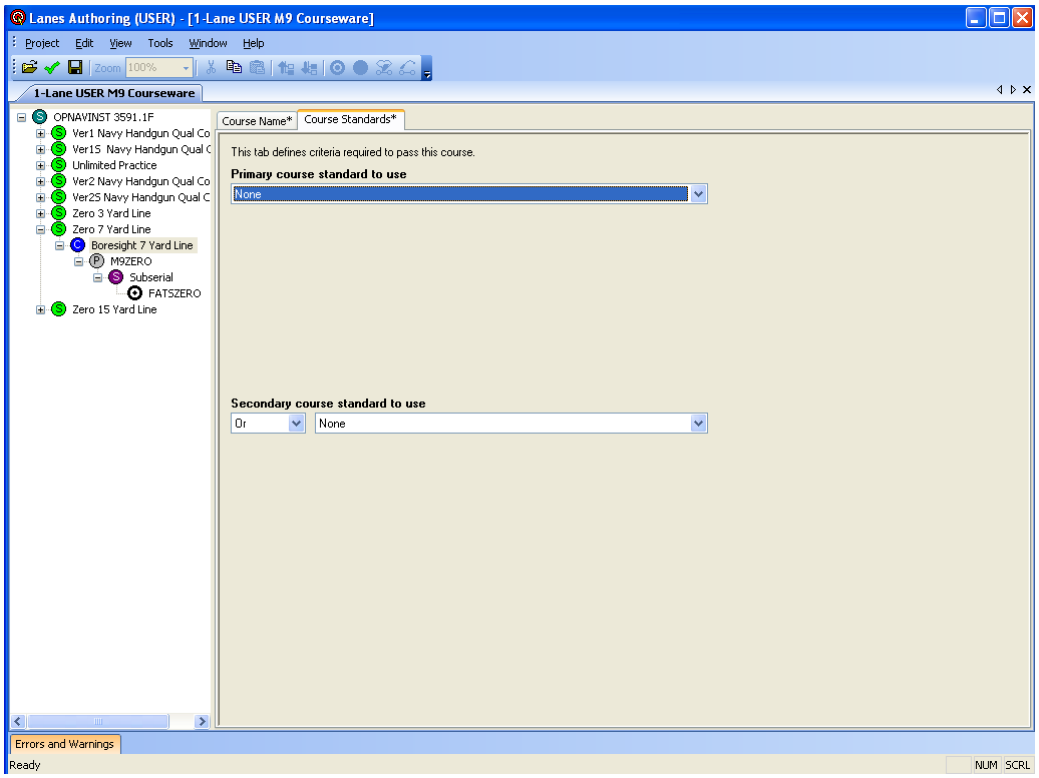
The contents of the appendix are screen captures of the 7-yard zero scenario. These pictures are provided so that anyone can recreate the course of fire used in this experiment. The scenario was established with respect to Navy Handgun Qualification Course found in the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification*.



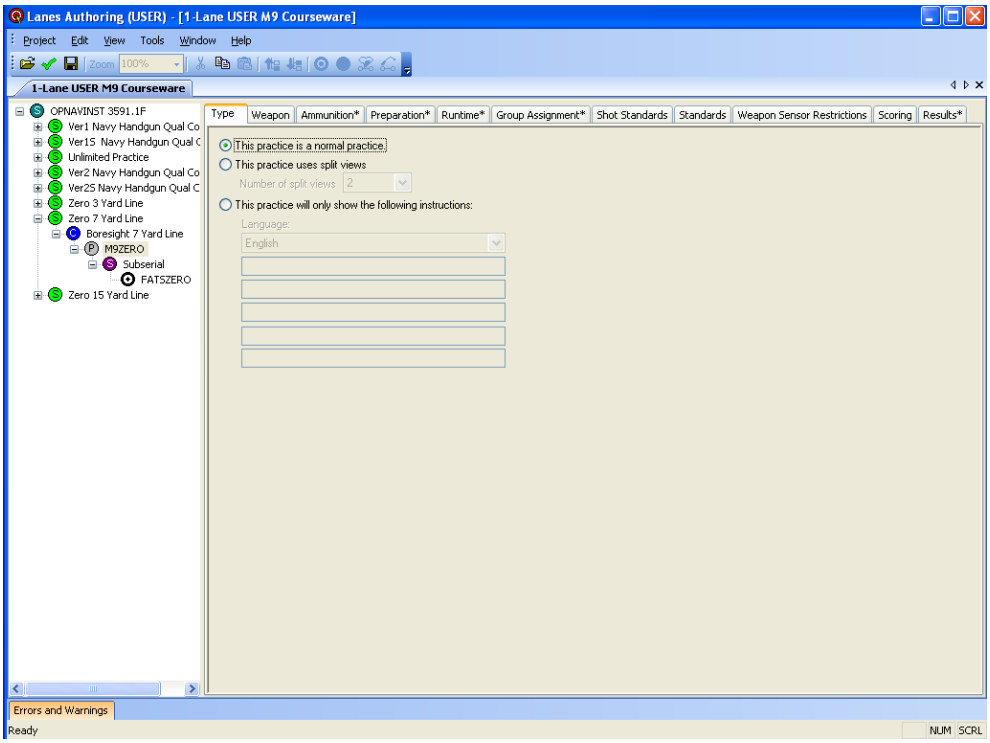
Sub Stage



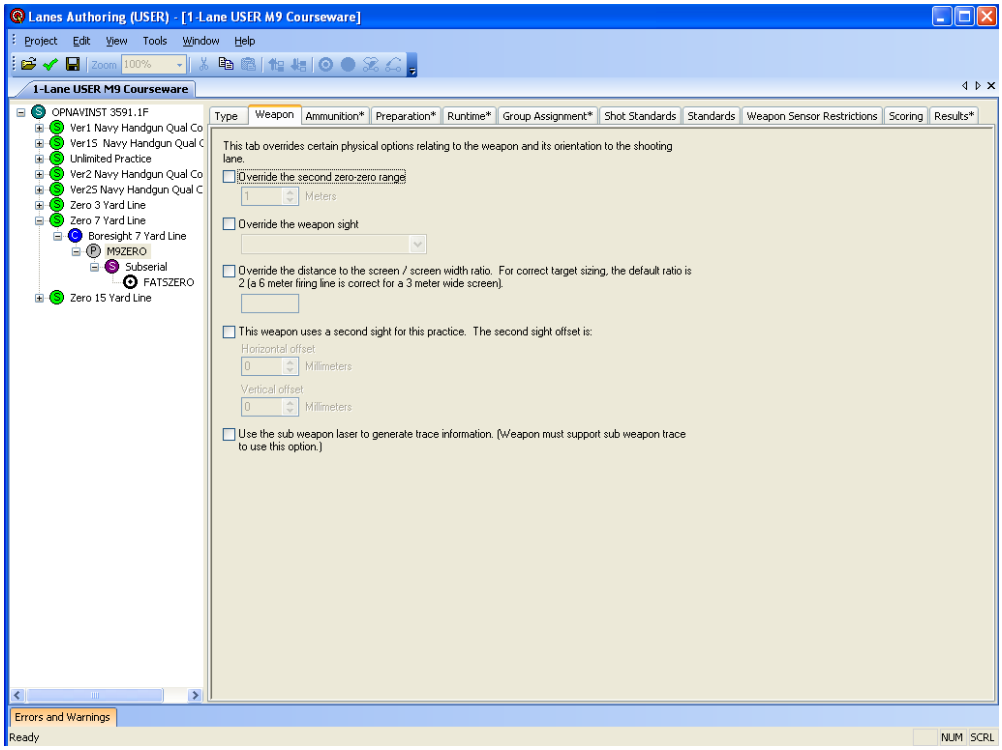
Course Name



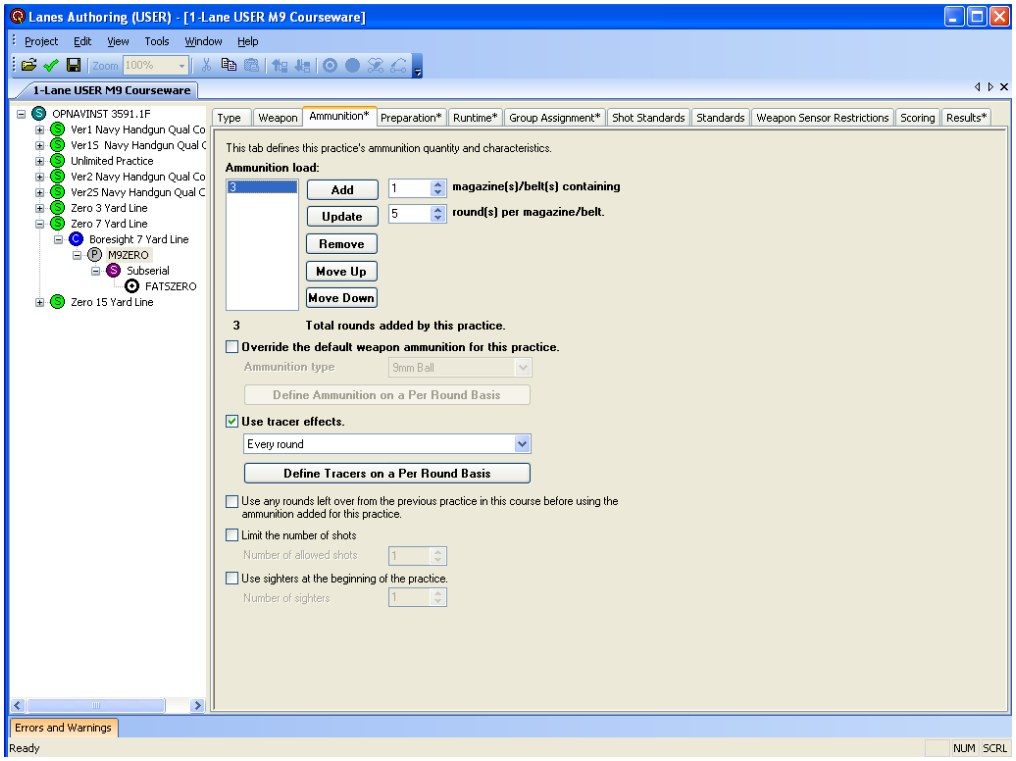
Course Standards



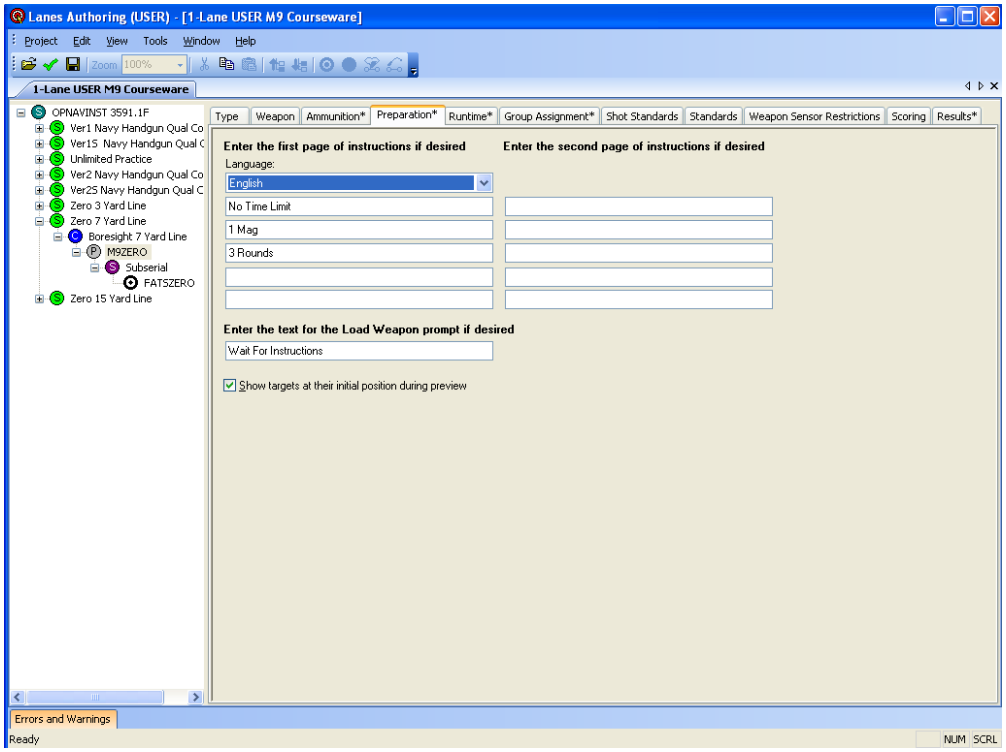
Practice Type



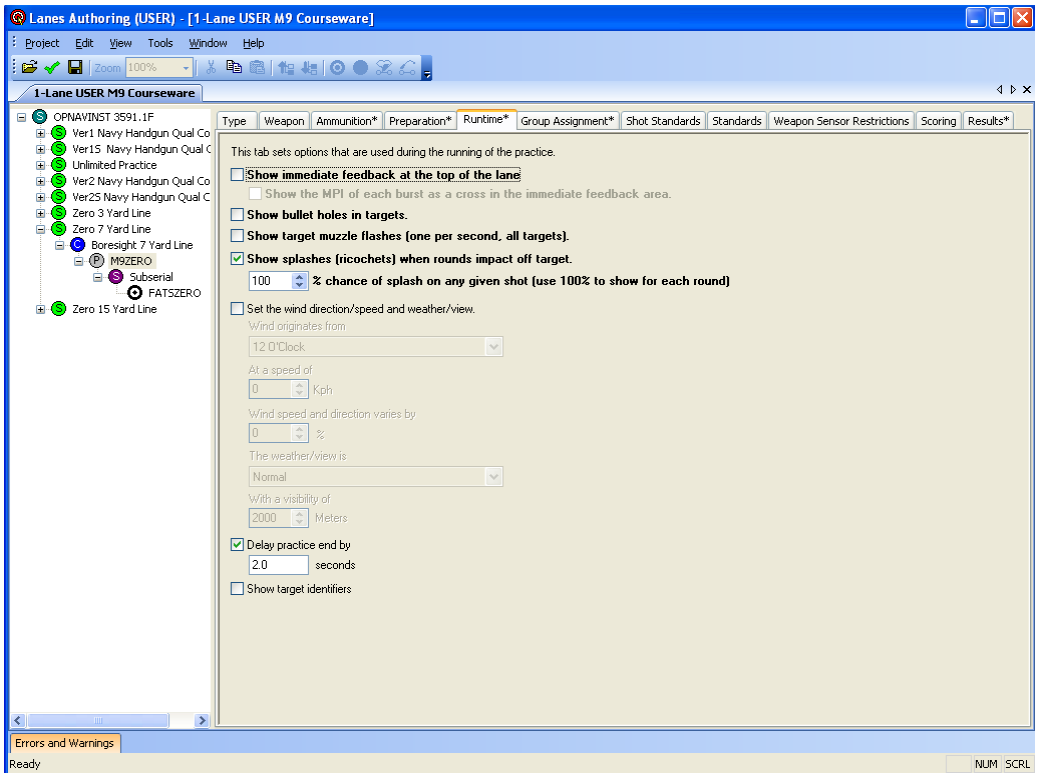
Practice Weapon



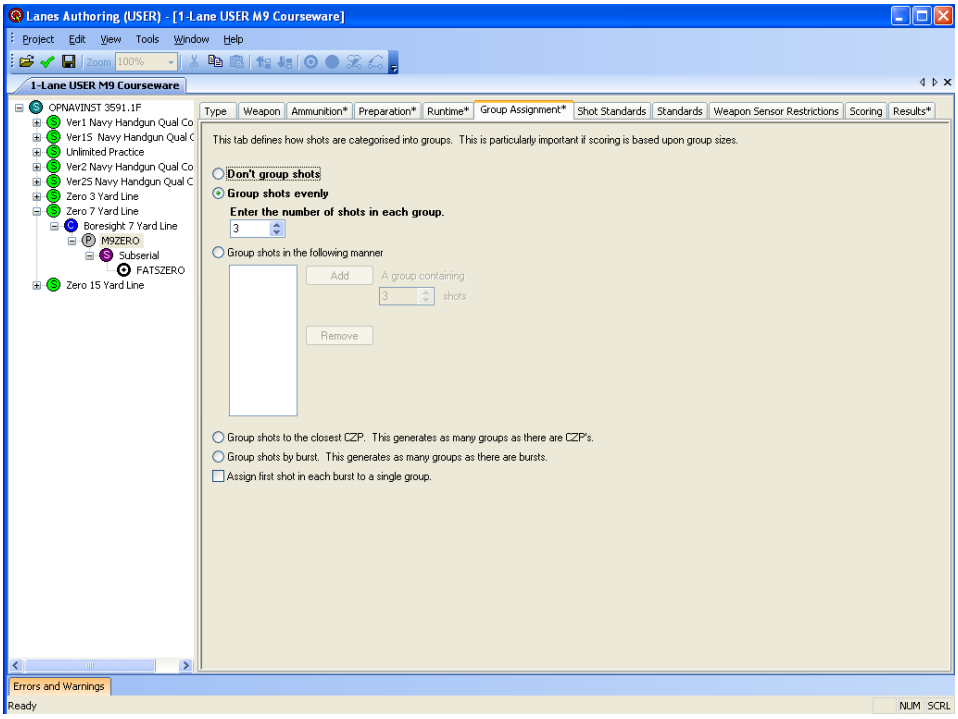
Practice Ammunition



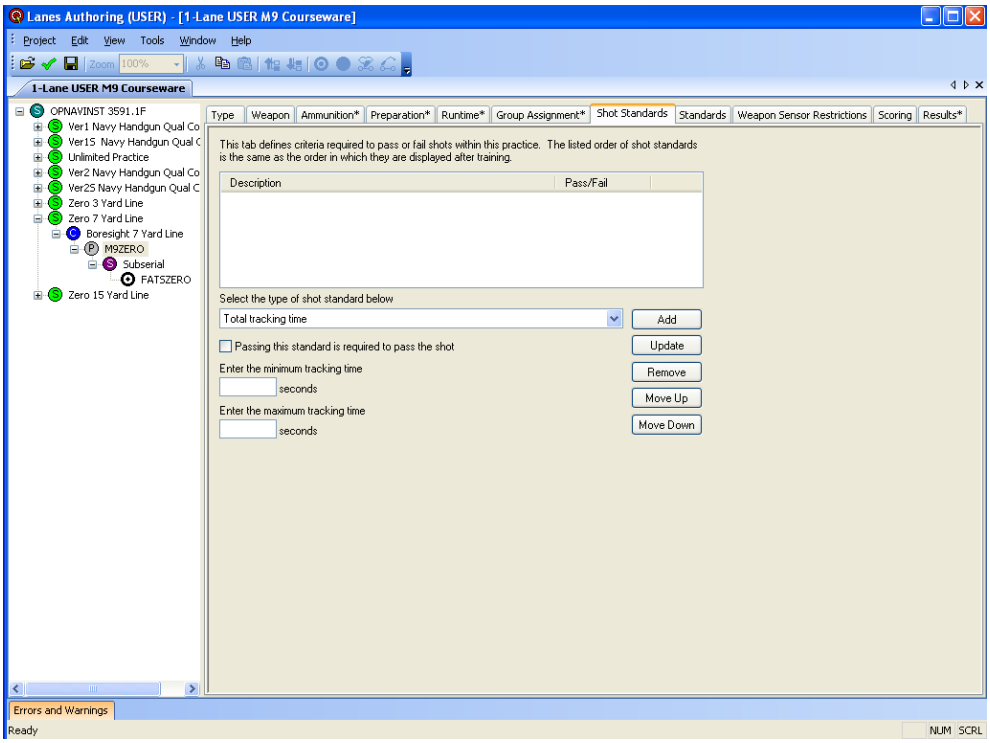
Practice Preparation



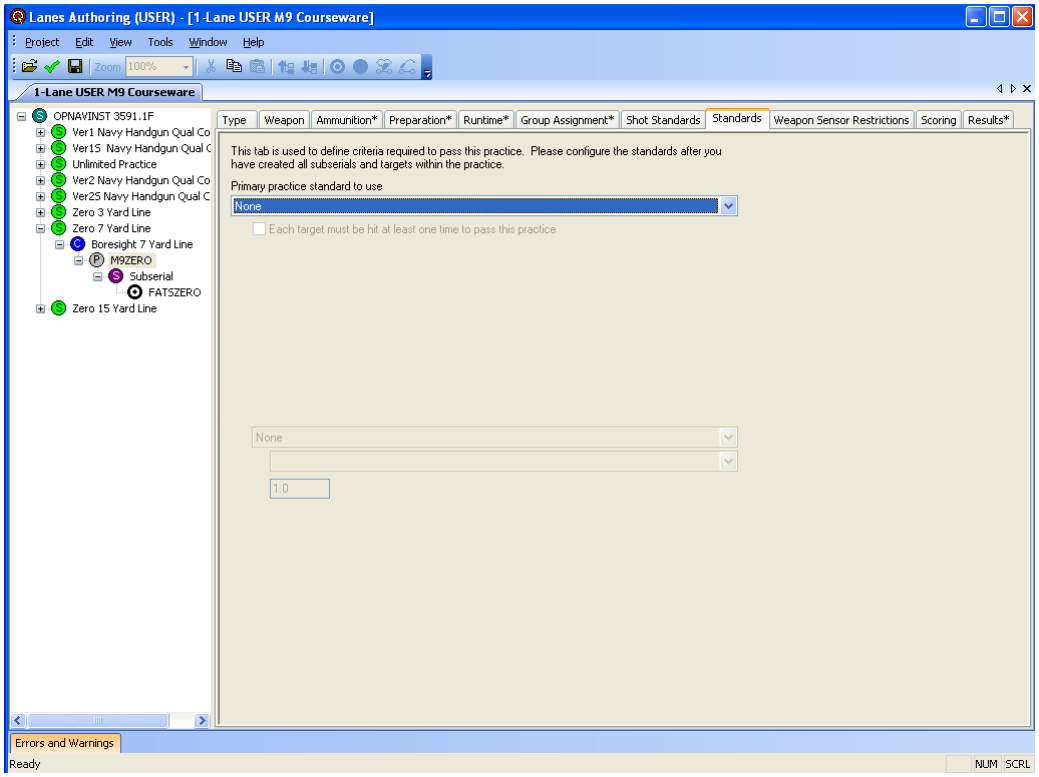
Practice Runtime



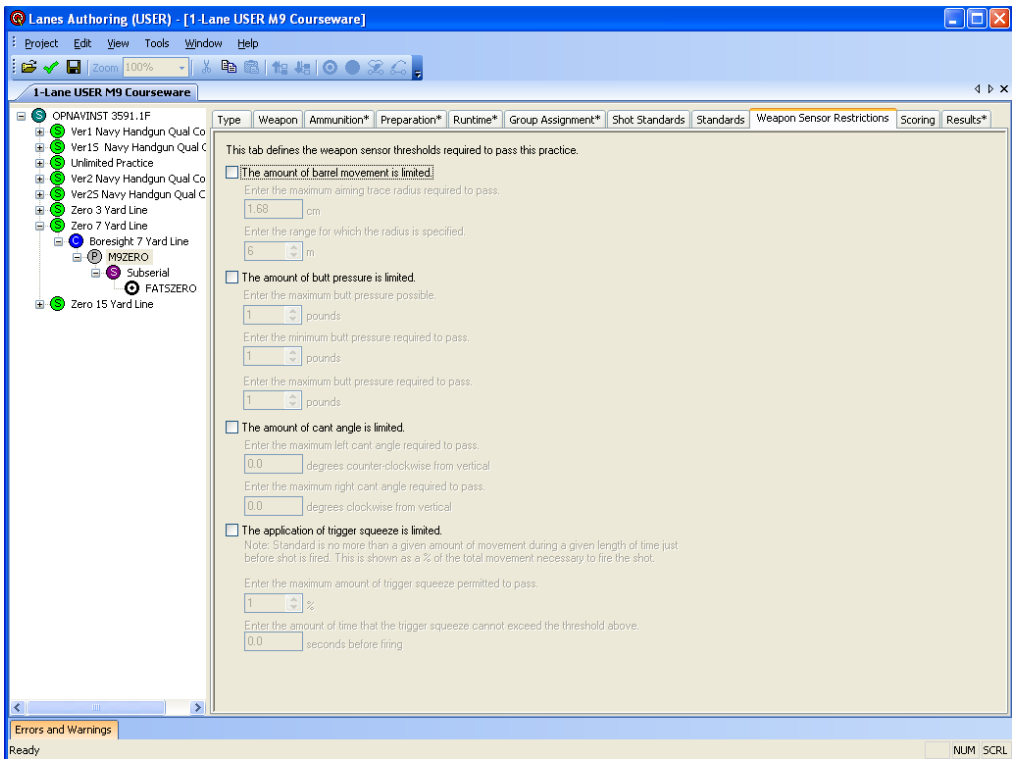
Practice Group Assignment



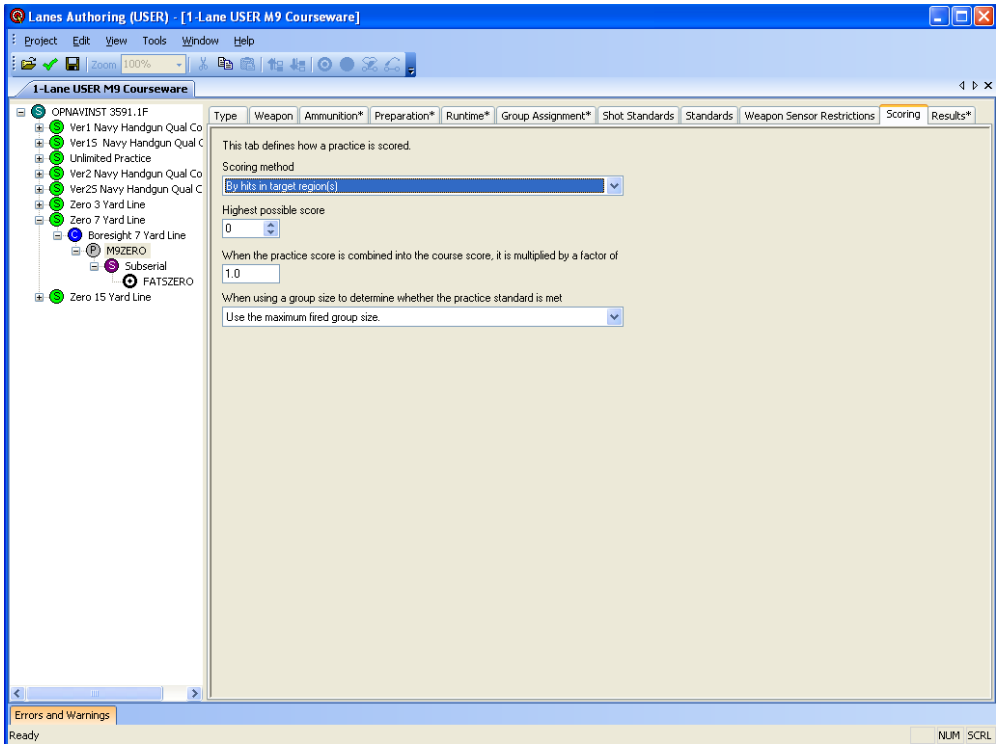
Practice Shot Standards



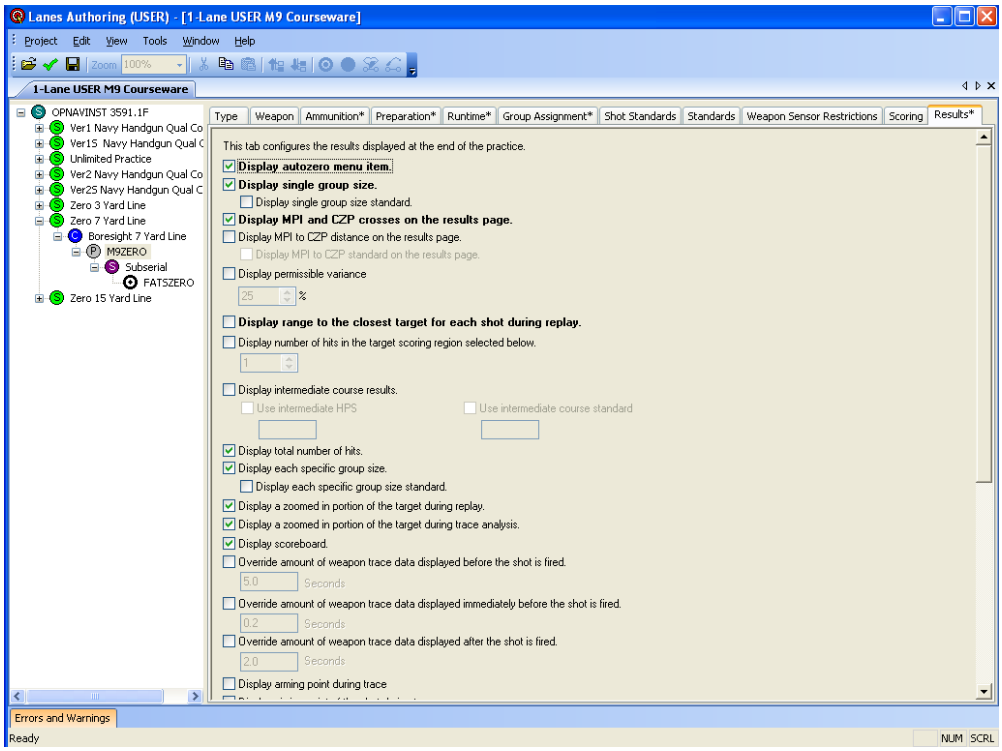
Practice Standards



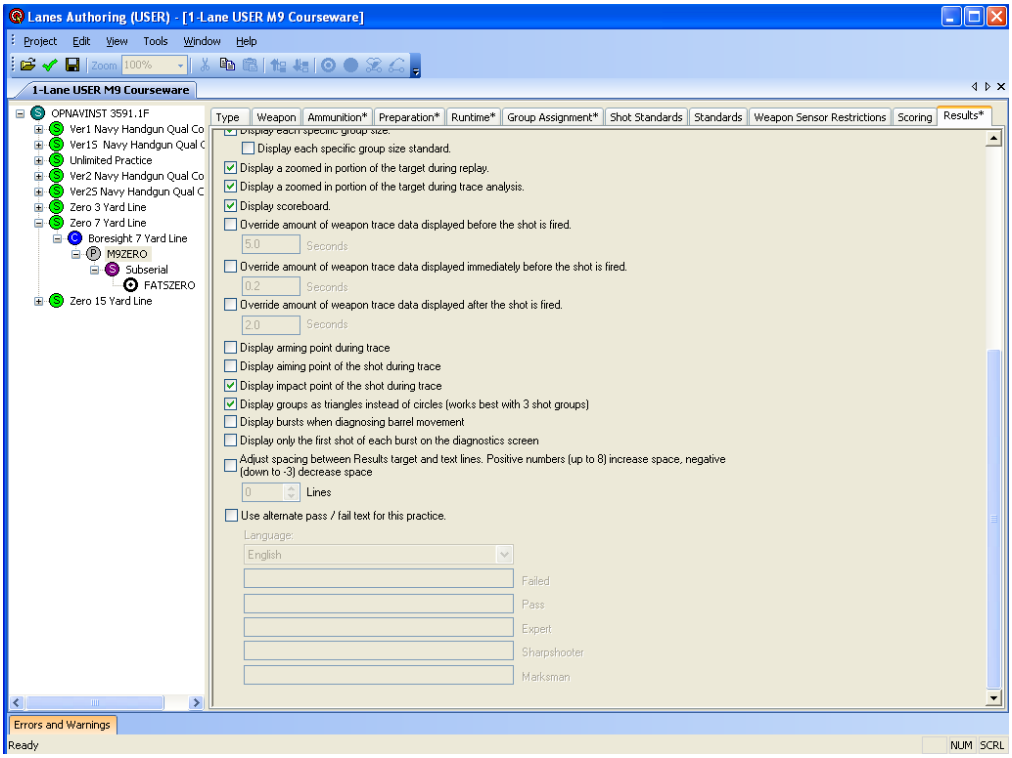
Practice Weapon Sensor Restrictions



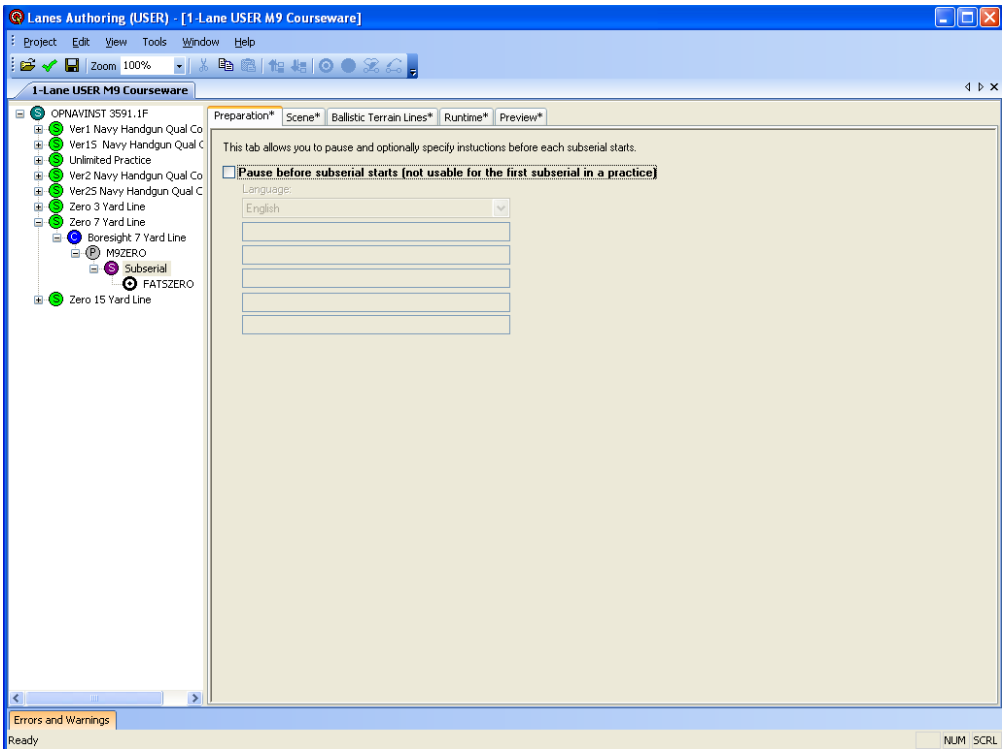
Practice Scoring



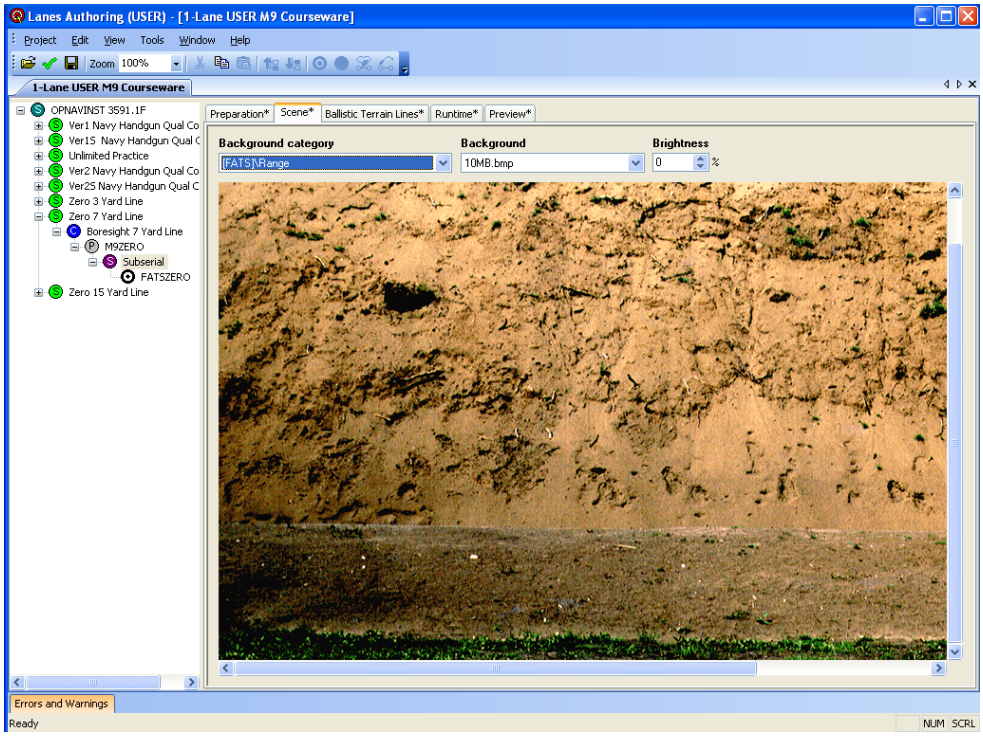
Practice Results Top



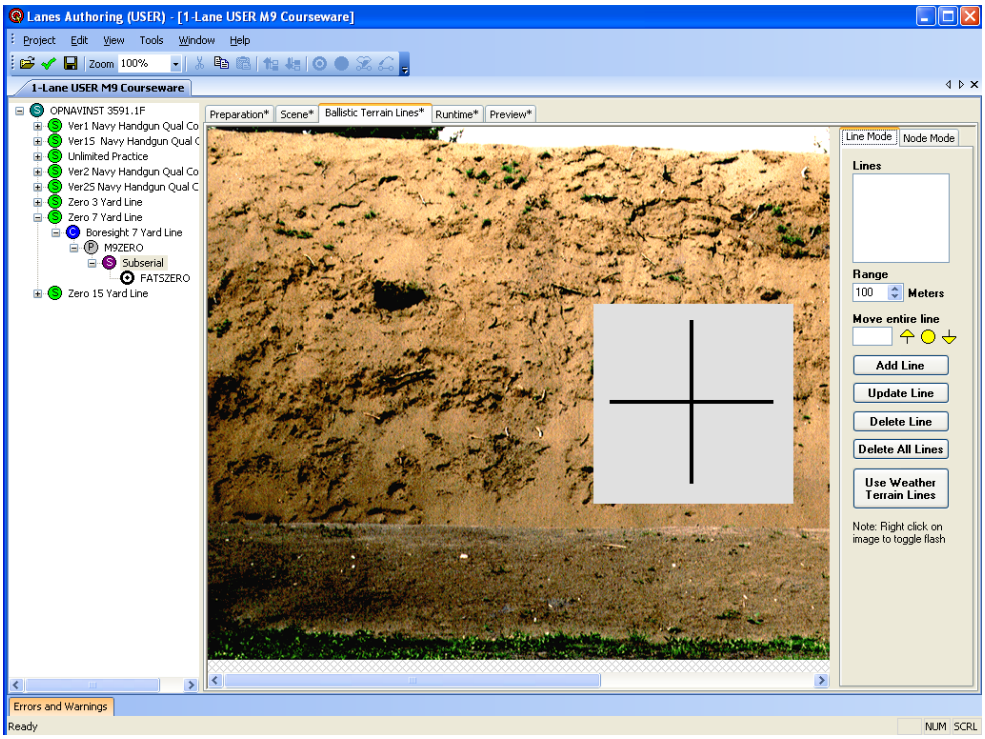
Practice Results Bottom



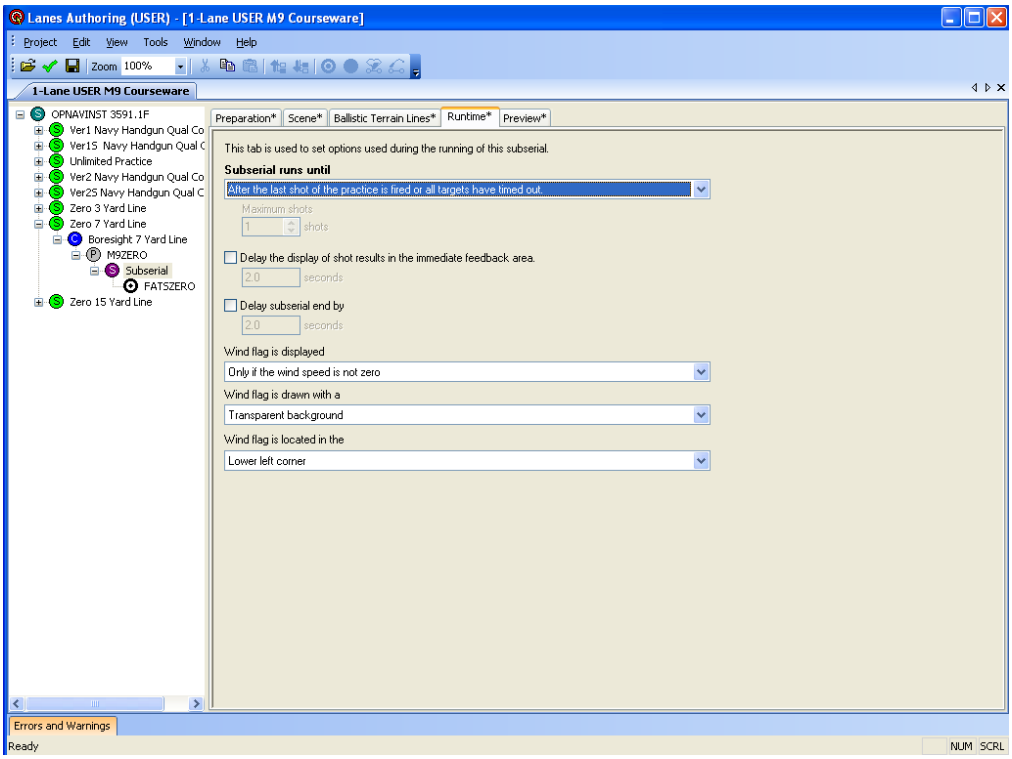
Sub Serial Preparation



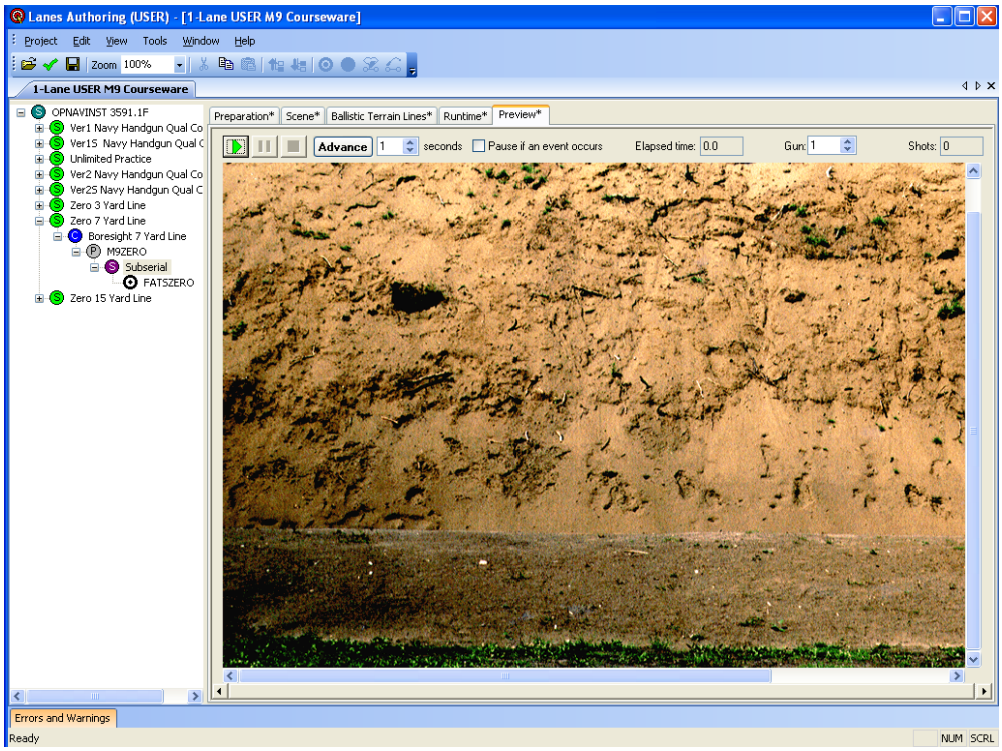
Sub Serial Scene



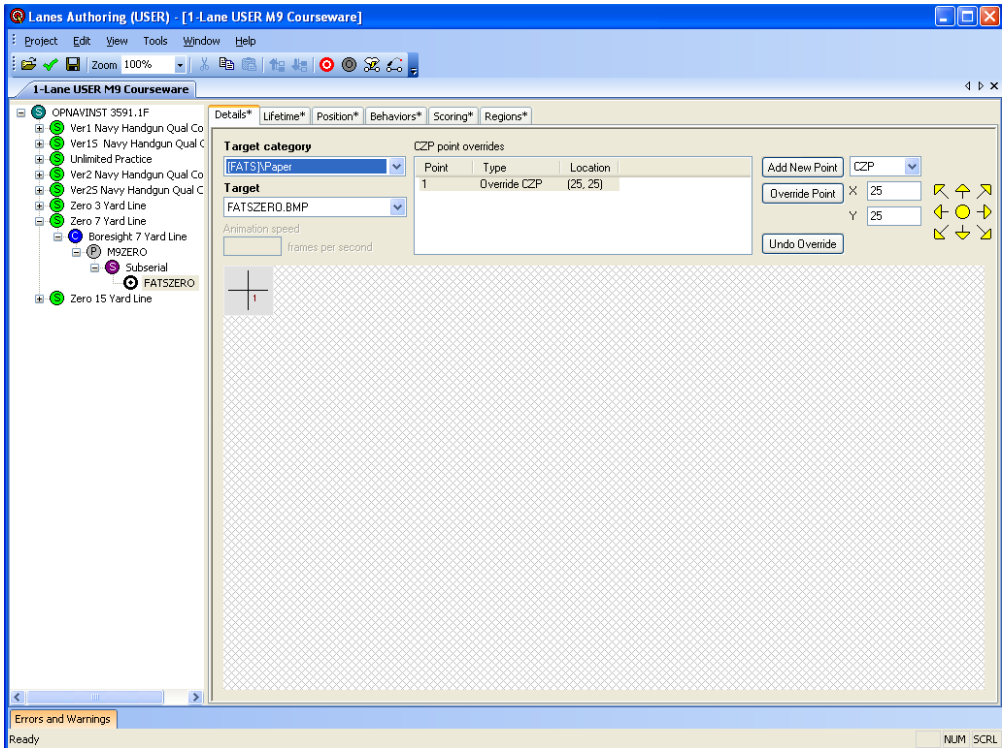
Sub Serial Ballistic Terrain Lines



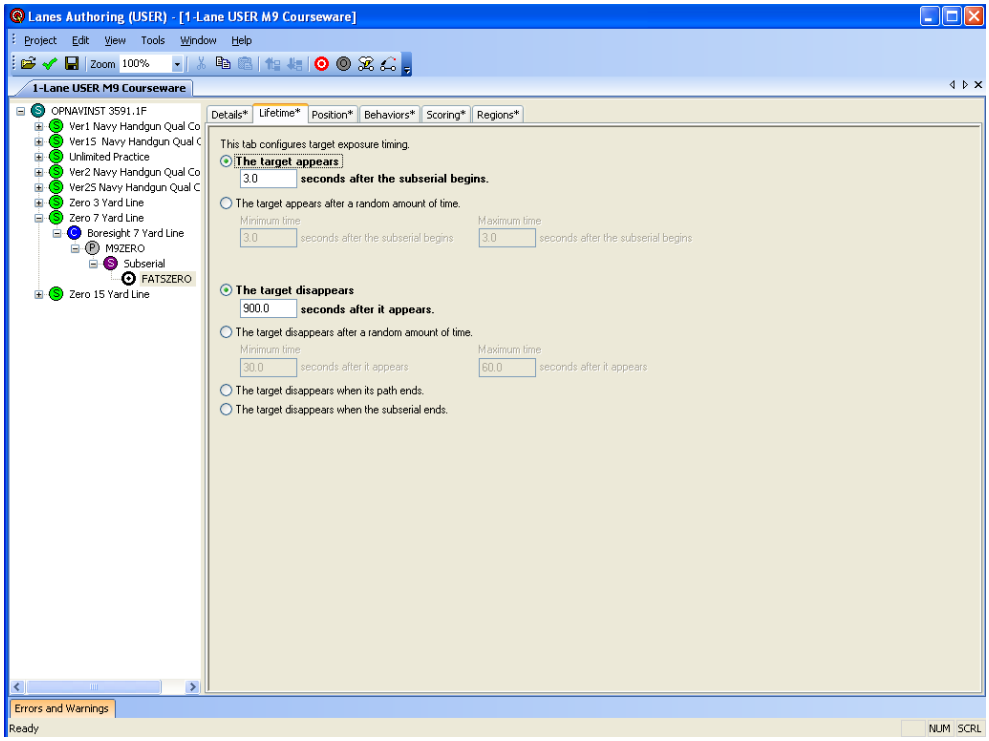
Sub Serial Runtime



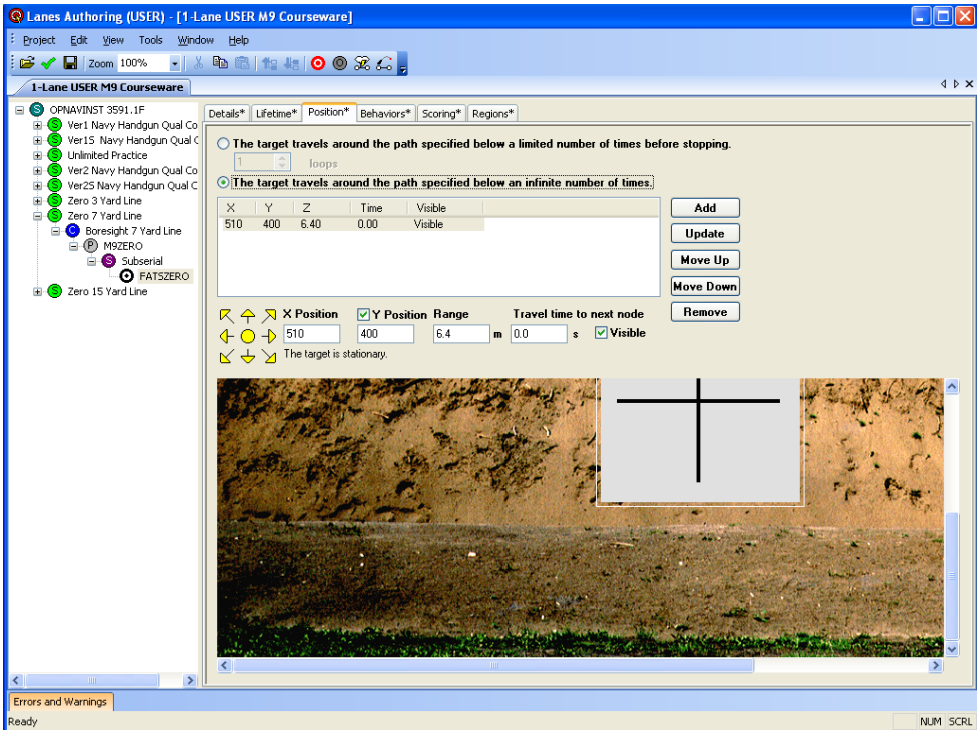
Sub Serial Preview



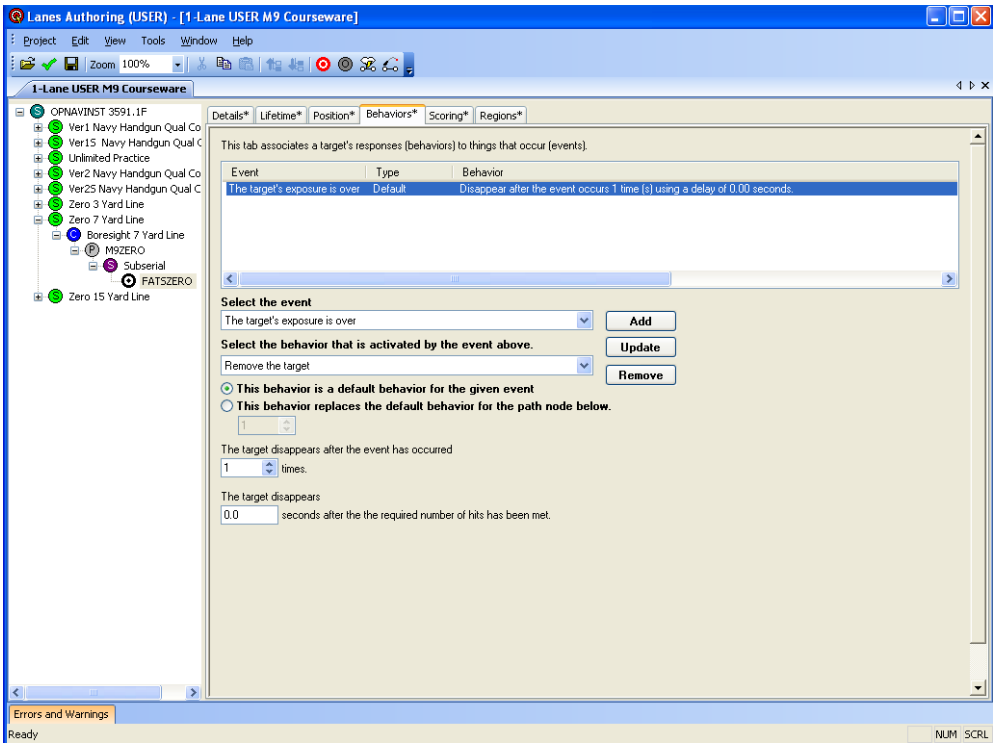
Target Details



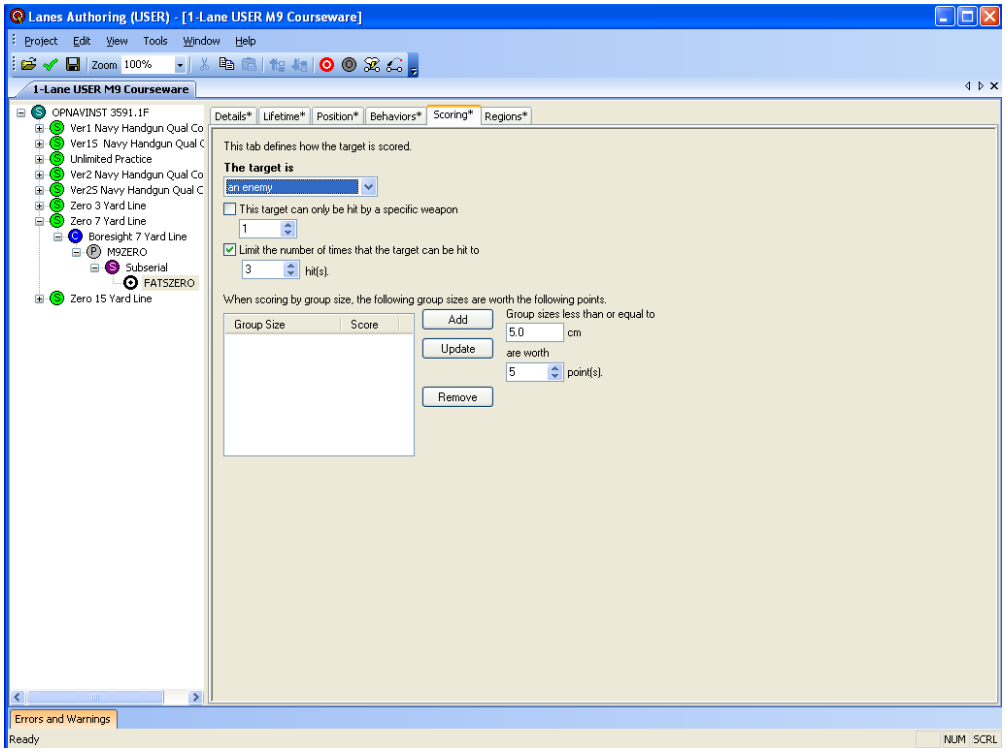
Target Lifetime



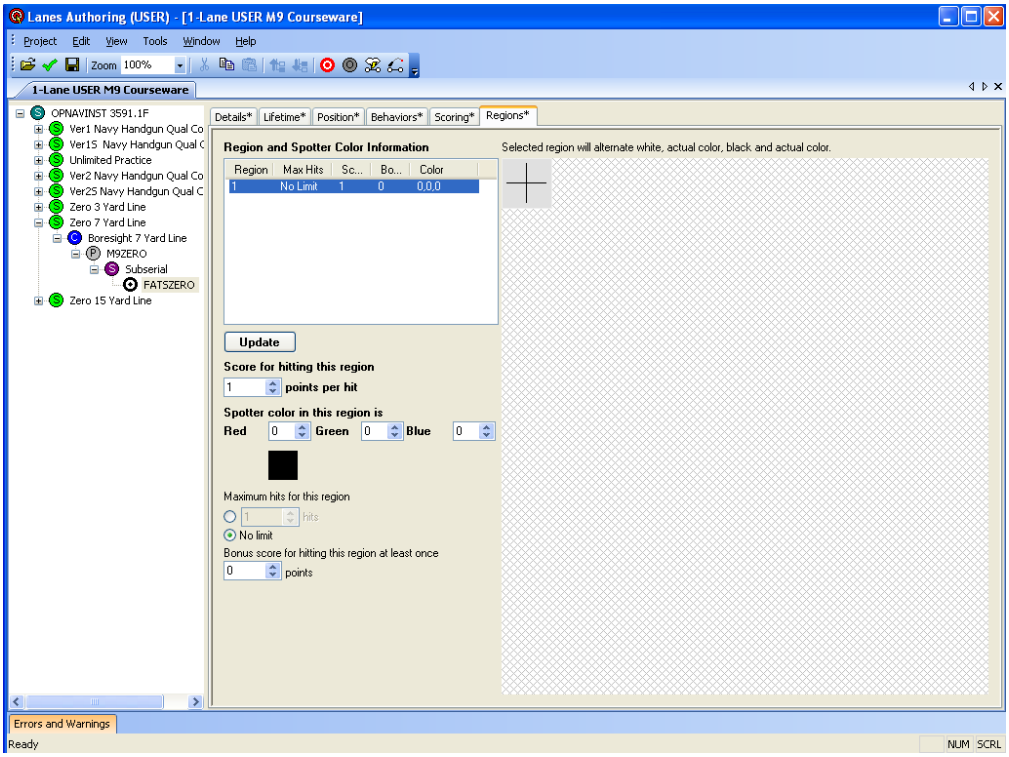
Target Position



Target Behaviors



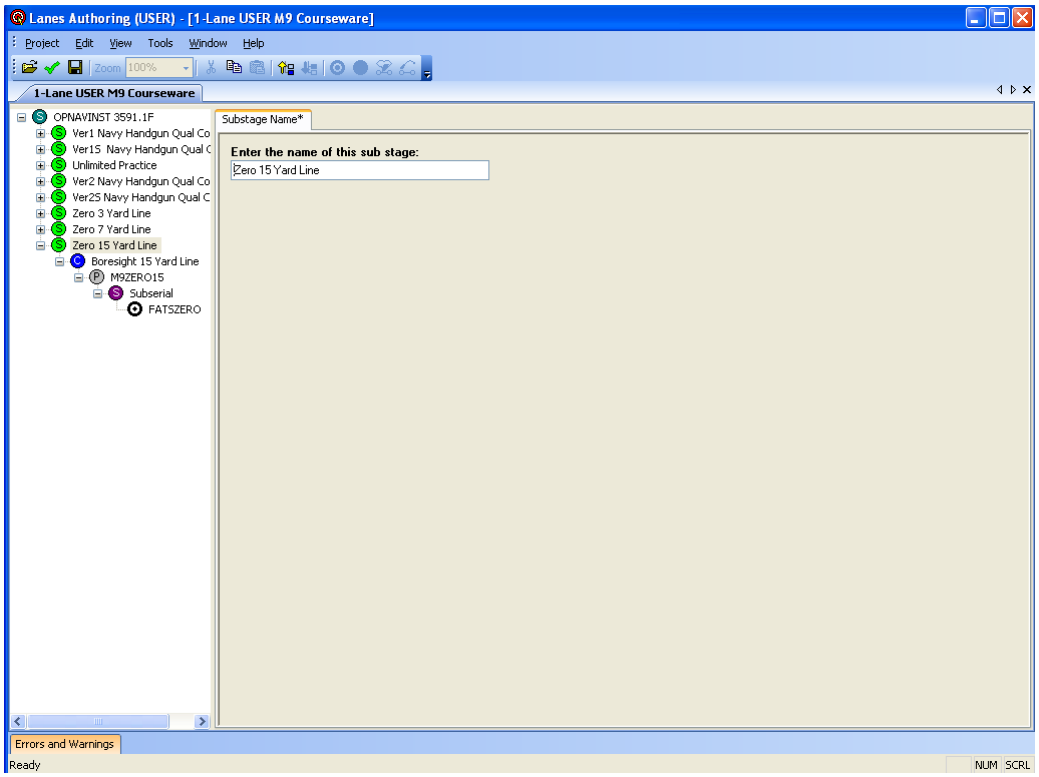
Target Scoring



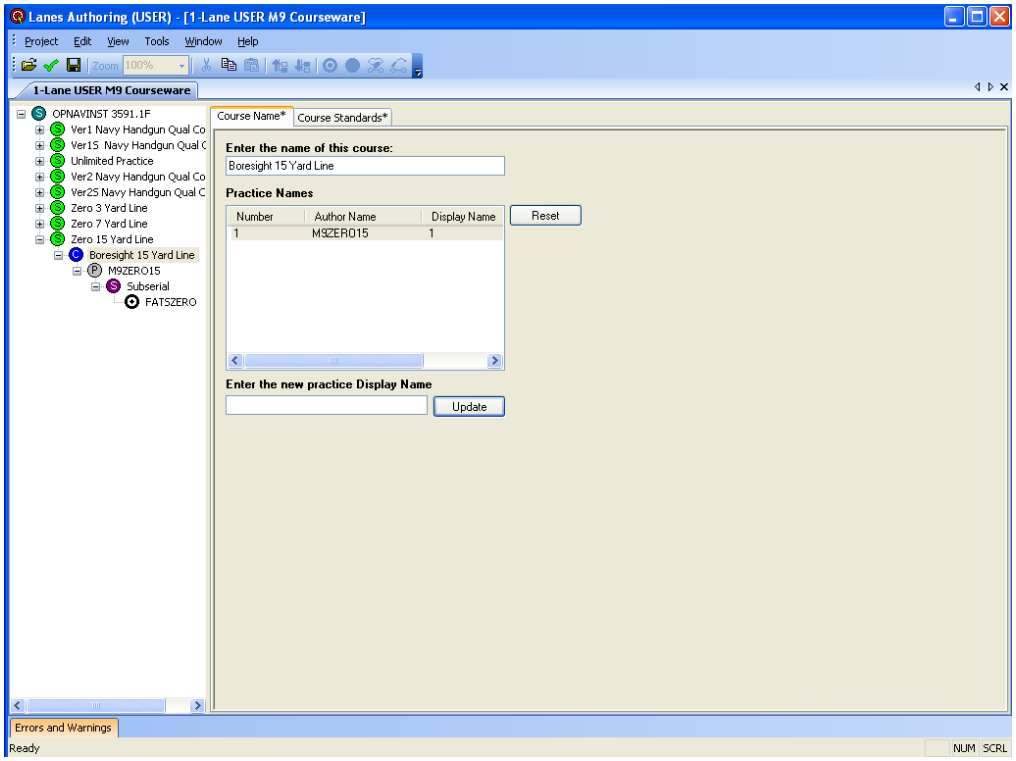
Target Regions

APPENDIX D. 15-YARD ZERO SCENARIO

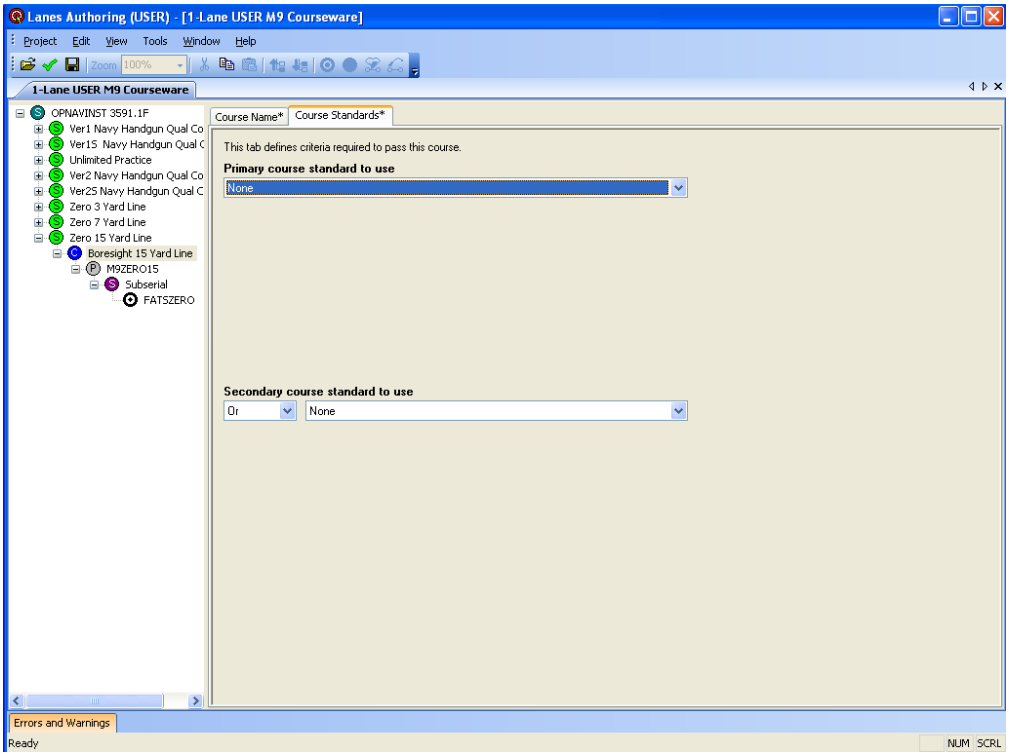
The contents of the appendix are screen captures of the 15-yard zero scenario. These pictures are provided so that anyone can recreate the course of fire used in this experiment. The scenario was established with respect to Navy Handgun Qualification Course found in the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification*.



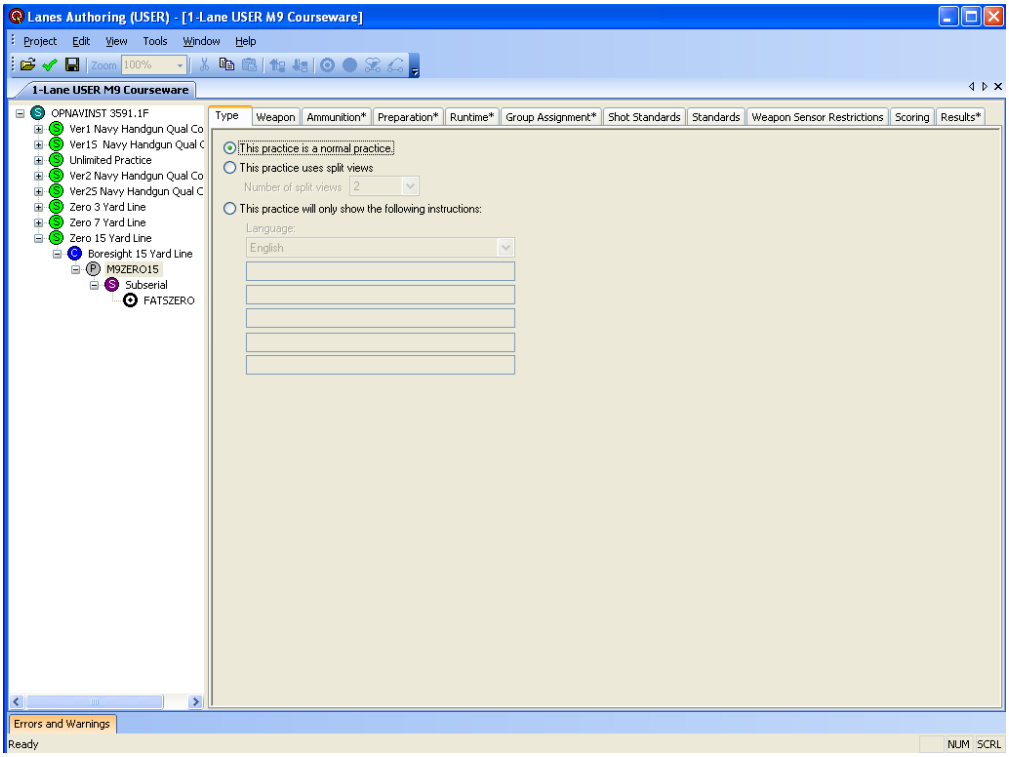
Sub Stage



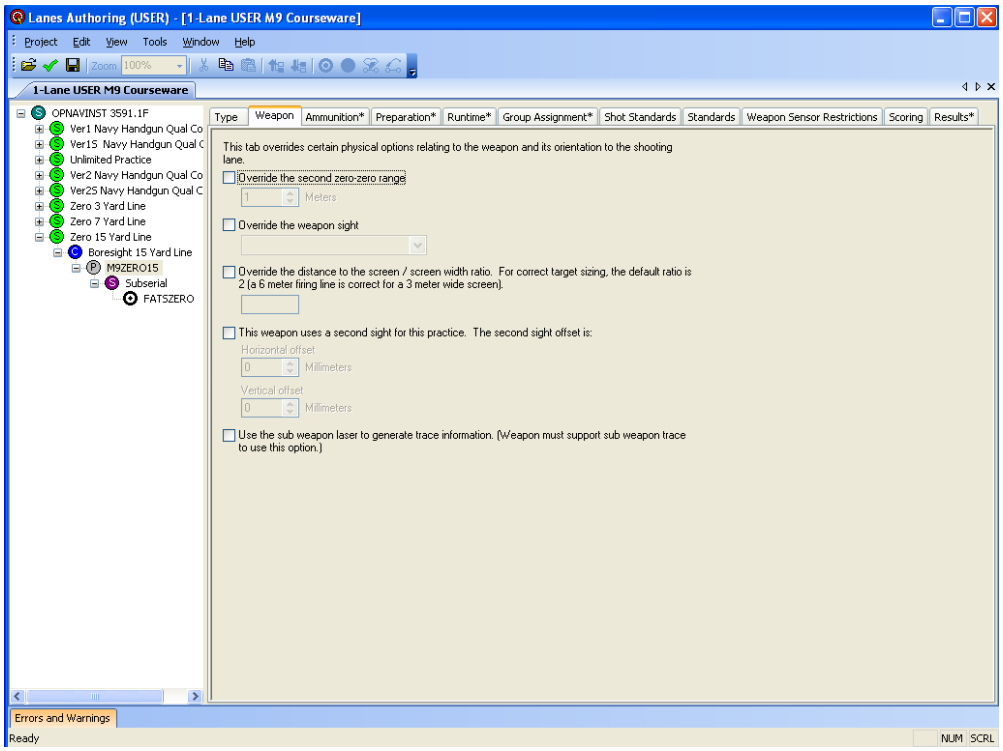
Course Name



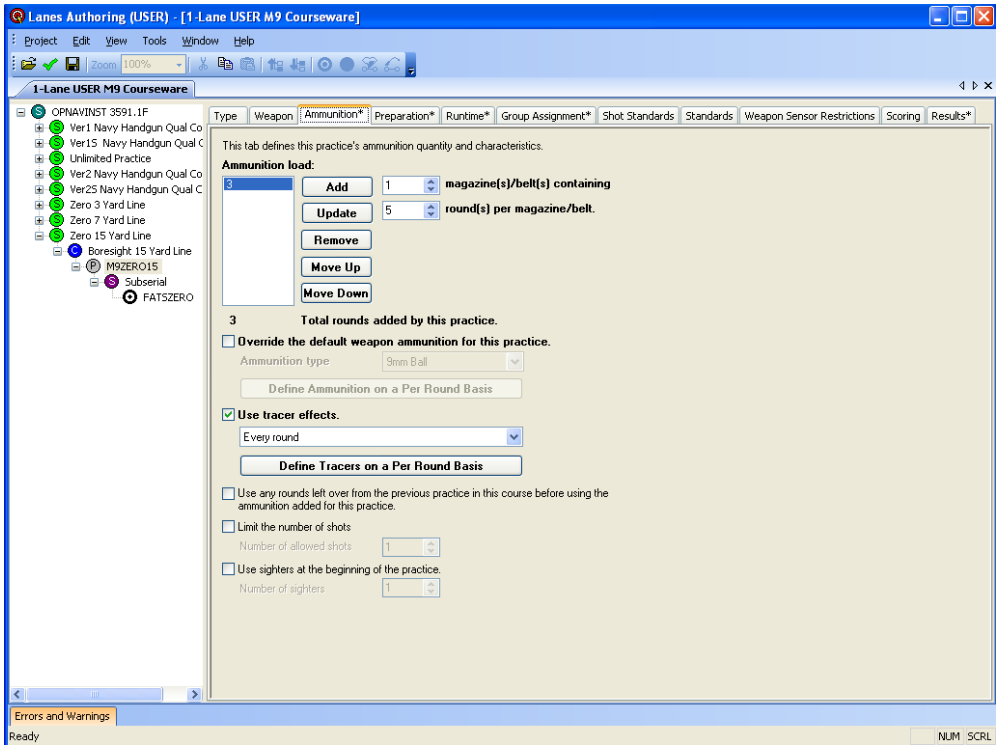
Course Standards



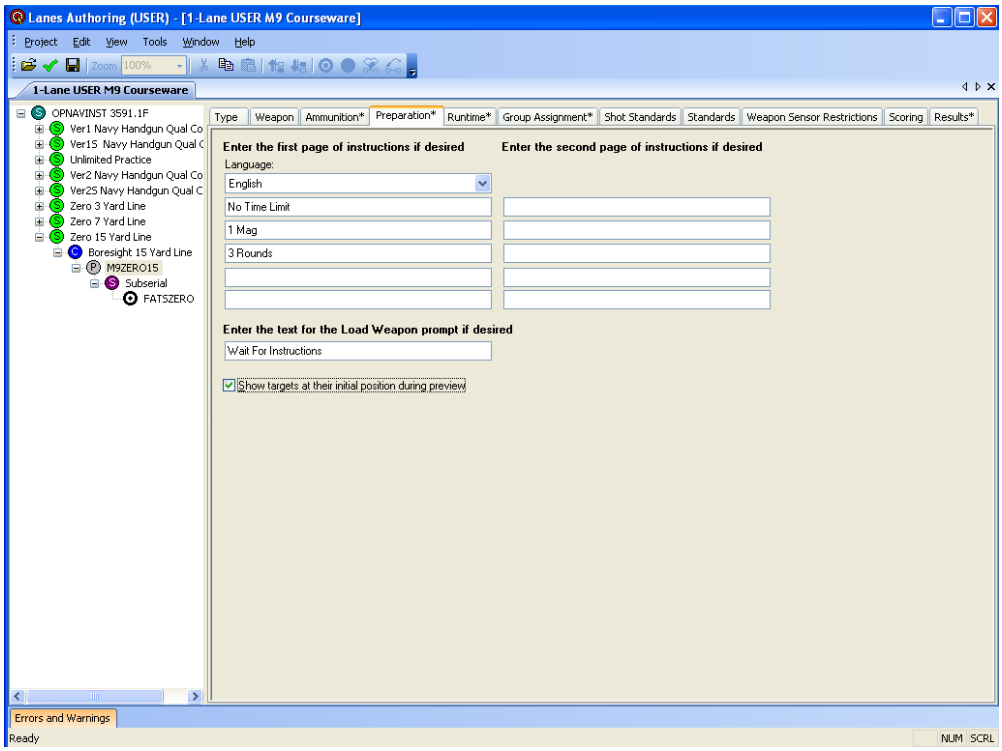
Practice Type



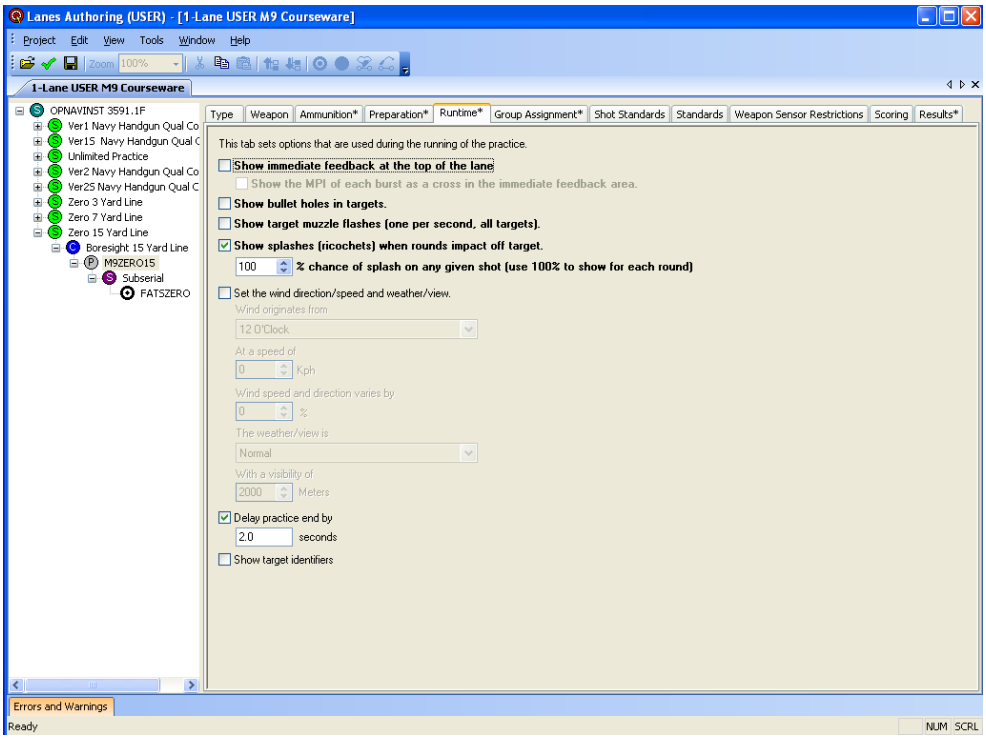
Practice Weapon



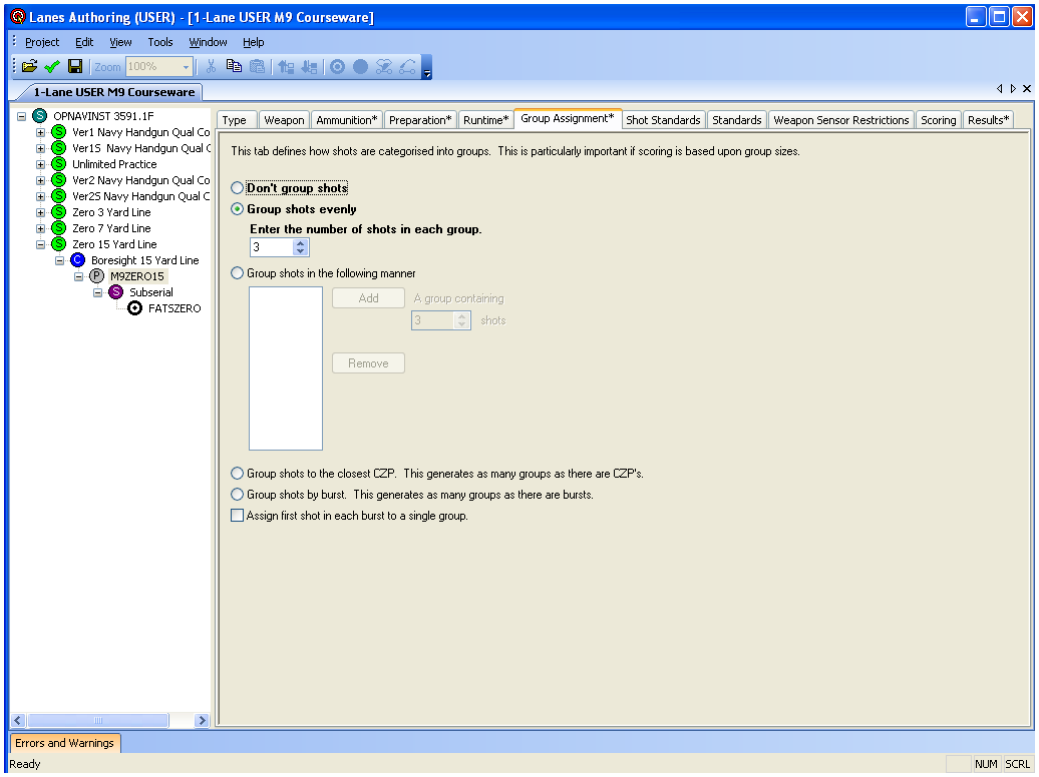
Practice Ammunition



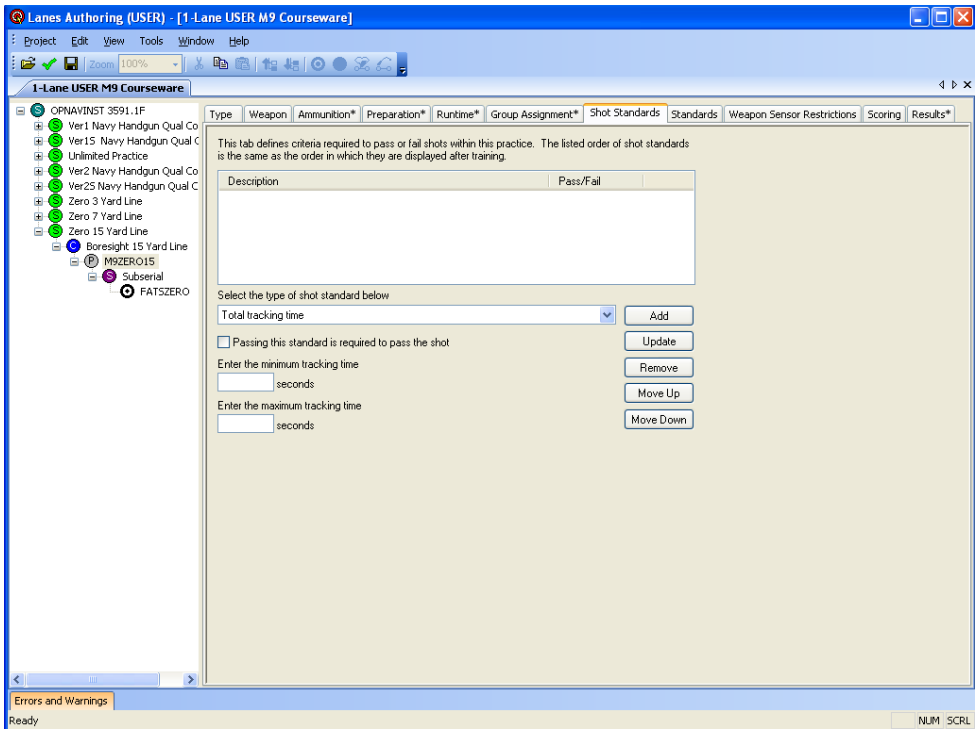
Practice Preparation



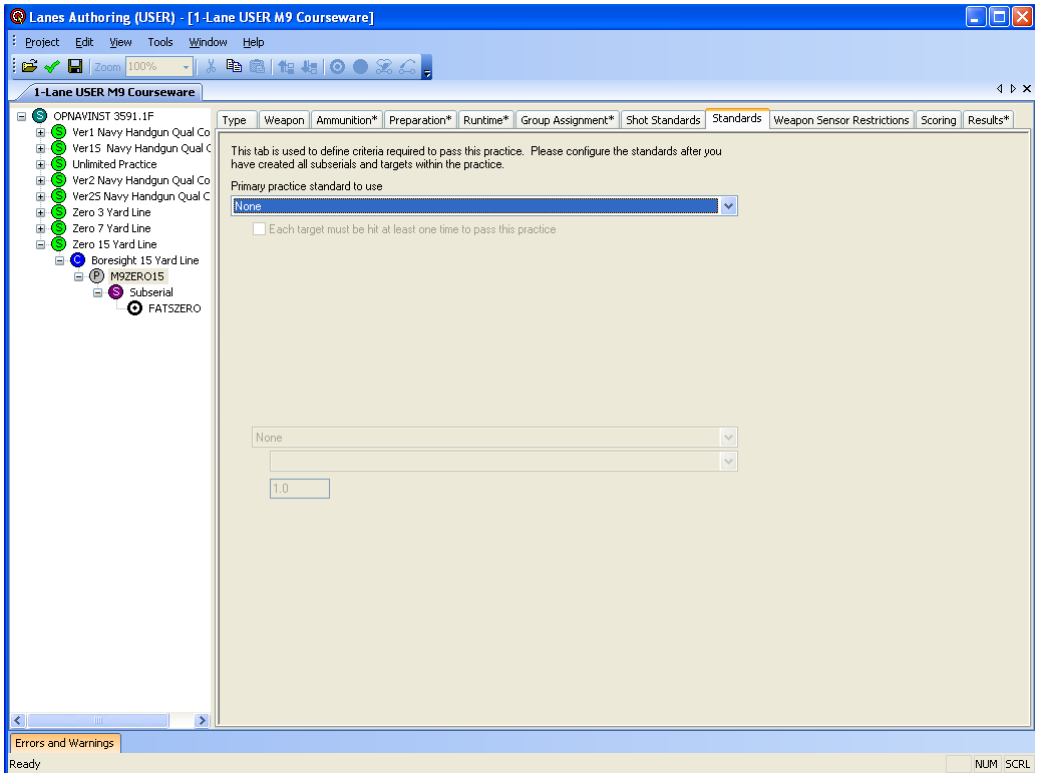
Practice Runtime



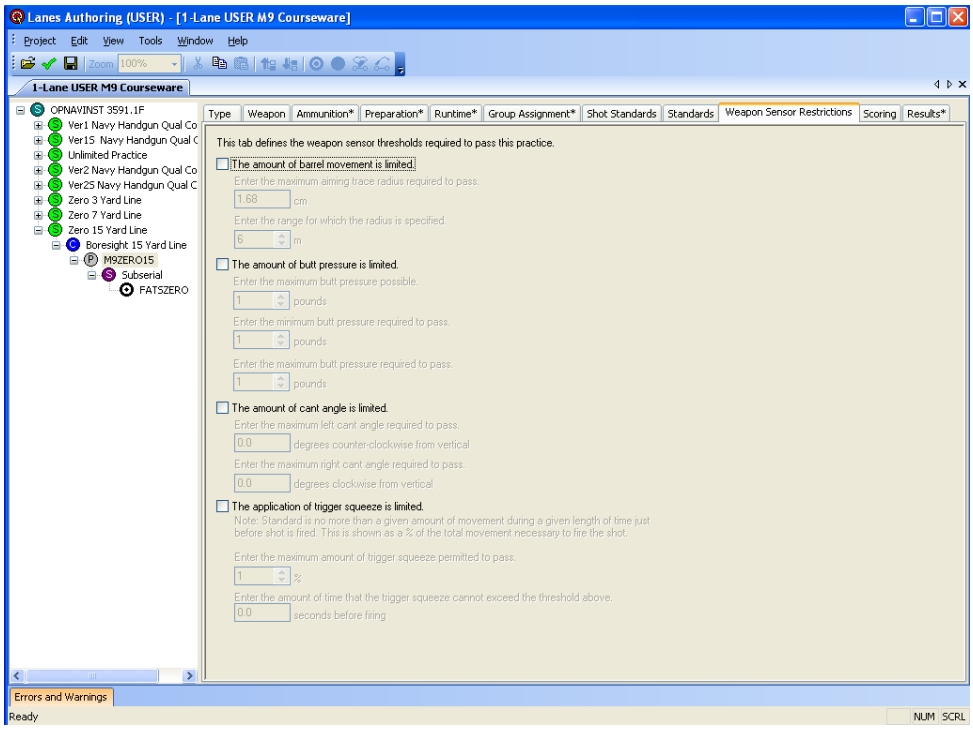
Practice Group Assignment



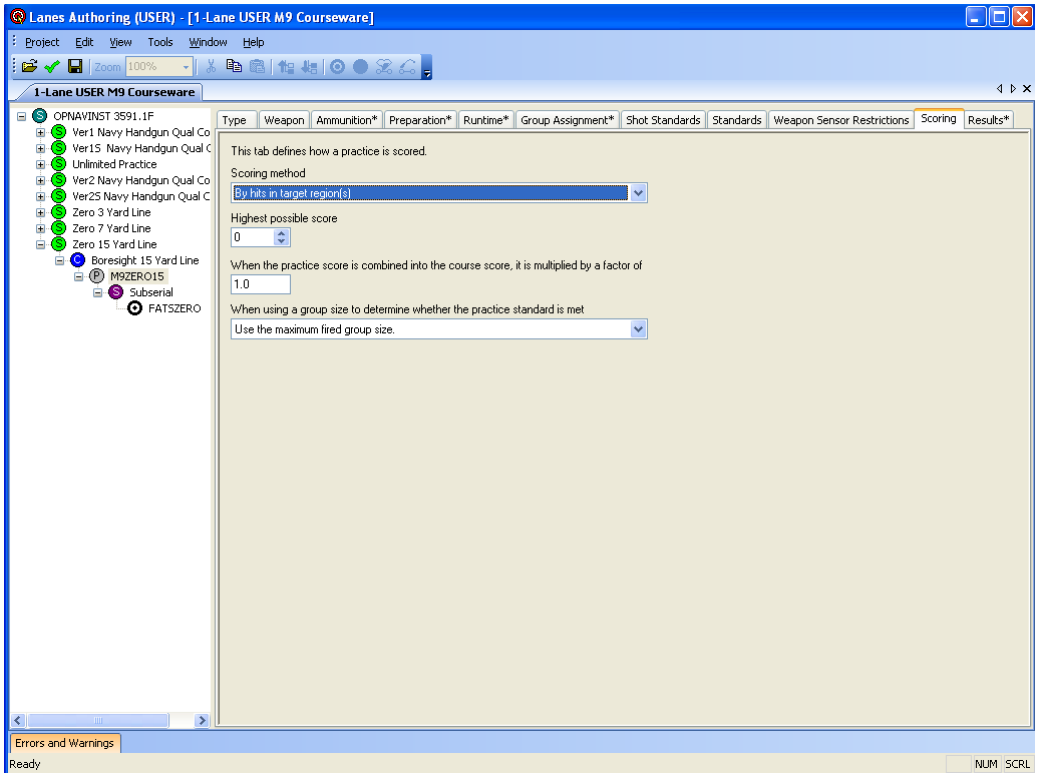
Practice Shot Standards



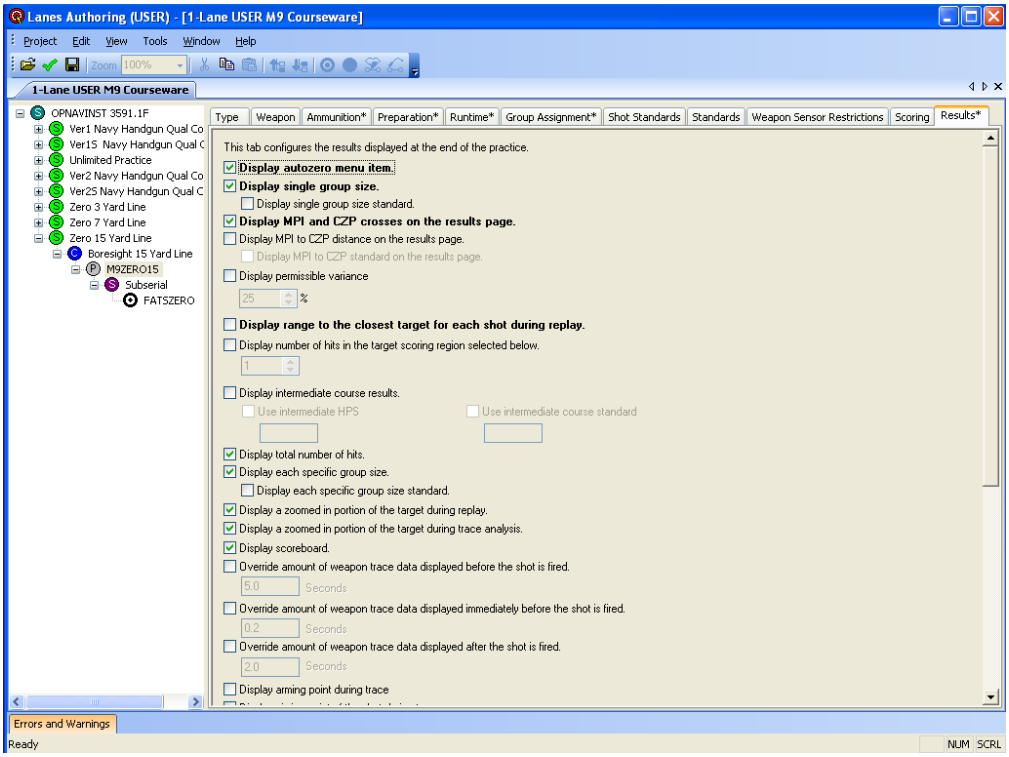
Practice Standards



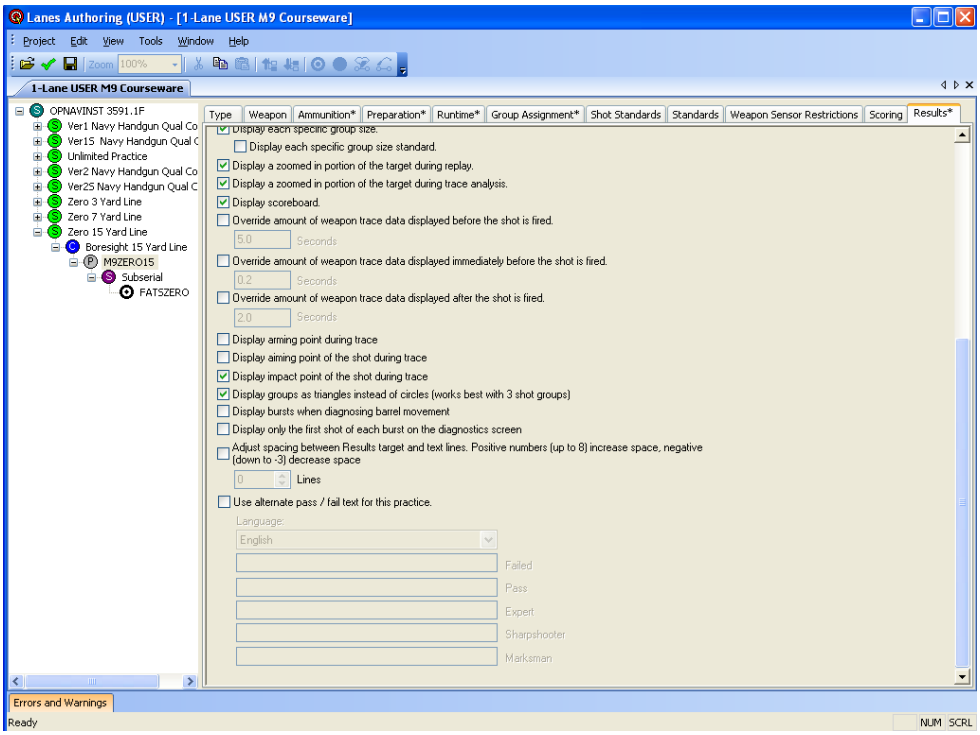
Practice Weapon Sensor Restrictions



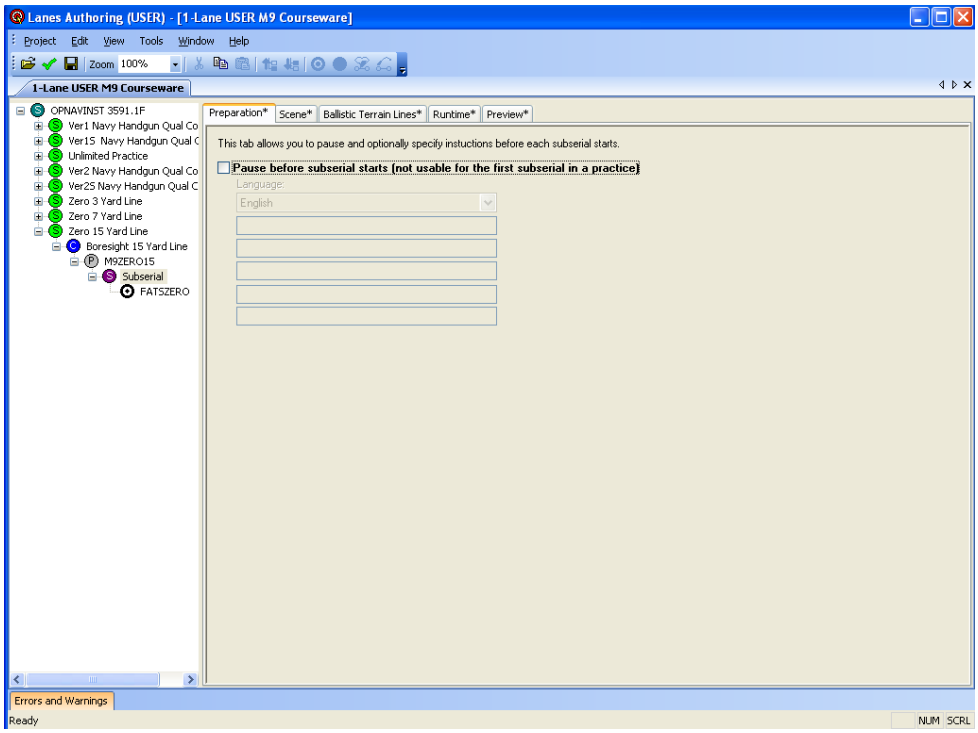
Practice Scoring



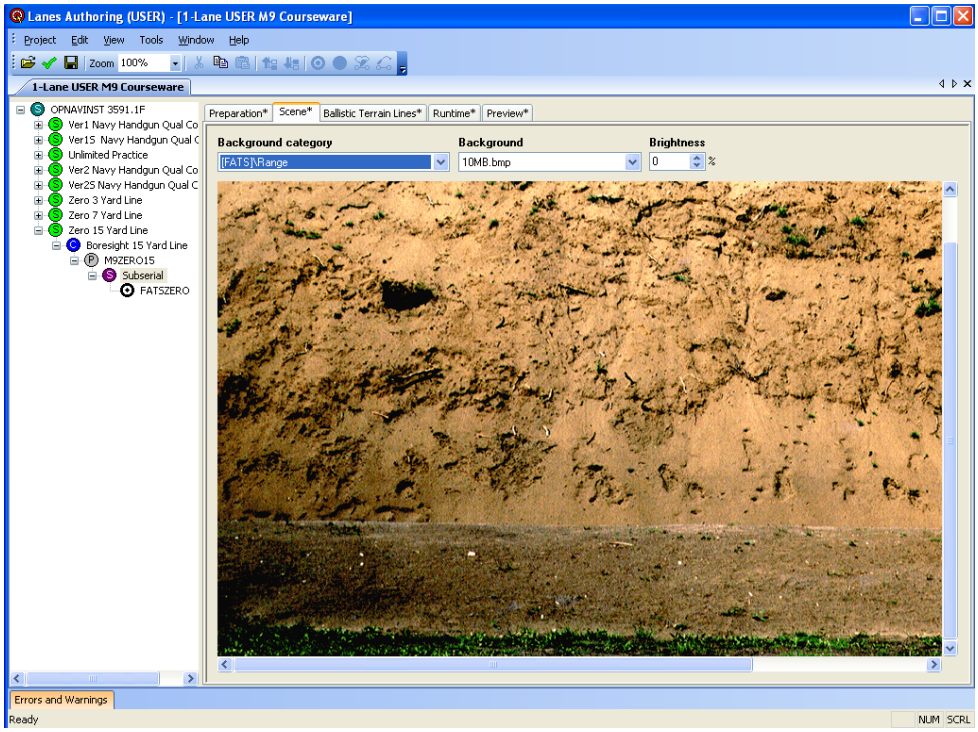
Practice Results Top



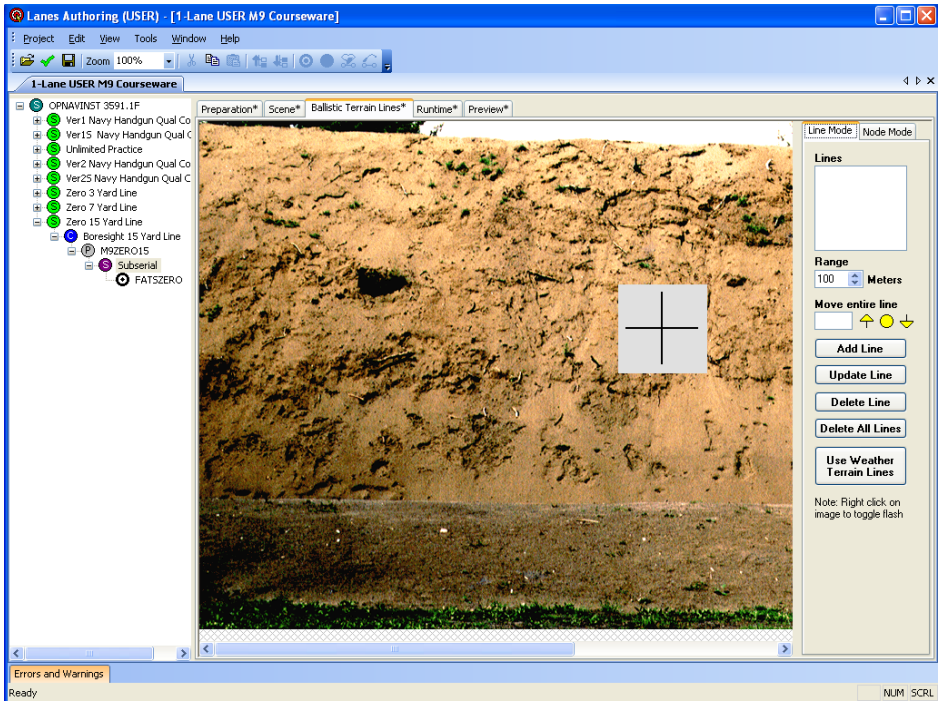
Practice Results Bottom



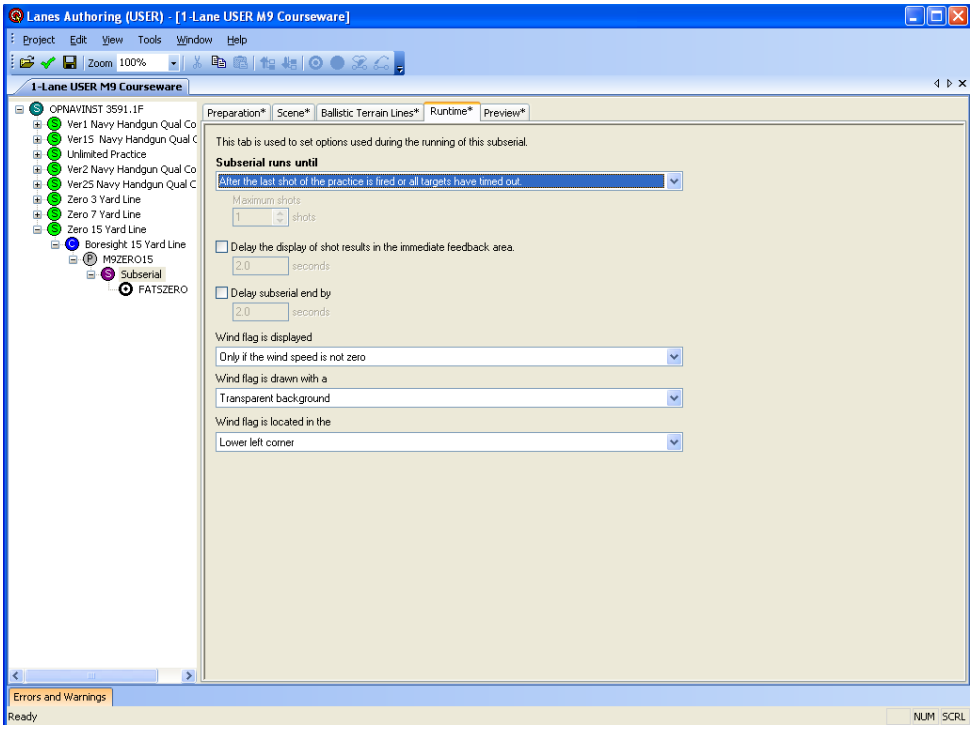
Sub Serial Preparation



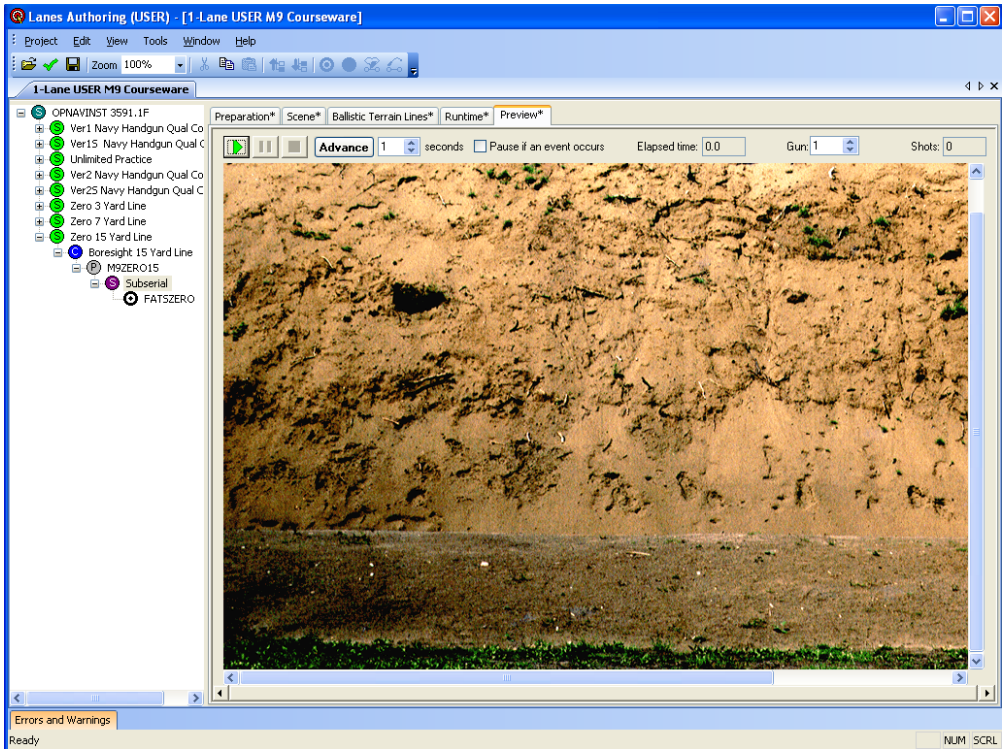
Sub Serial Scene



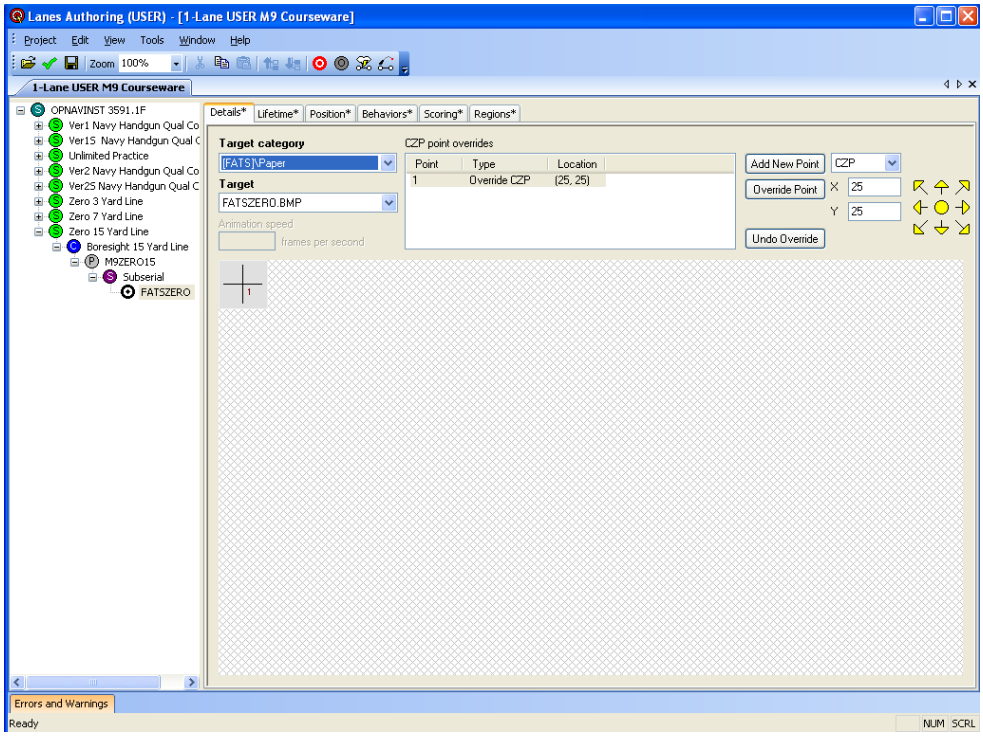
Sub Serial Ballistic Terrain Lines



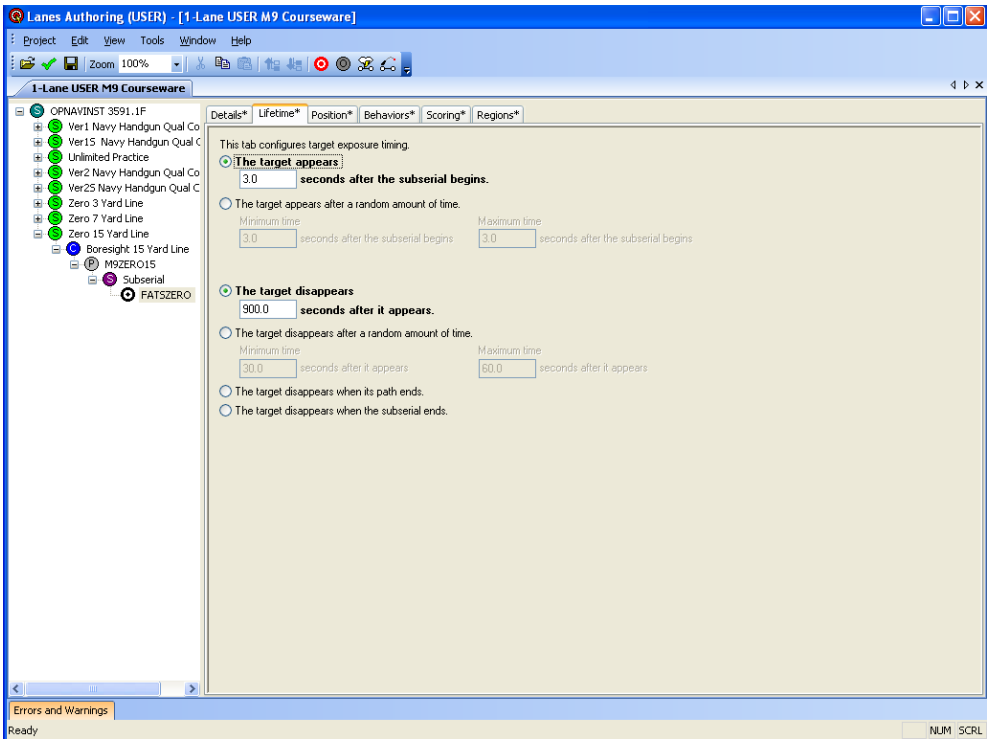
Sub Serial Runtime



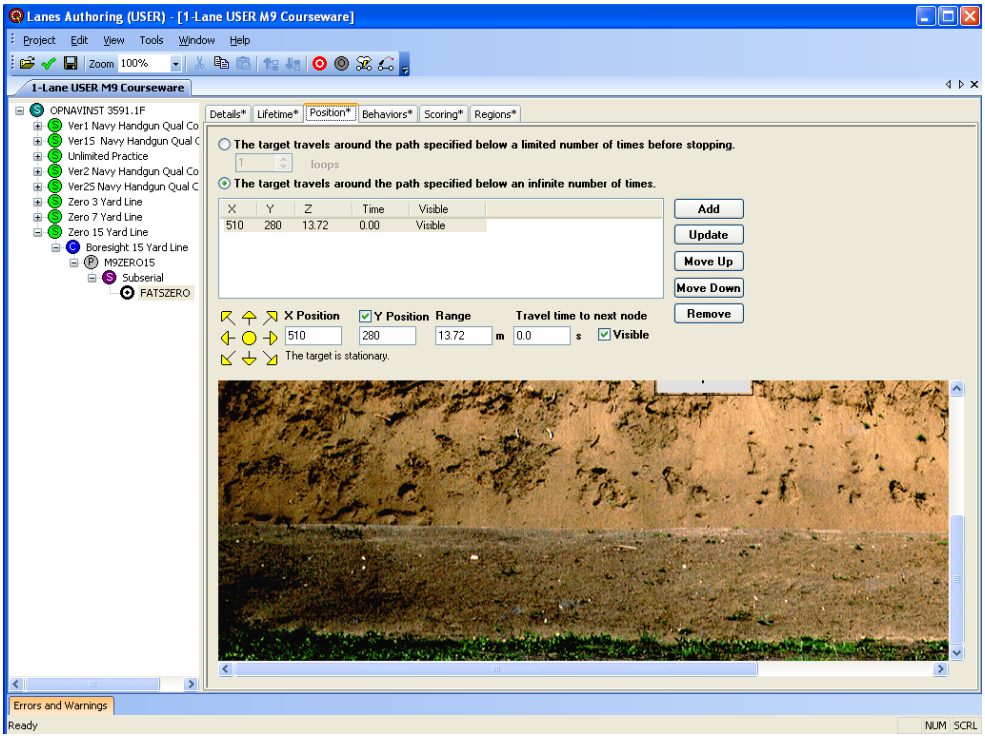
Sub Serial Preview



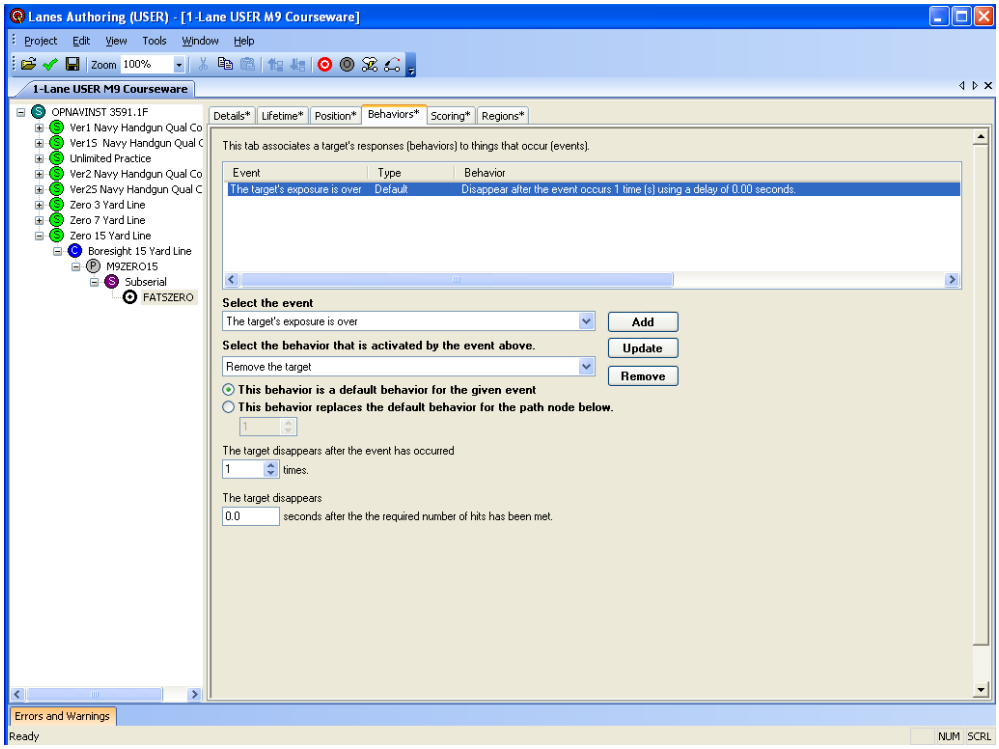
Target Details



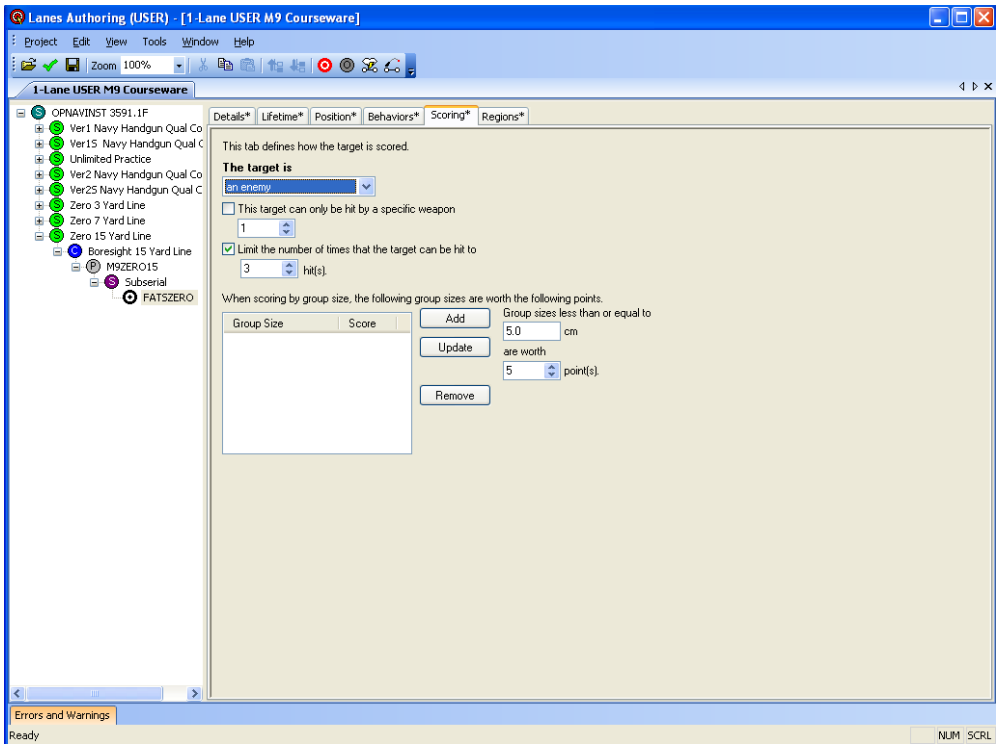
Target Lifetime



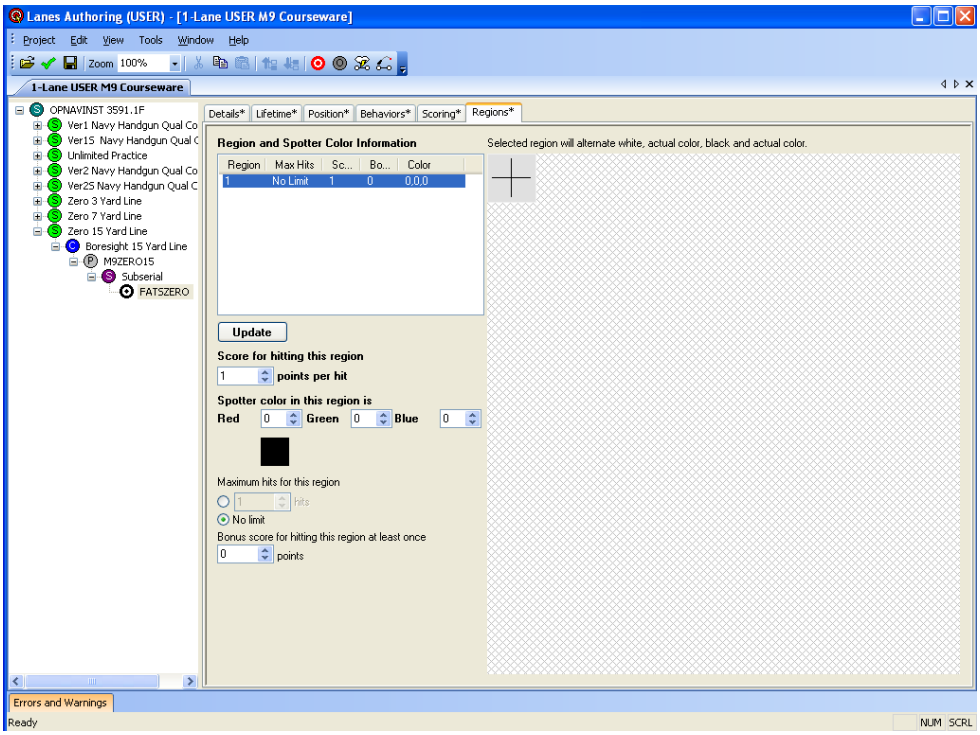
Target Position



Target Behaviors



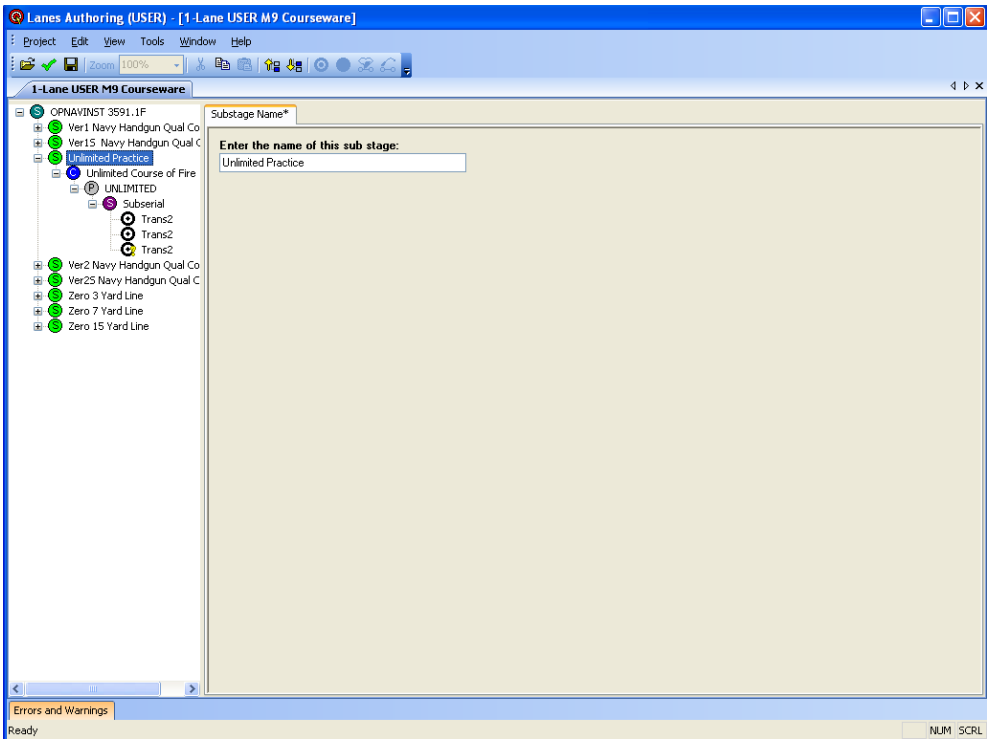
Target Scoring



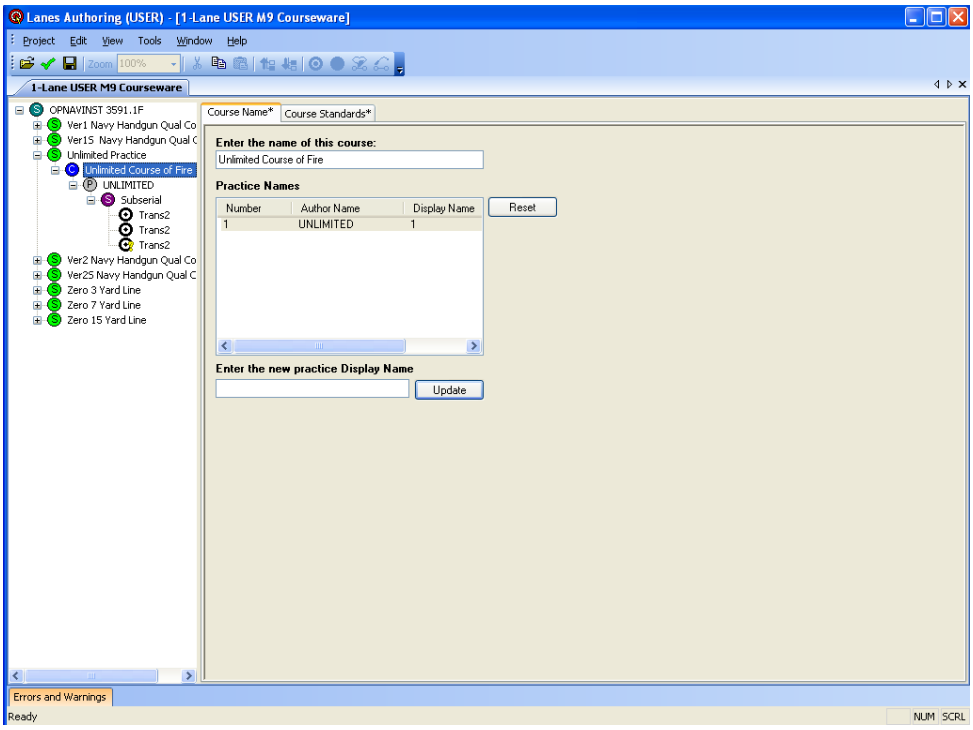
Target Regions

APPENDIX E. UNLIMITED PRACTICE SCENARIO

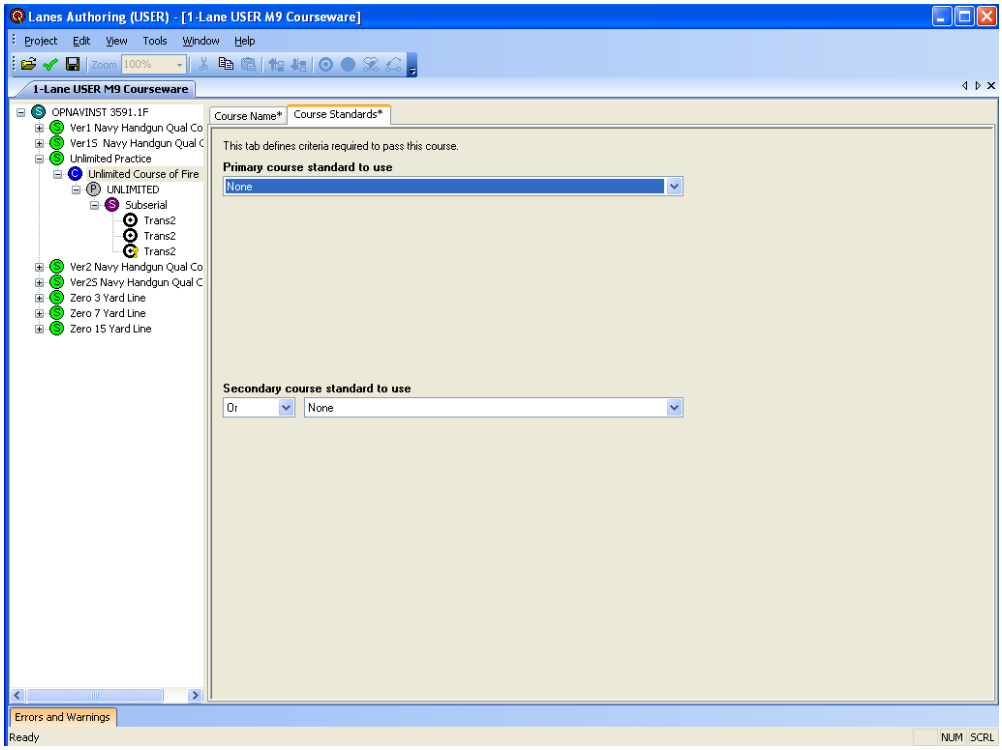
The contents of the appendix are screen captures of the unlimited practice scenario. These pictures are provided so that anyone can recreate the course of fire used in this experiment. The scenario was established with respect to Navy Handgun Qualification Course found in the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification.*



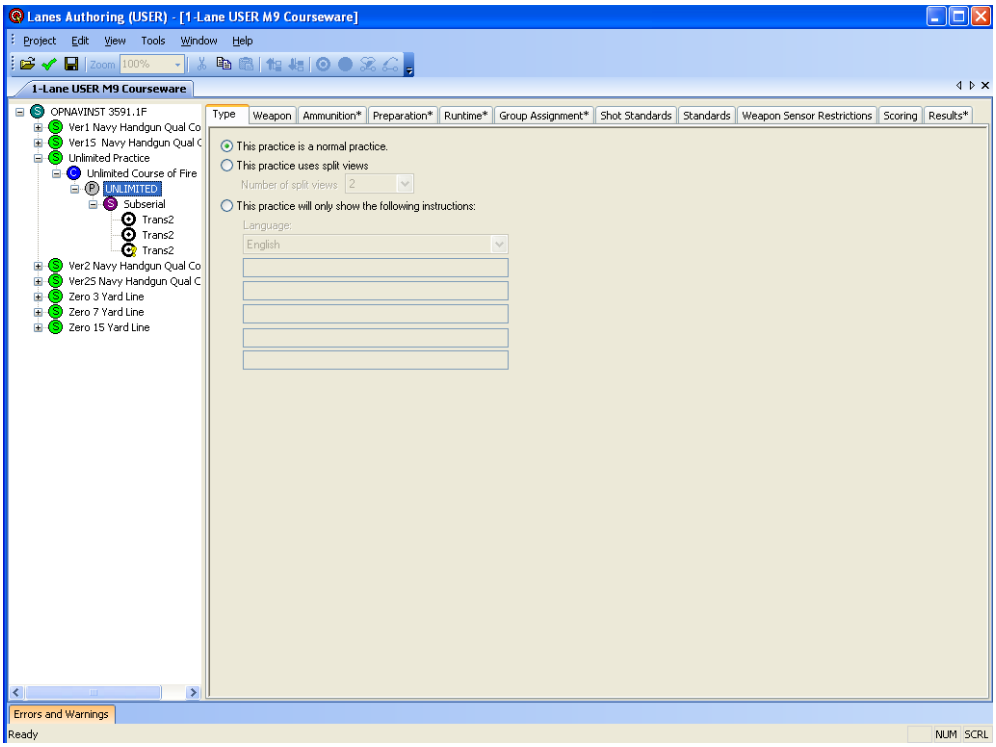
Sub Stage



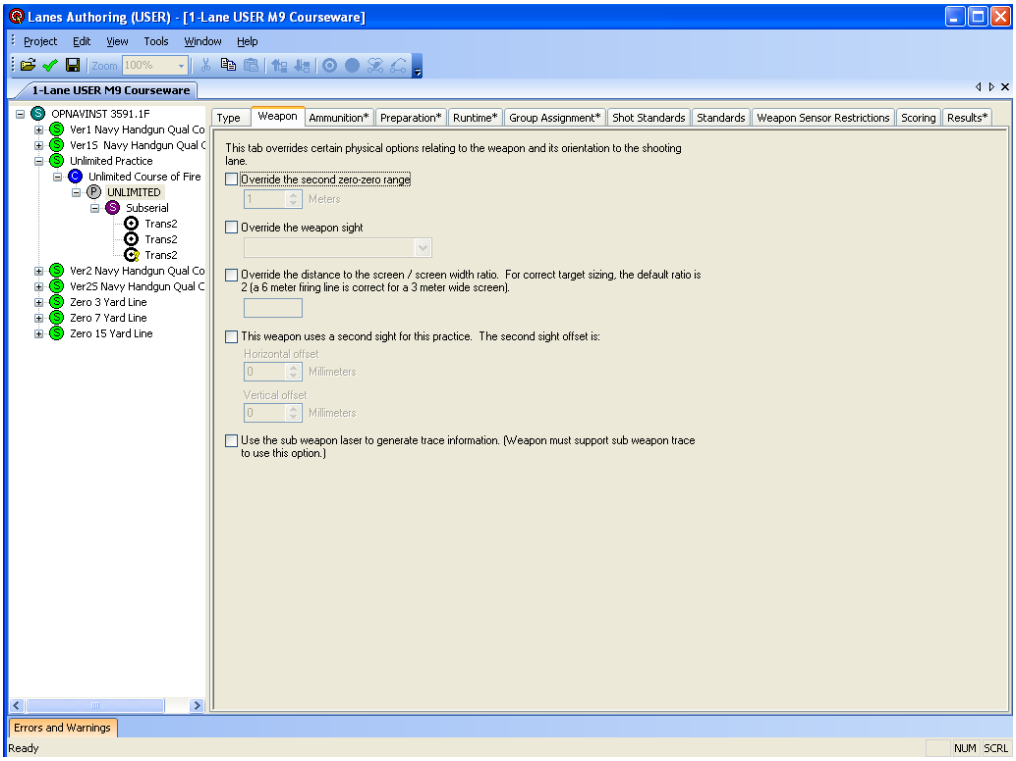
Course Name



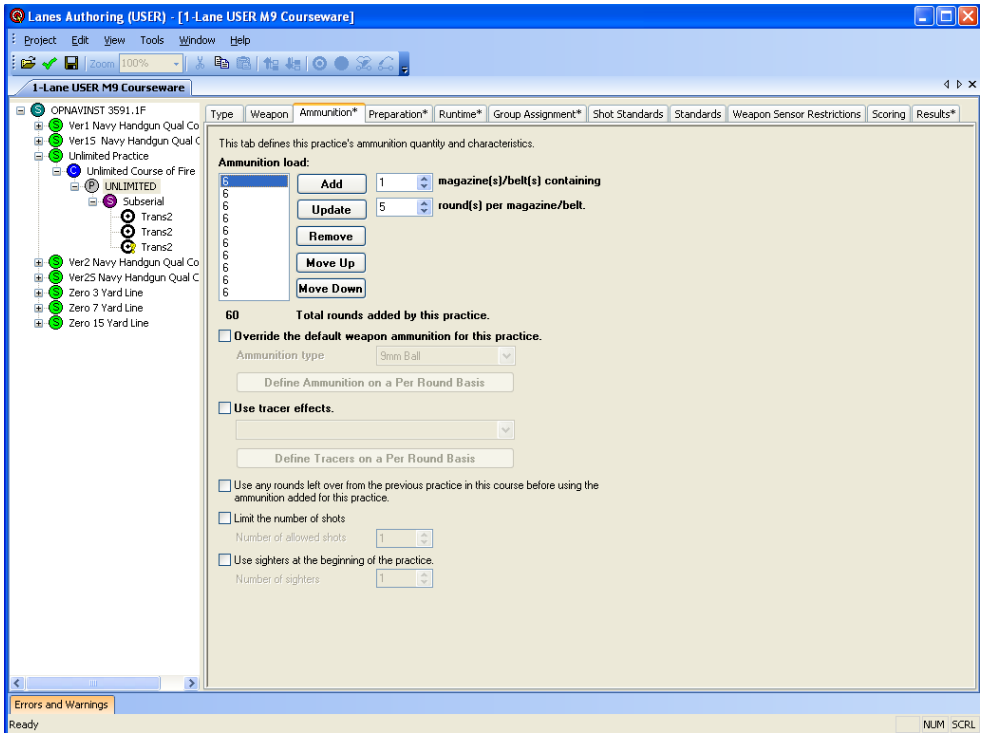
Course Standards



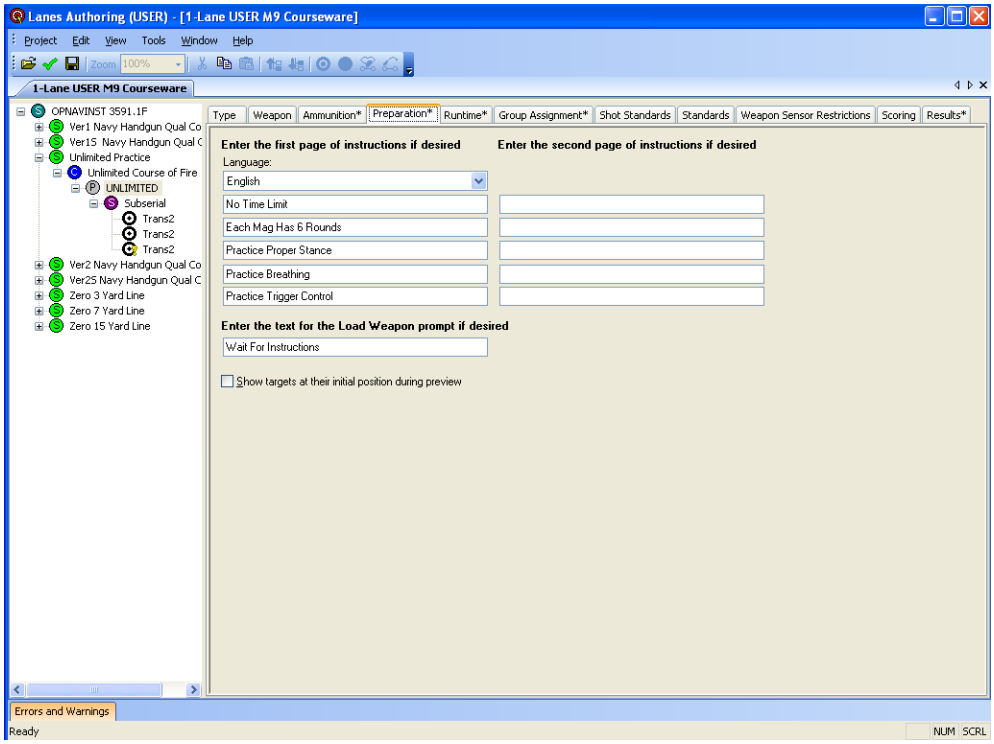
Practice Type



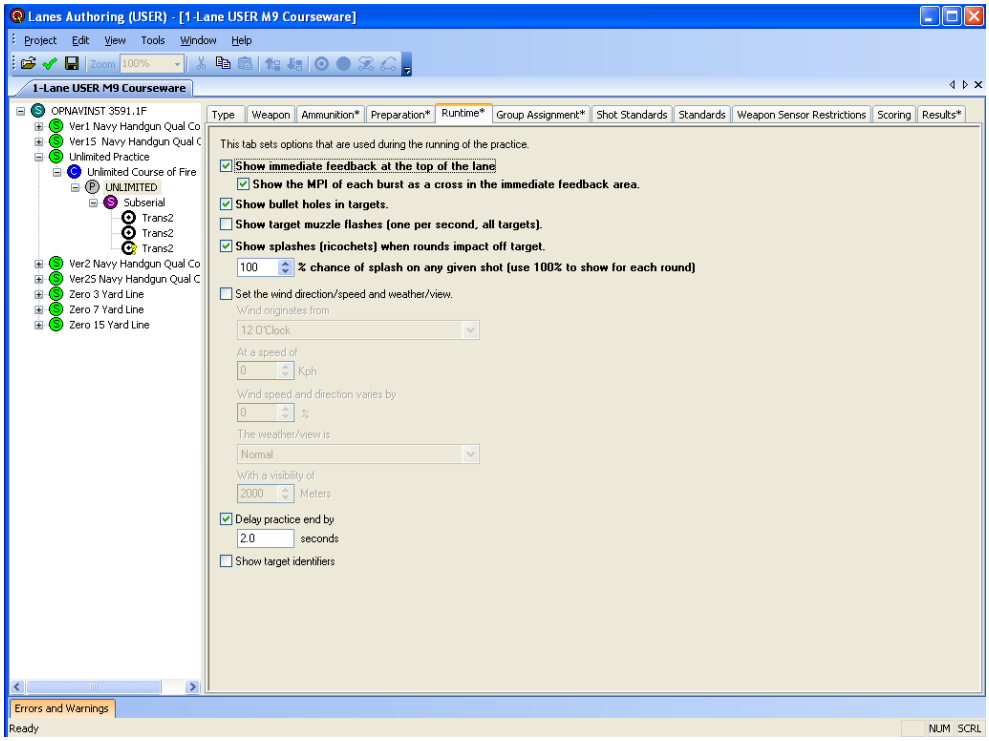
Practice Weapon



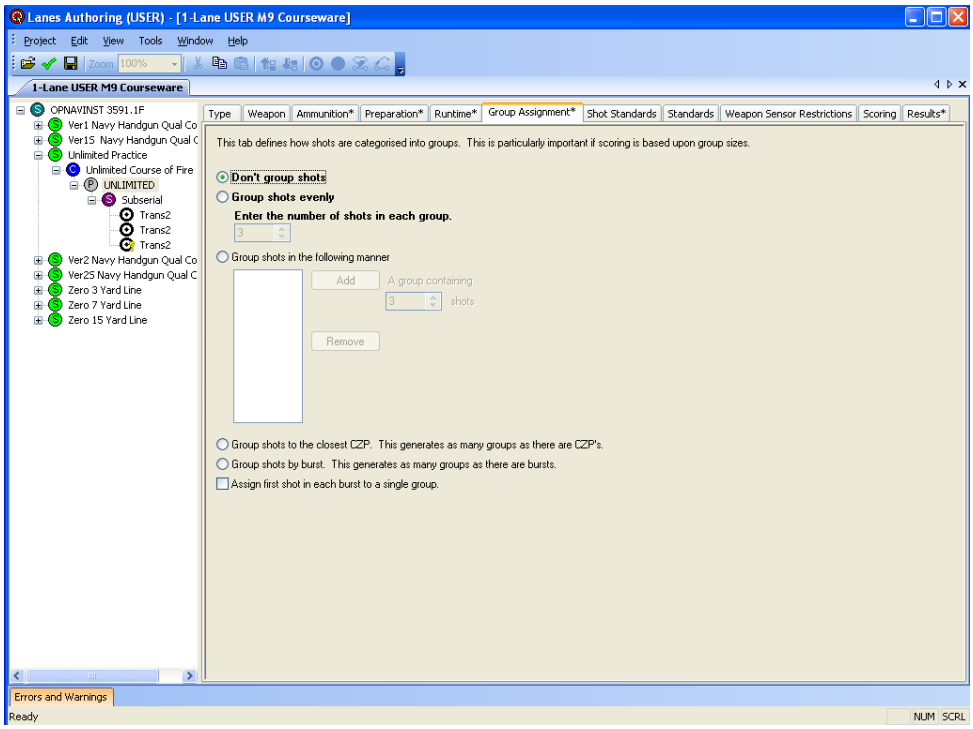
Practice Ammunition



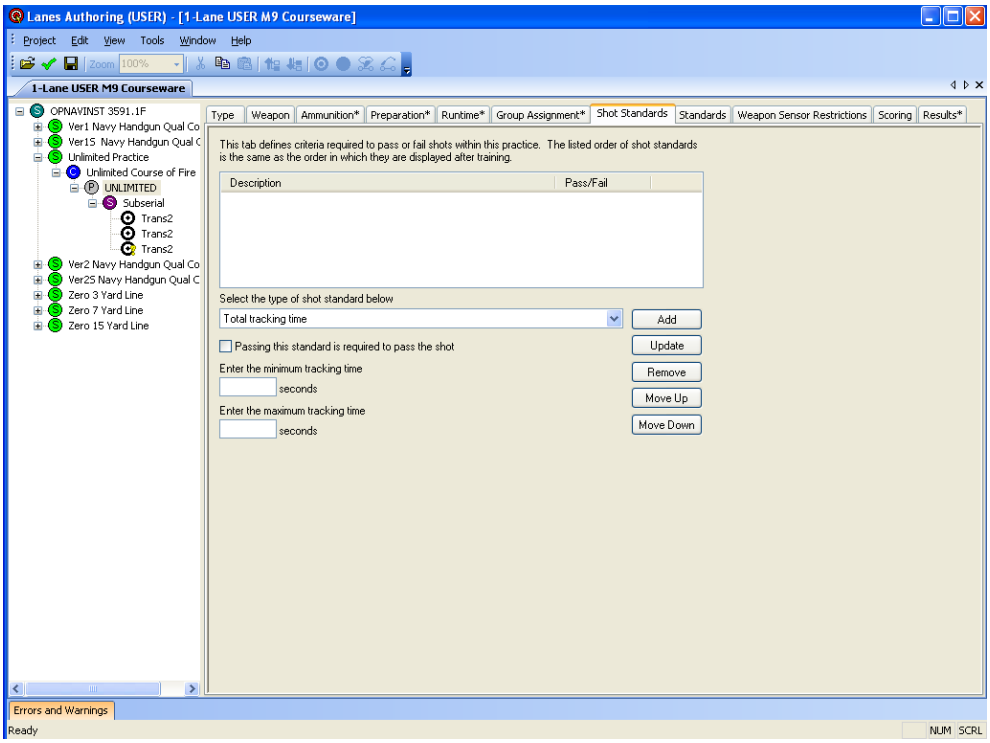
Practice Preparation



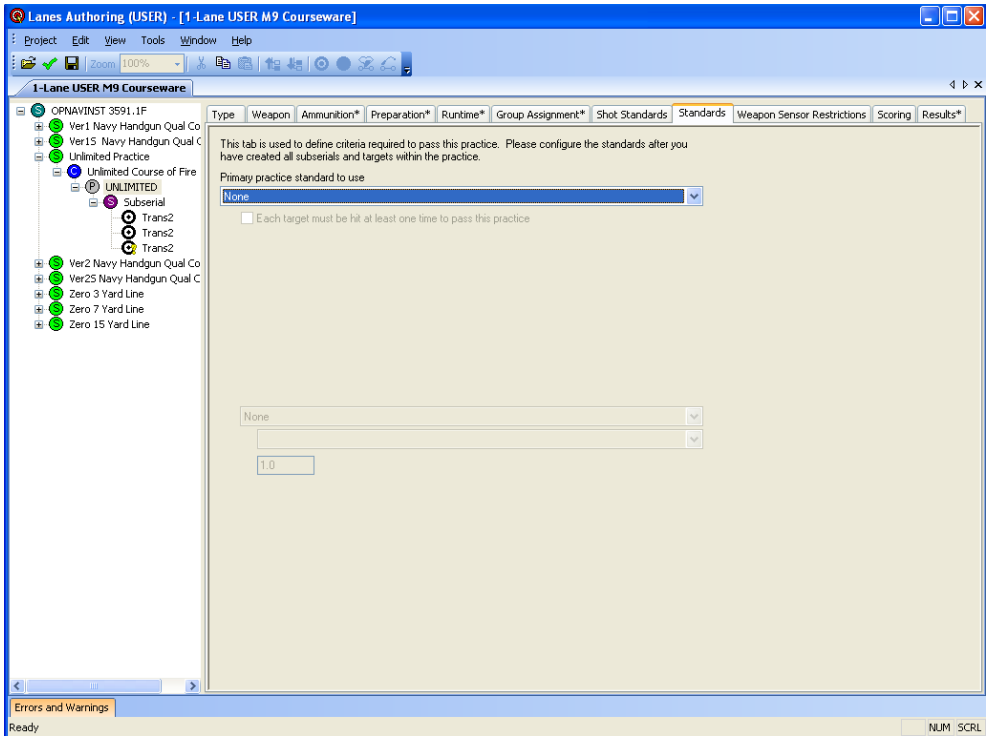
Practice Runtime



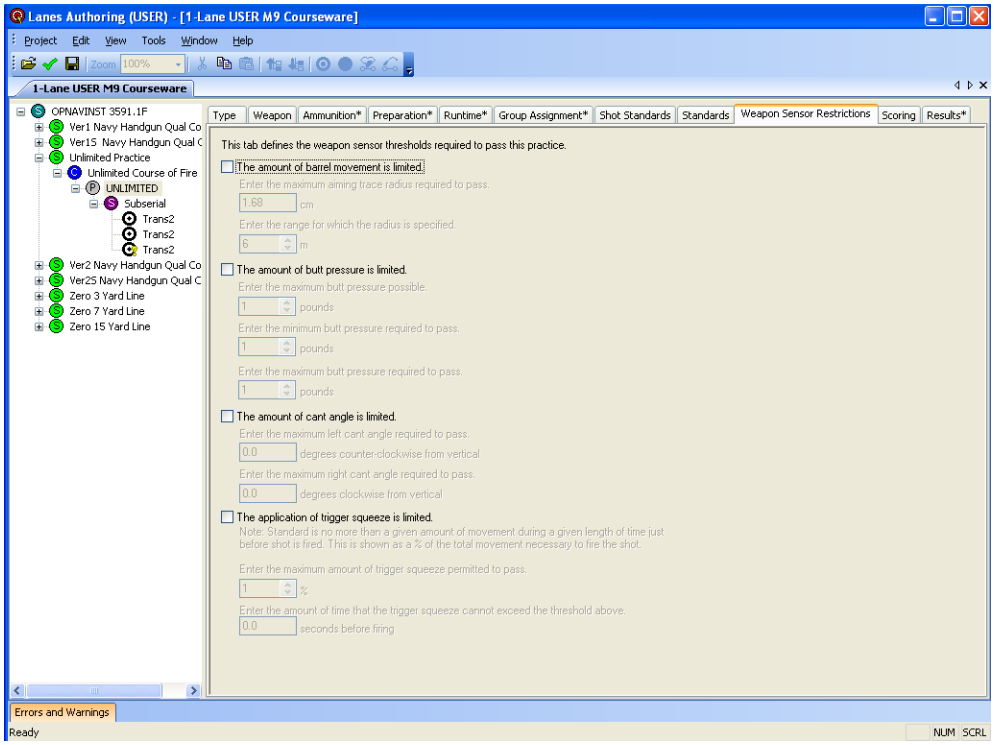
Practice Group Assignment



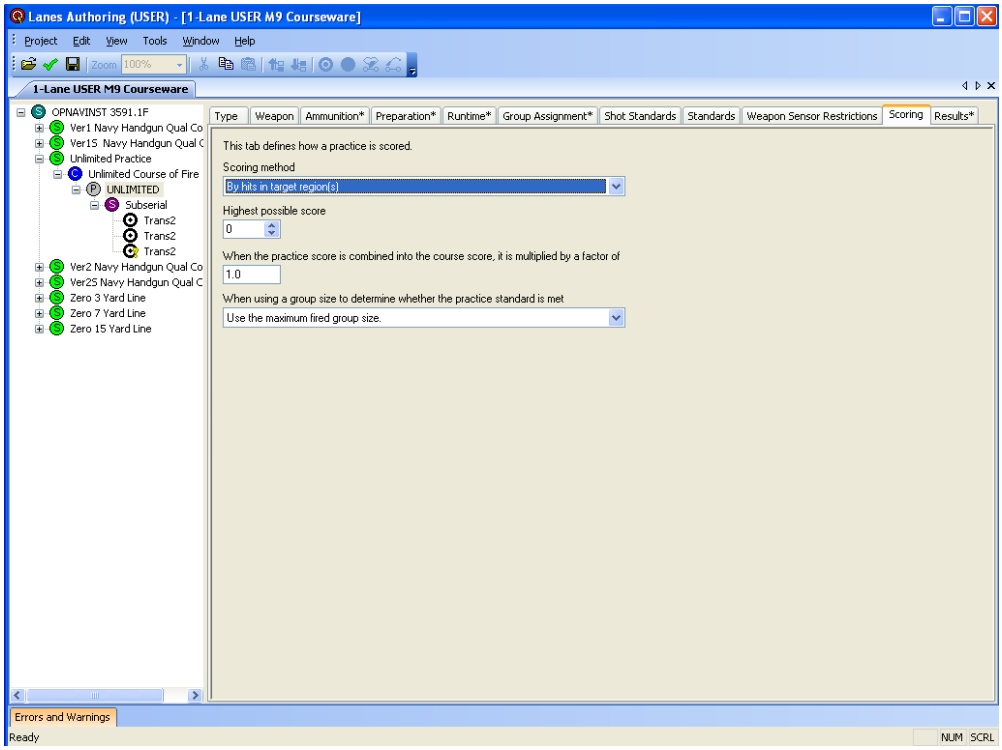
Practice Shot Standards



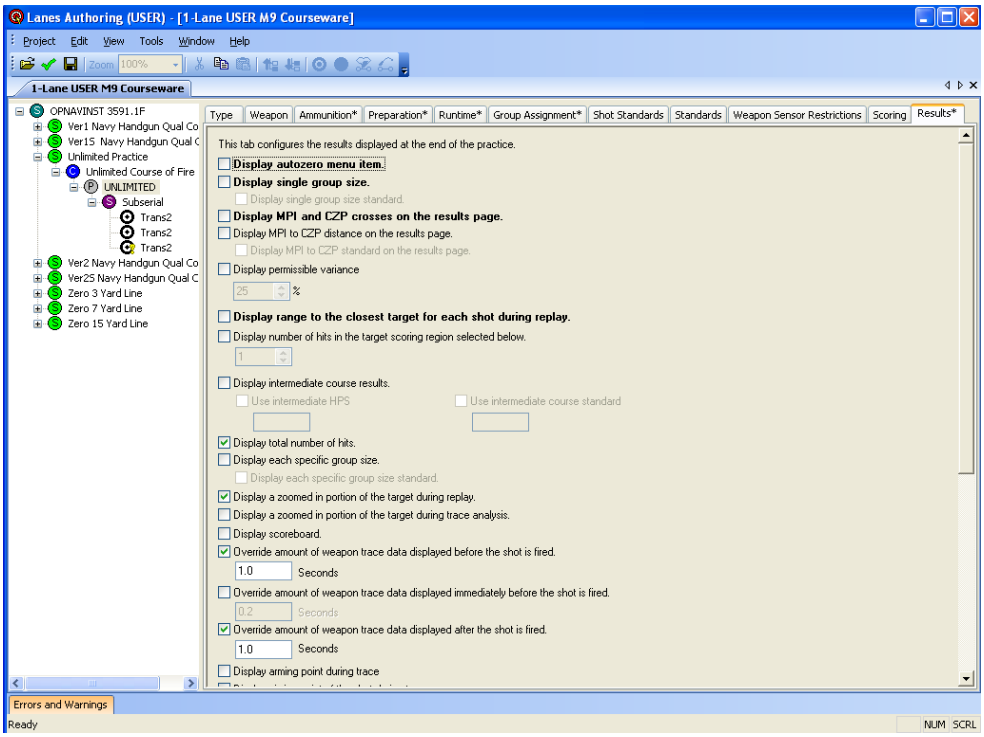
Practice Standards



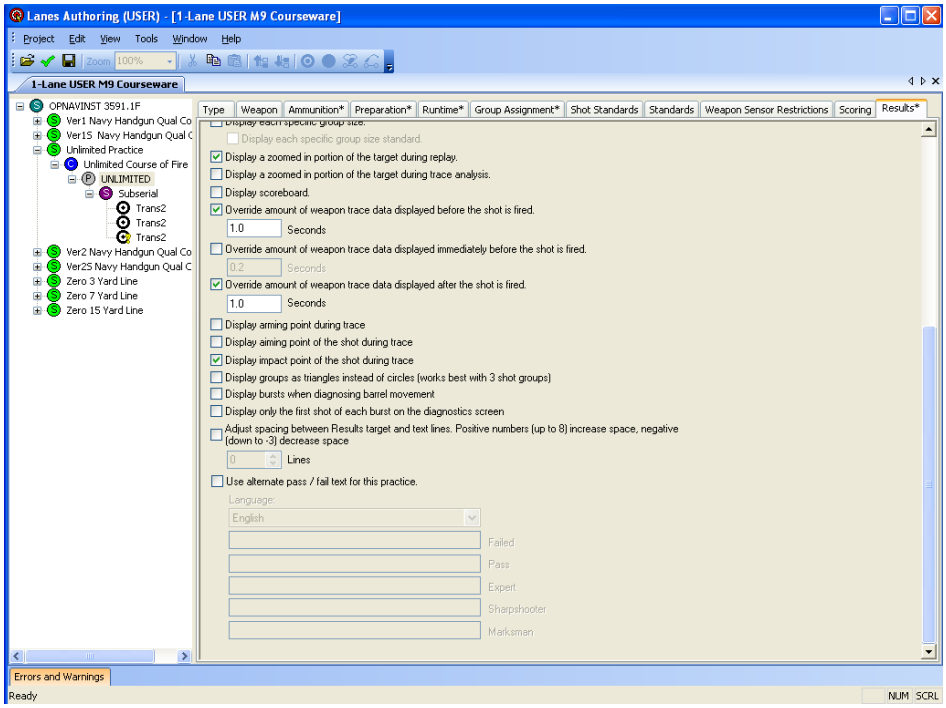
Practice Weapon Sensor Restrictions



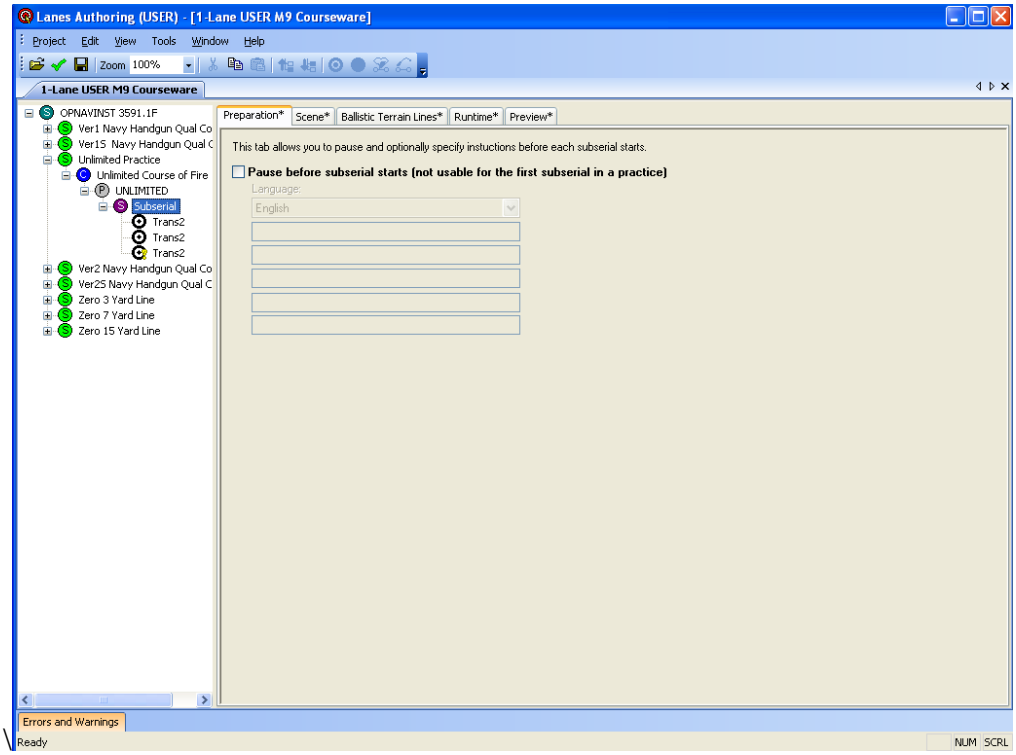
Practice Scoring



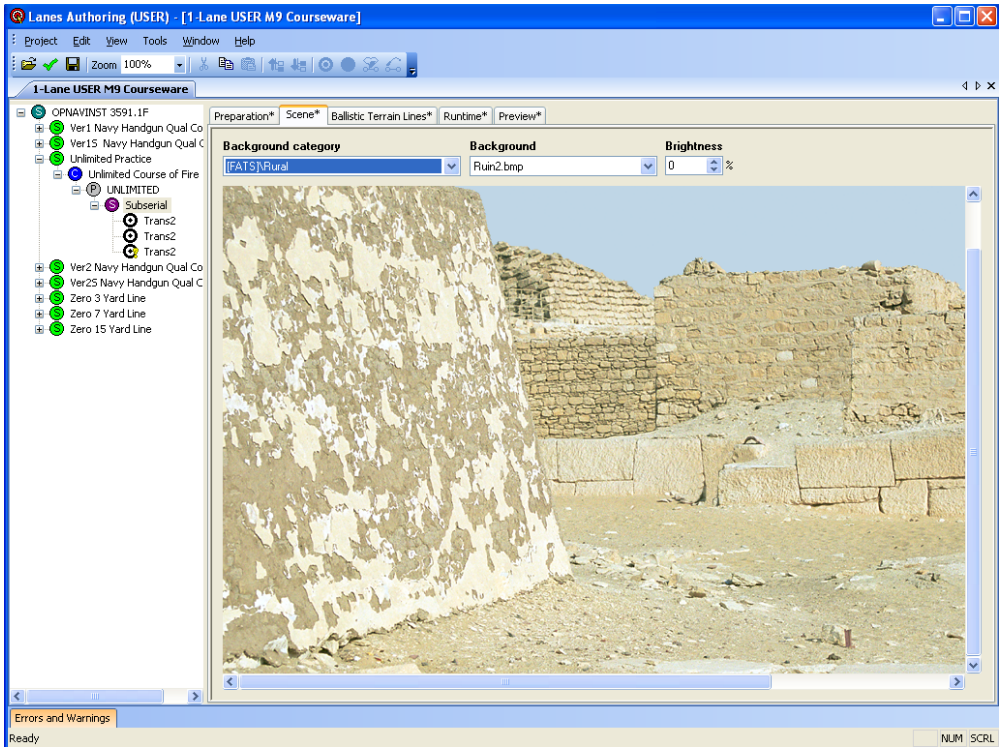
Practice Results Top Half



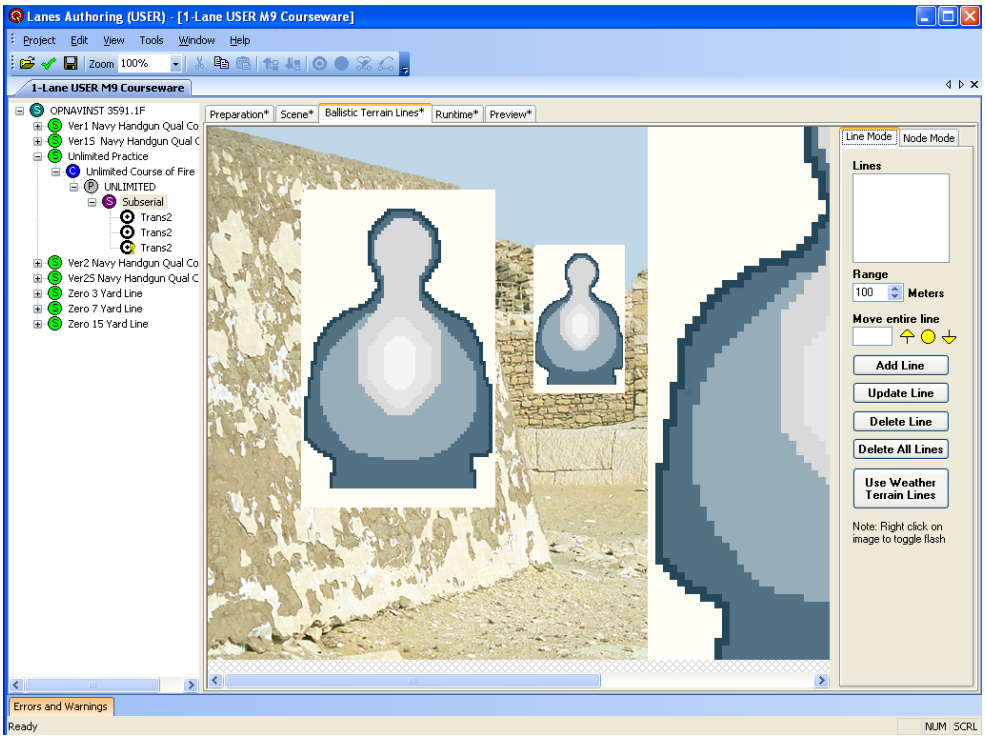
Practice Results Bottom Half



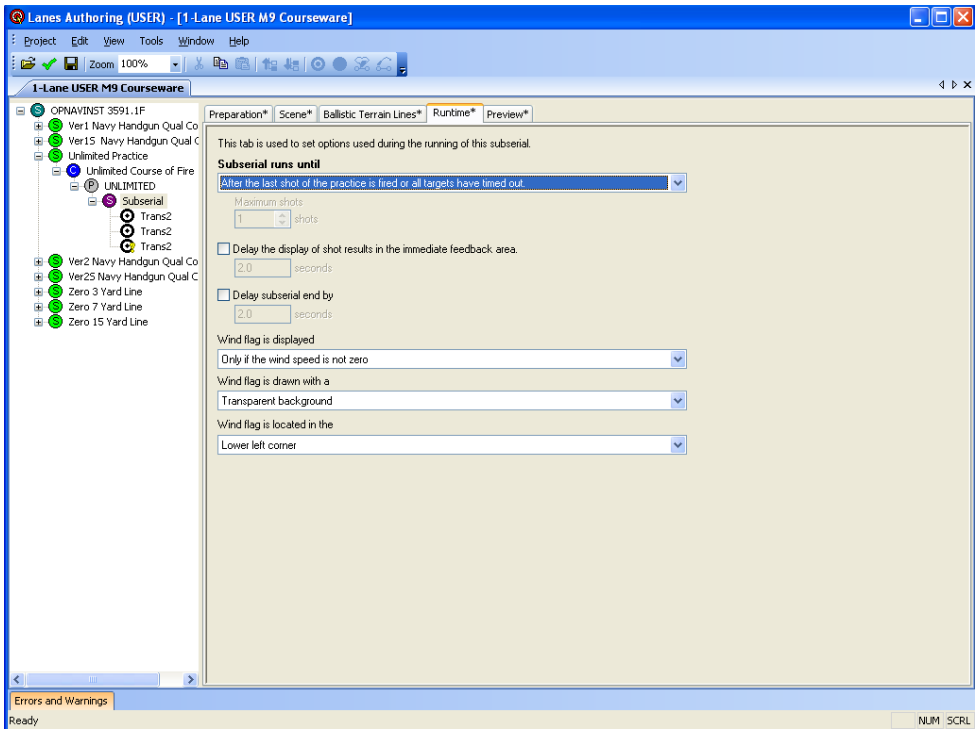
Sub Serial Preparation



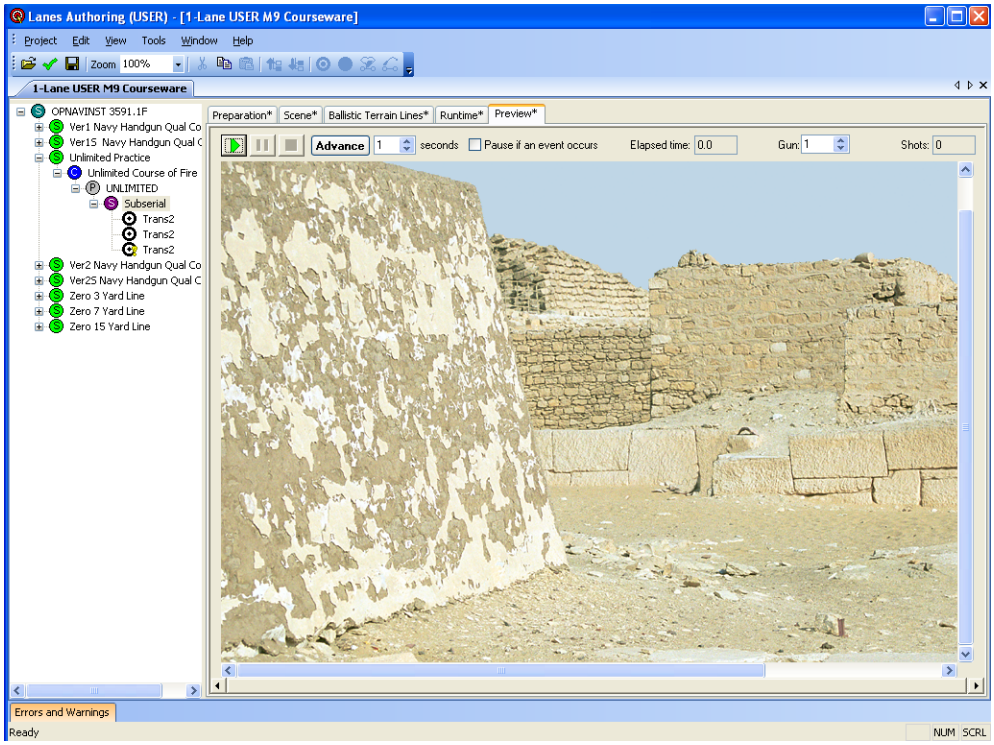
Sub Serial Scene



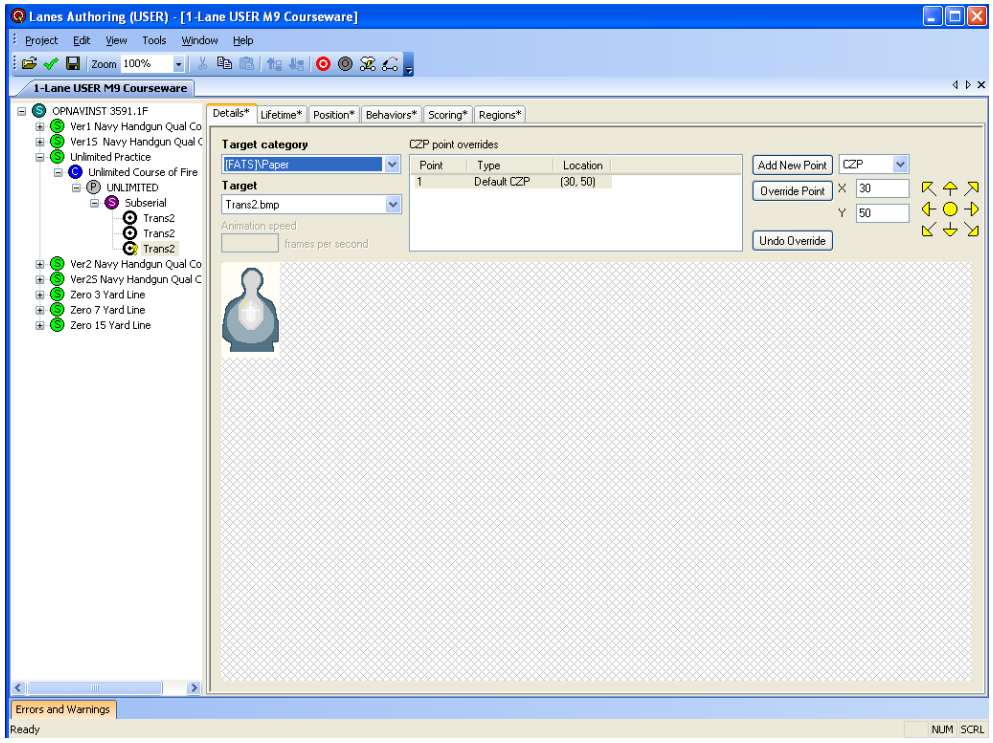
Sub Serial Ballistic Terrain Lines



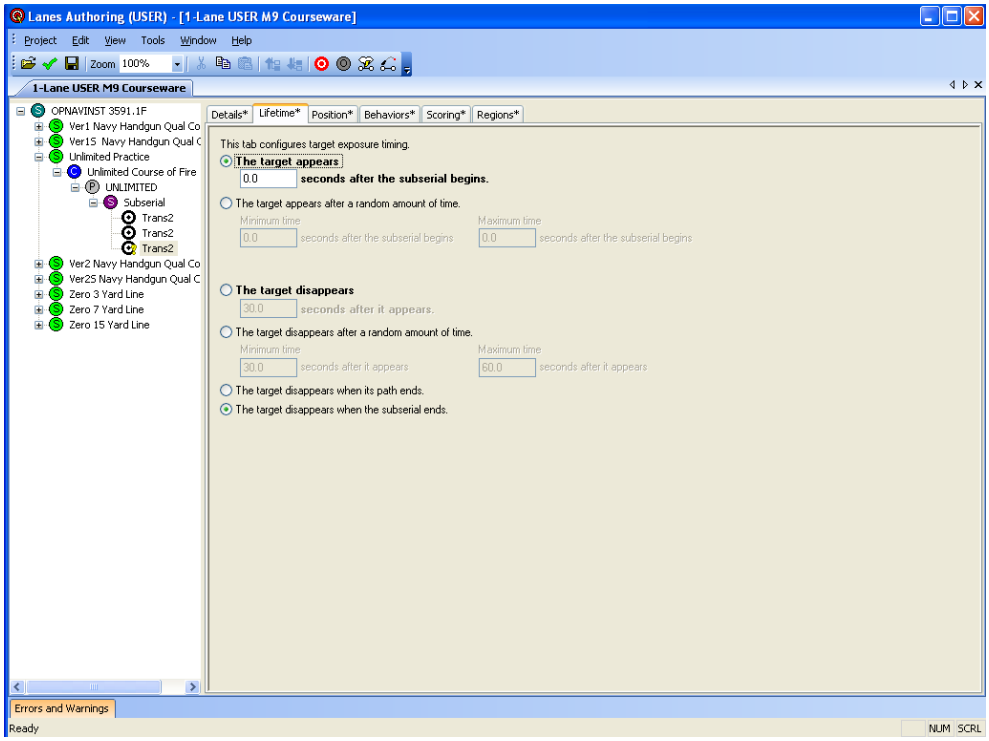
Sub Serial Runtime



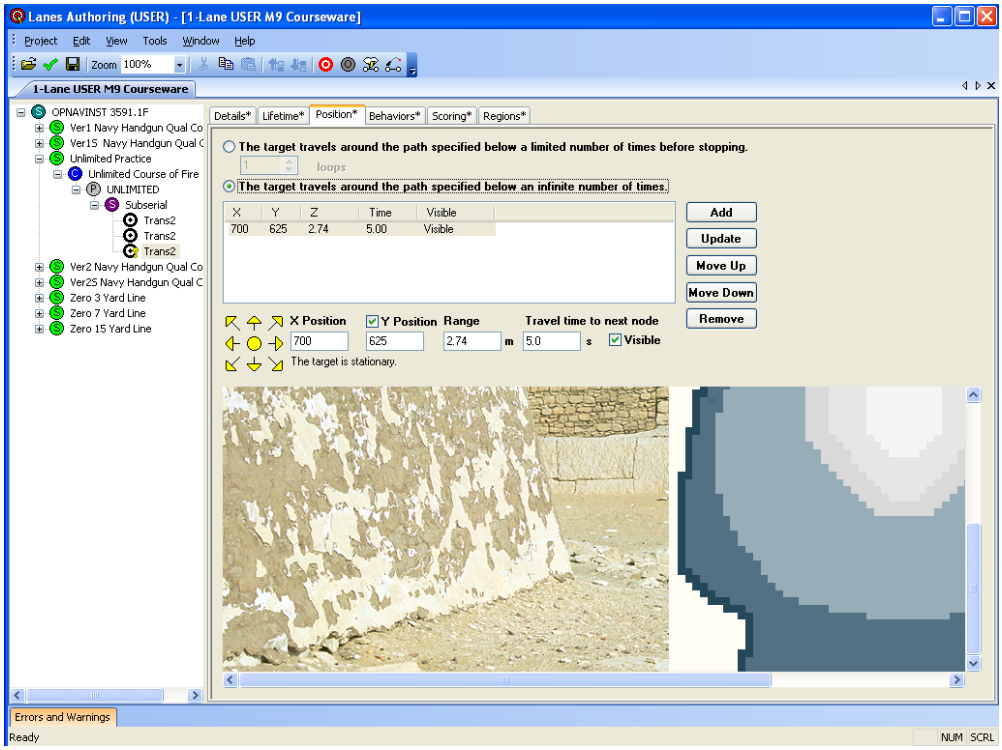
Sub Serial Preview



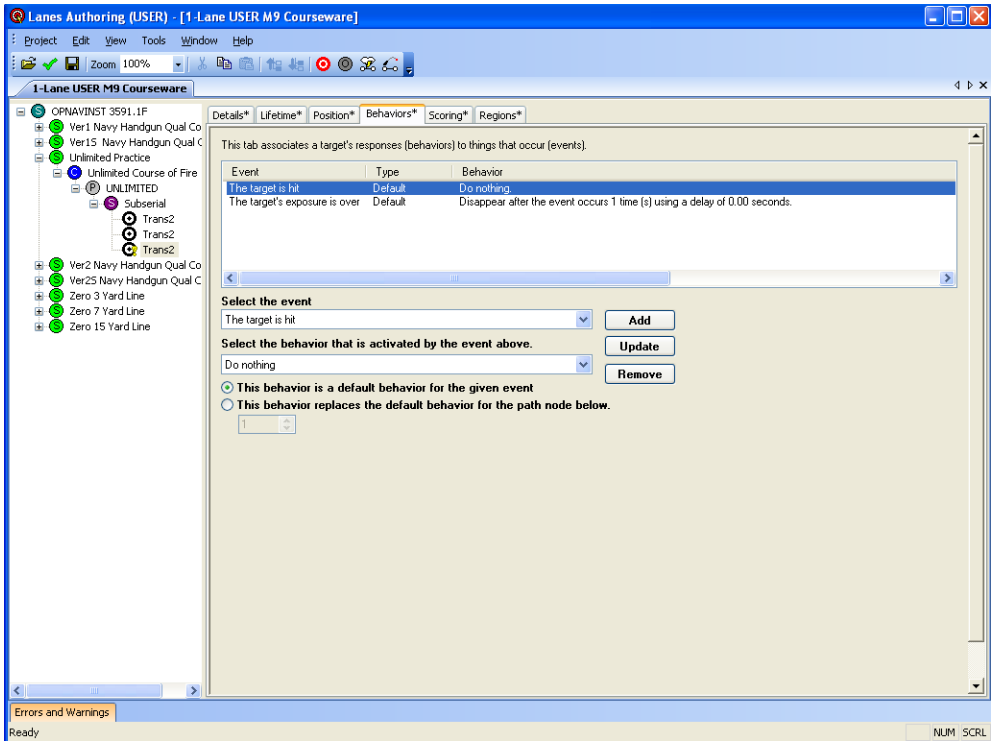
3-Yard Target Details



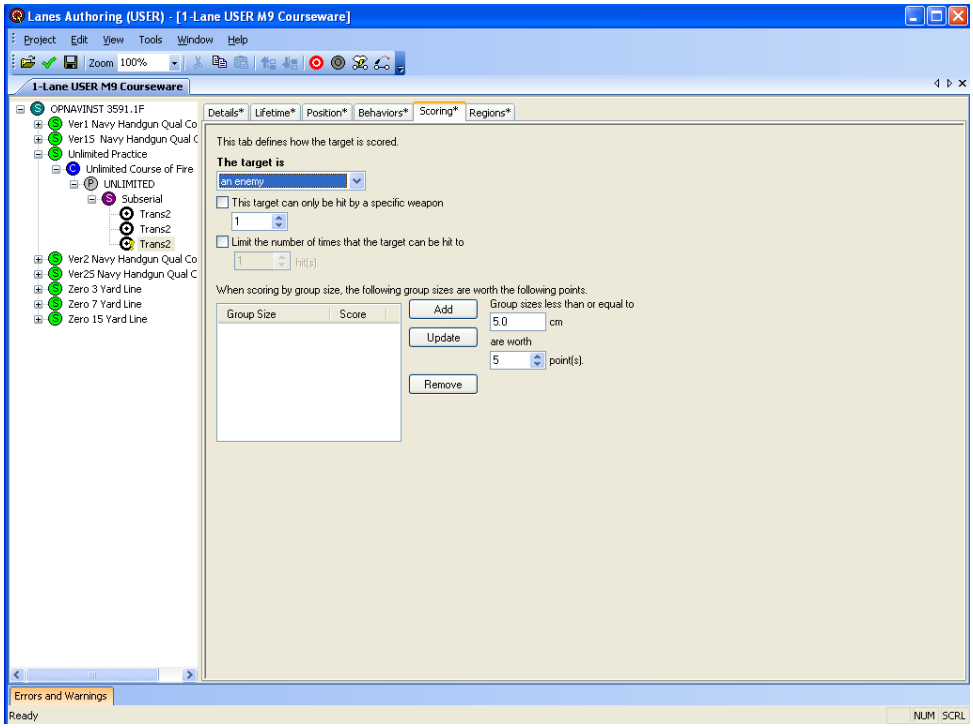
3-Yard Target Lifetime



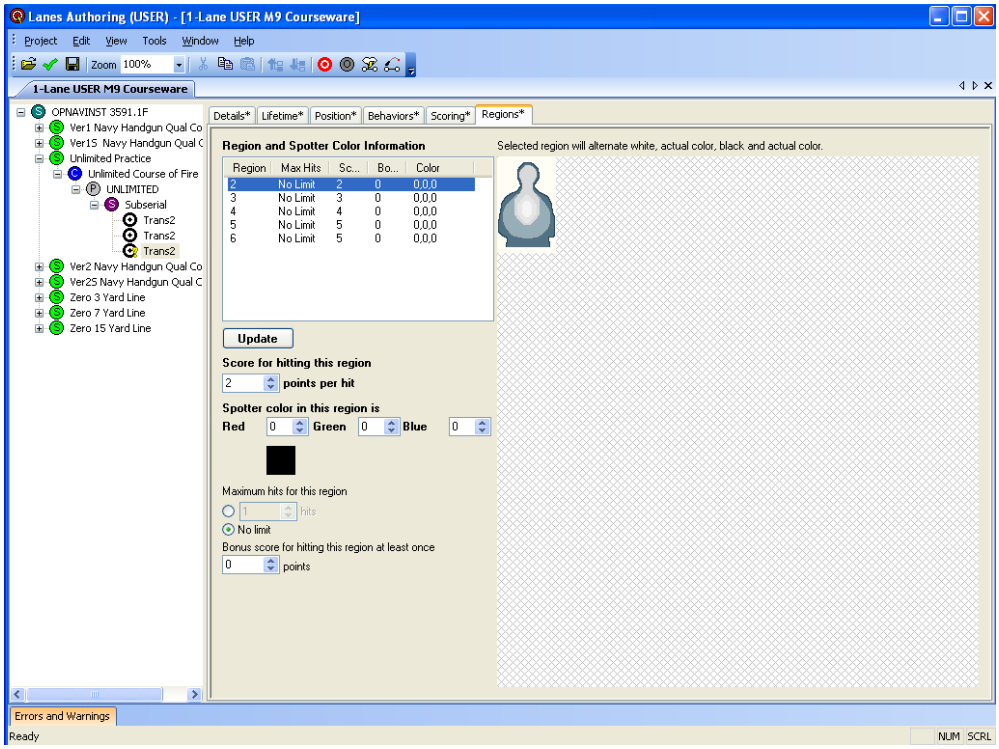
3-Yard Target Position



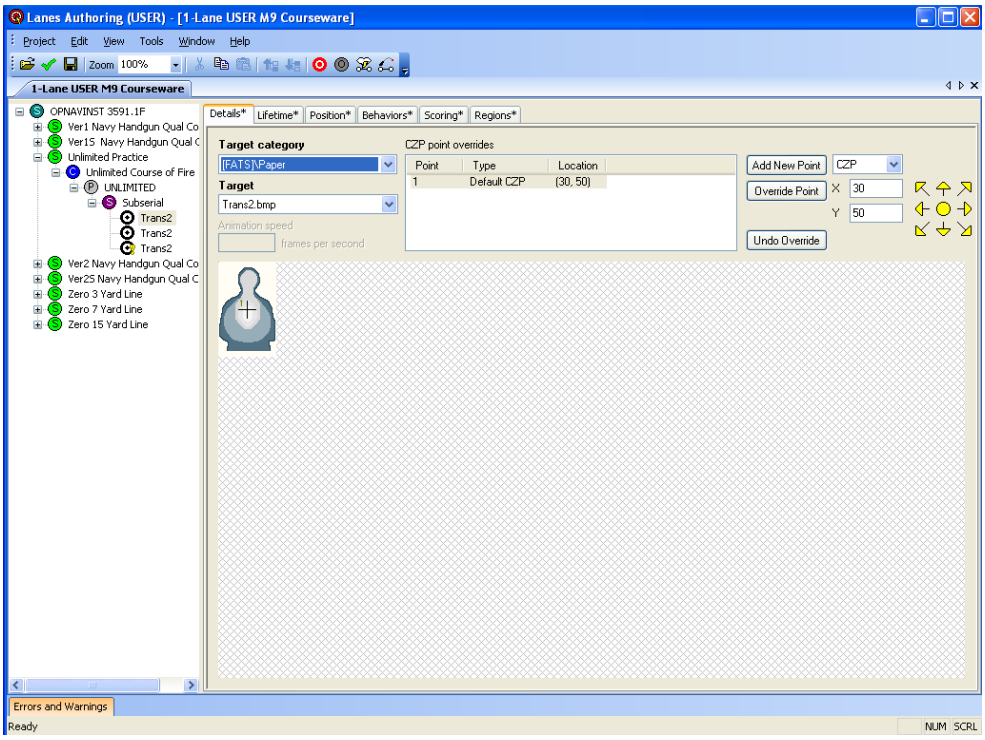
3-Yard Target Behaviors



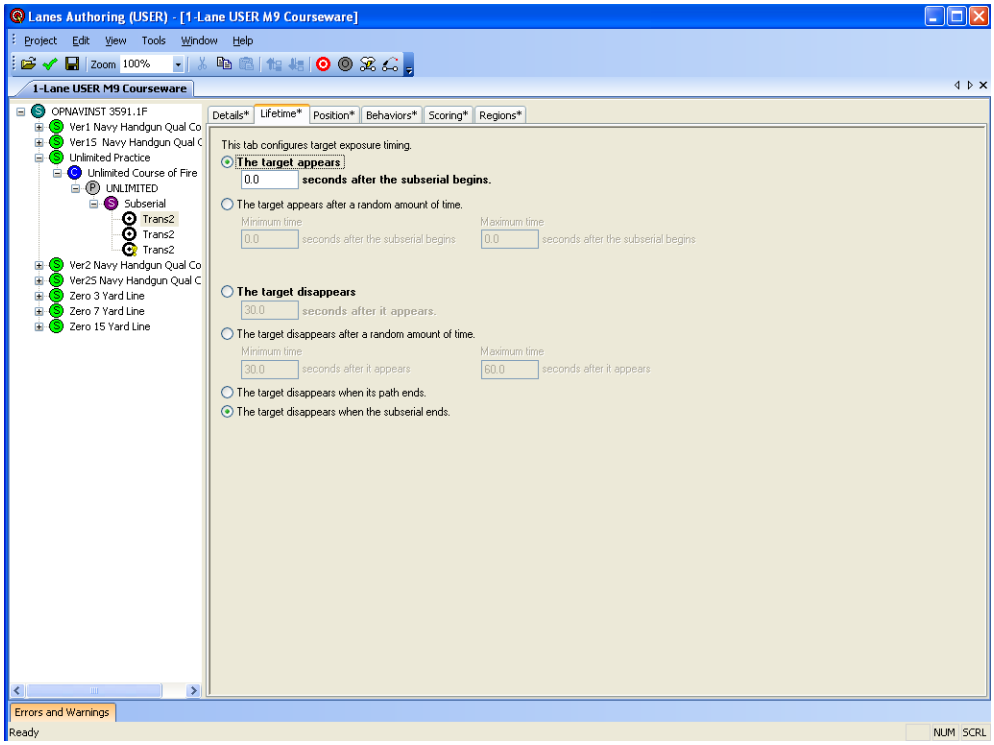
3-Yard Target Scoring



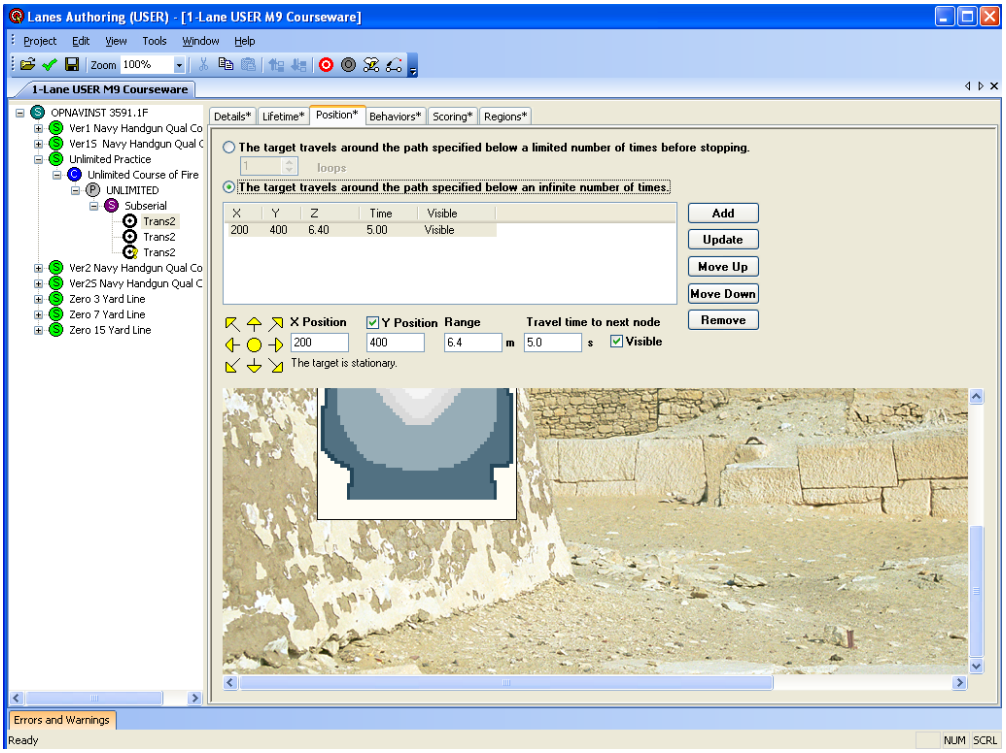
3-Yard Target Regions



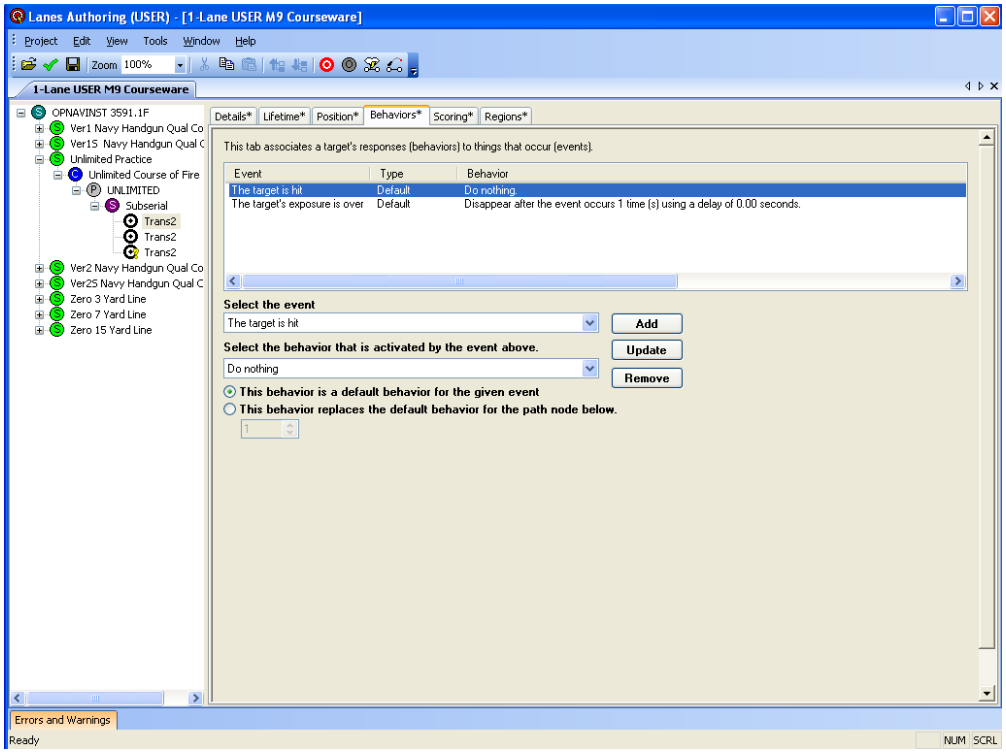
7-Yard Target Details



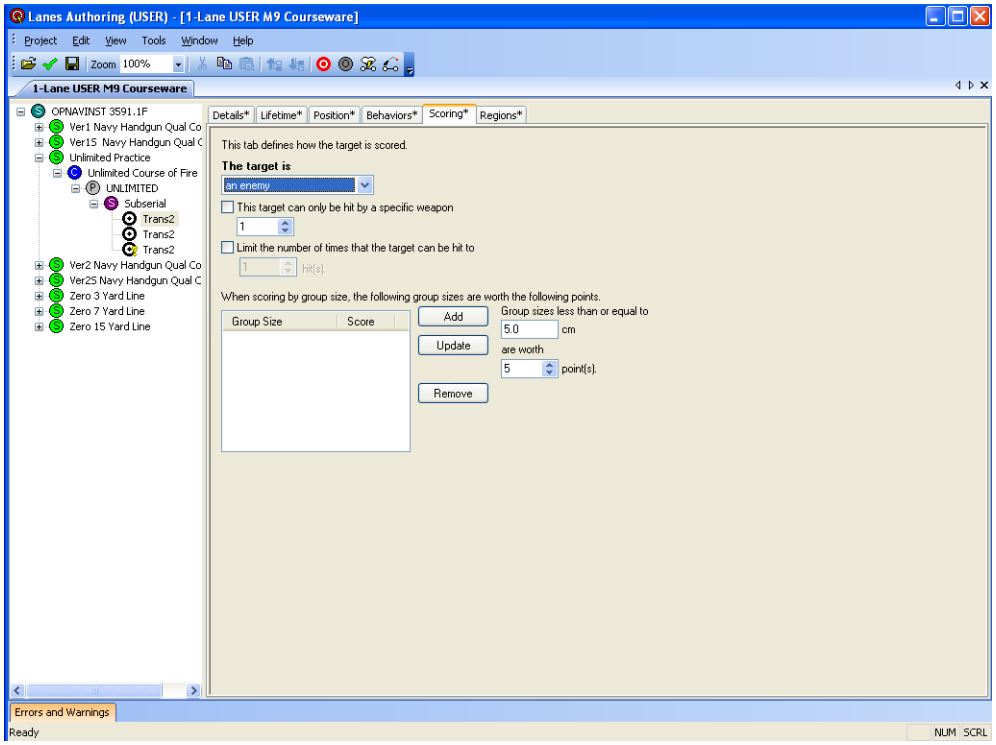
7-Yard Target Lifetime



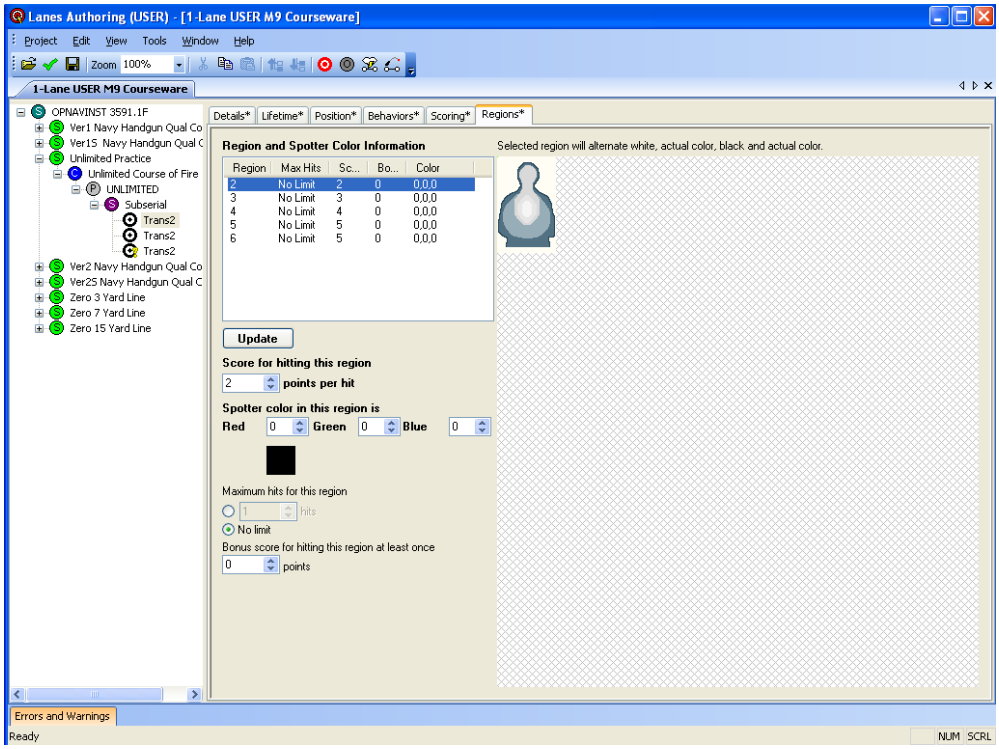
7-Yard Target Position



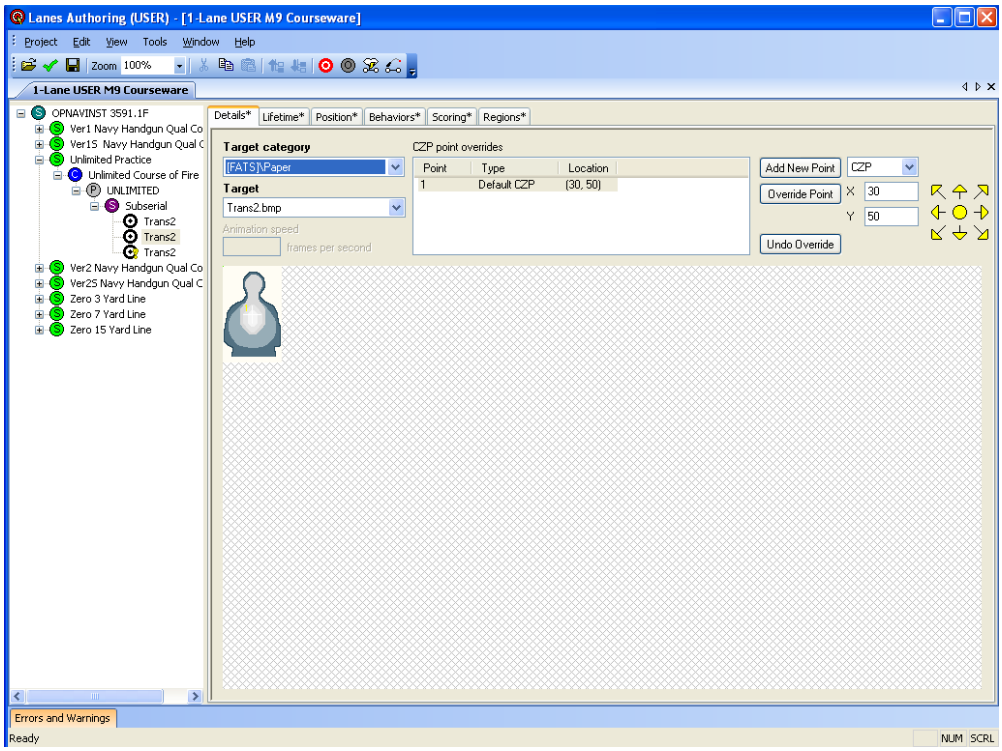
7-Yard Target Behaviors



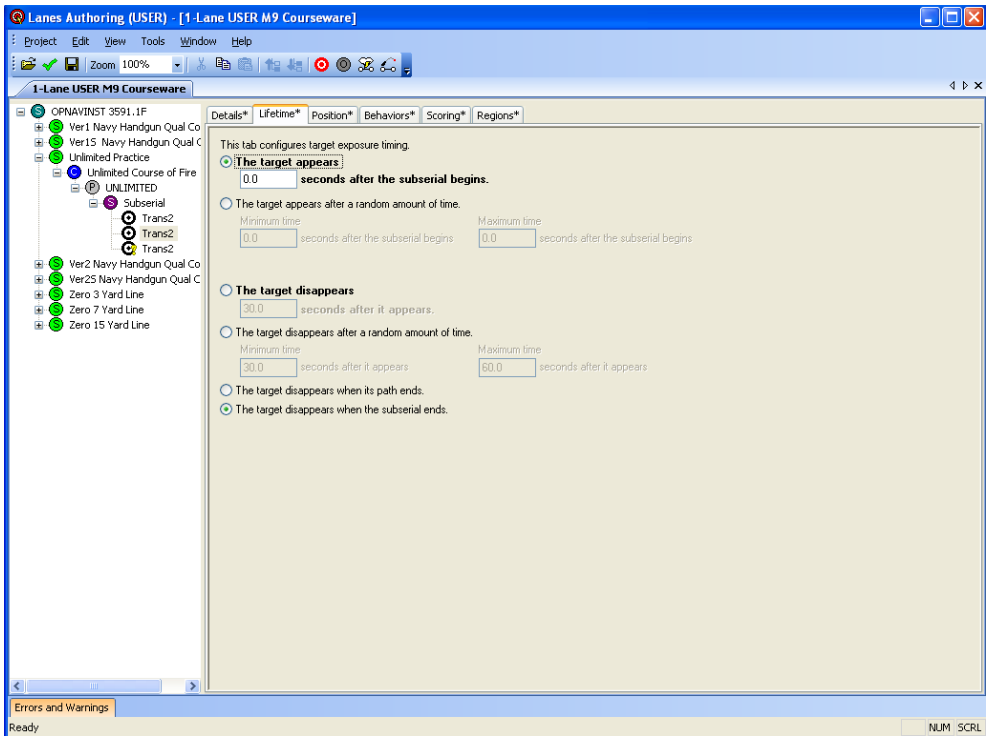
7-Yard Target Scoring



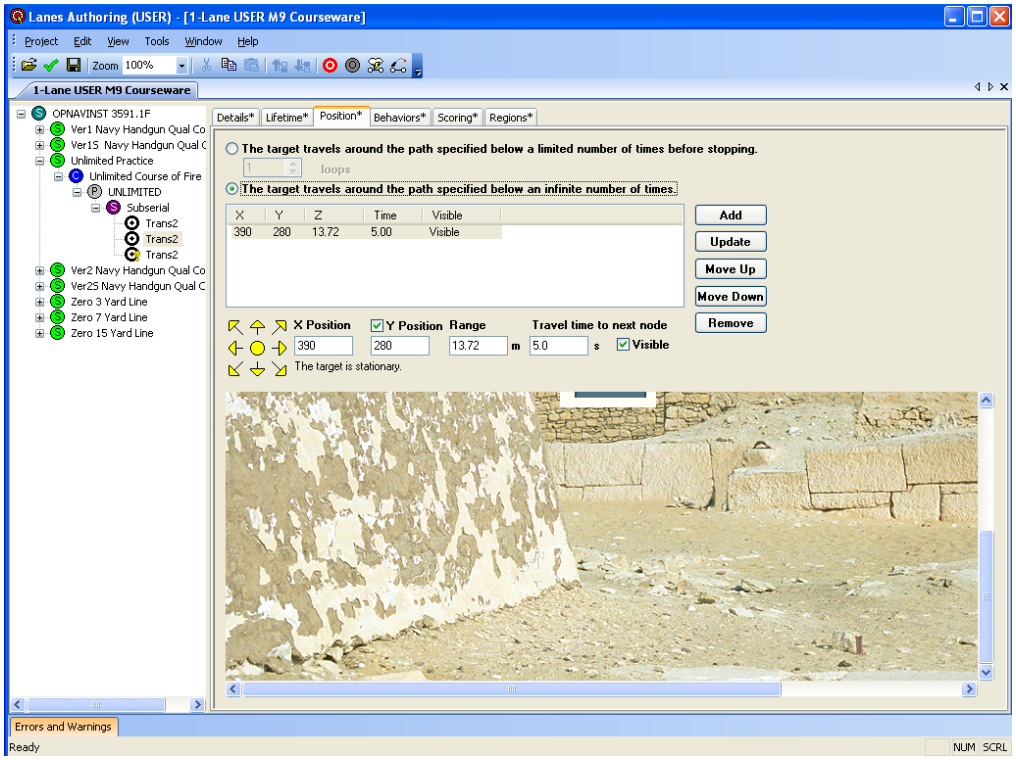
7-Yard Target Regions



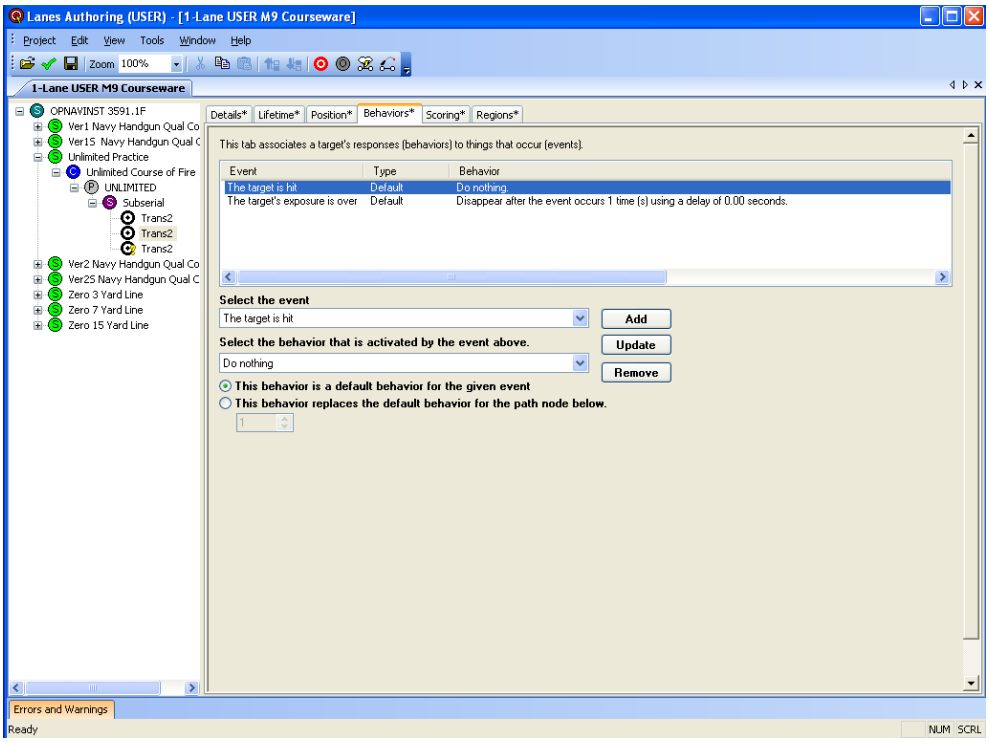
15-Yard Target Details



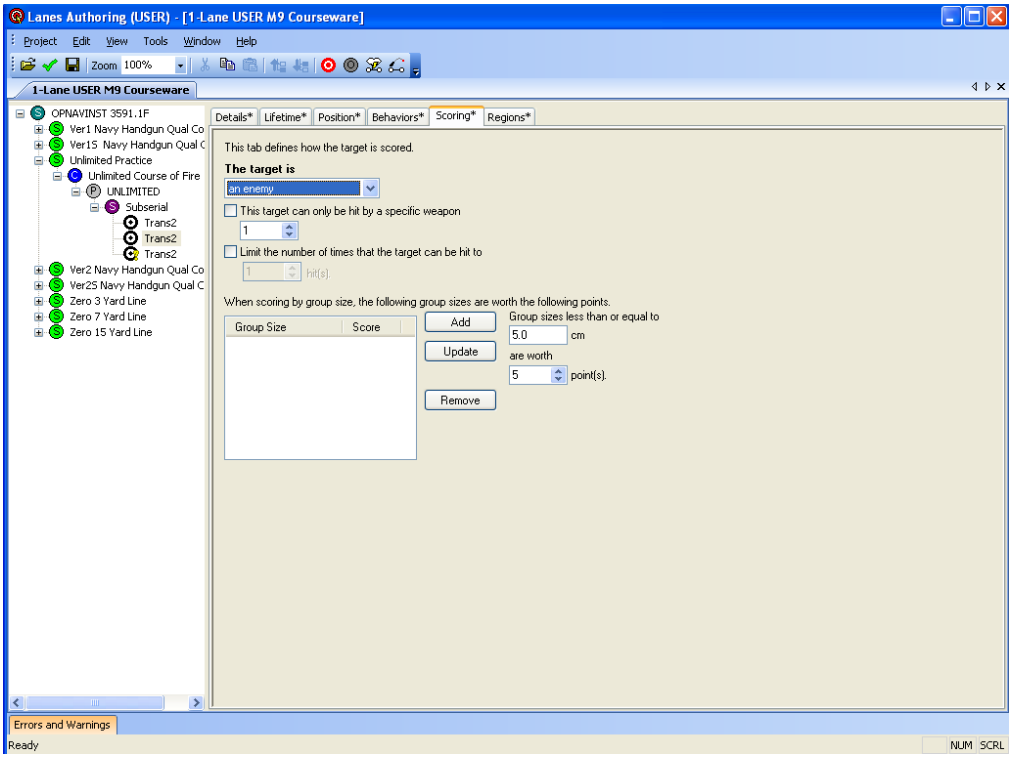
15-Yard Target Lifetime



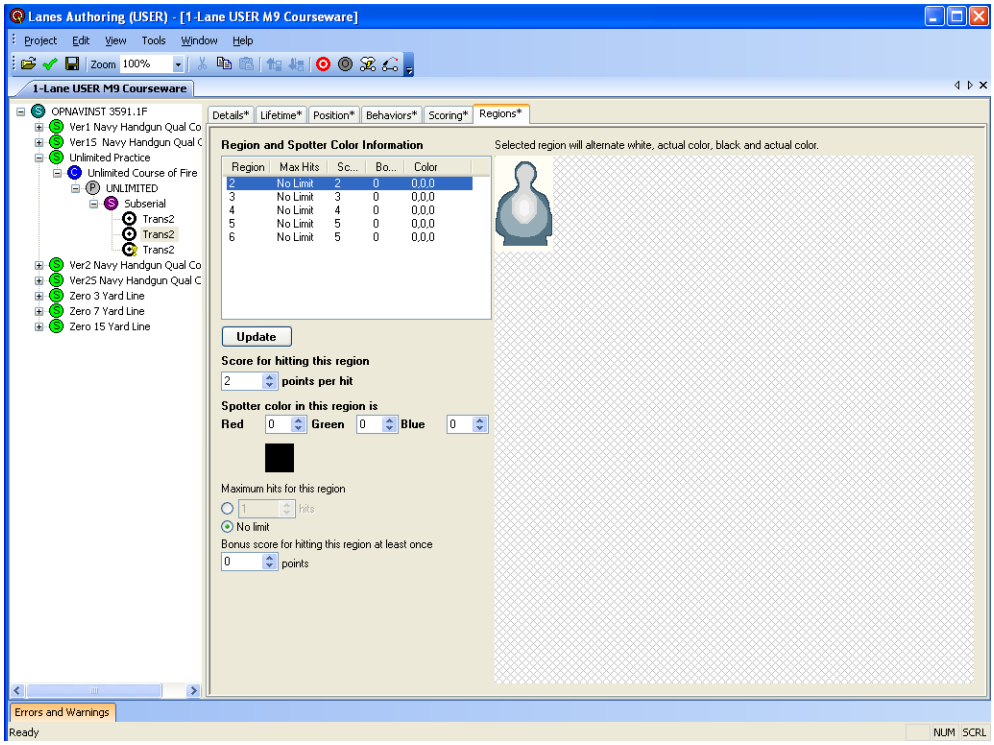
15-Yard Target Position



15-Yard Target Behaviors



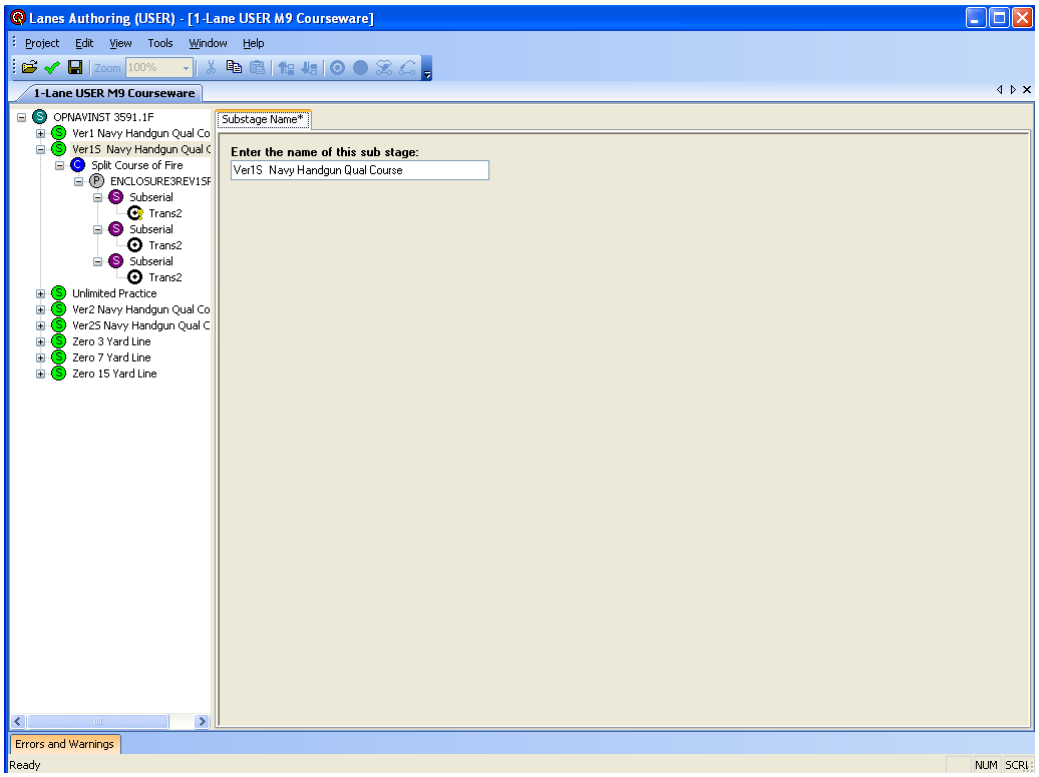
15-Yard Target Scoring



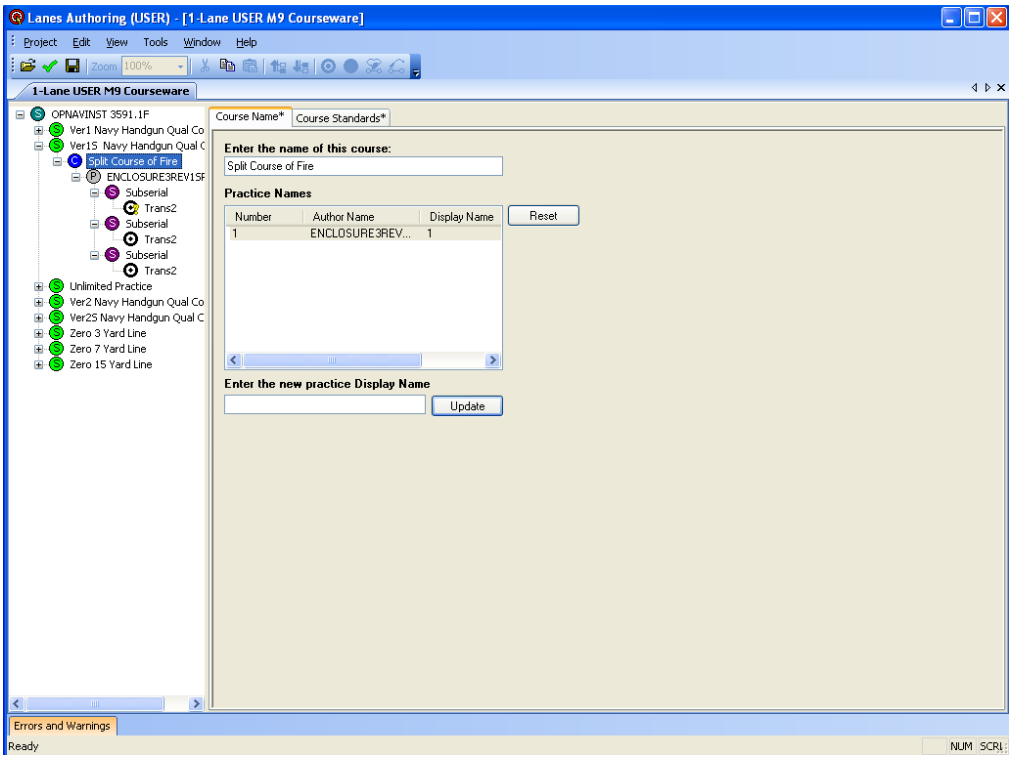
15-Yard Target Regions

APPENDIX F. PRACTICE QUALIFICATION SCENARIO

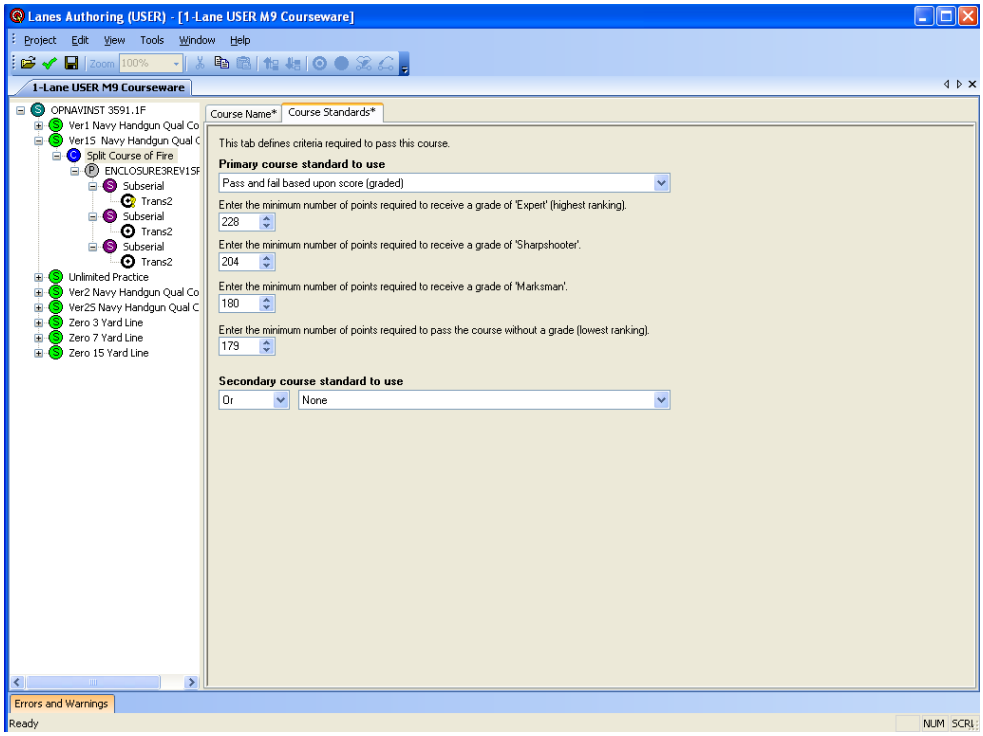
The contents of the appendix are screen captures of the practice qualification scenario. These pictures are provided so that anyone can recreate the course of fire used in this experiment. The scenario was established with respect to Navy Handgun Qualification Course found in the OPNAV INSTRUCTION 3591.1F *Small Arms Training and Qualification.*



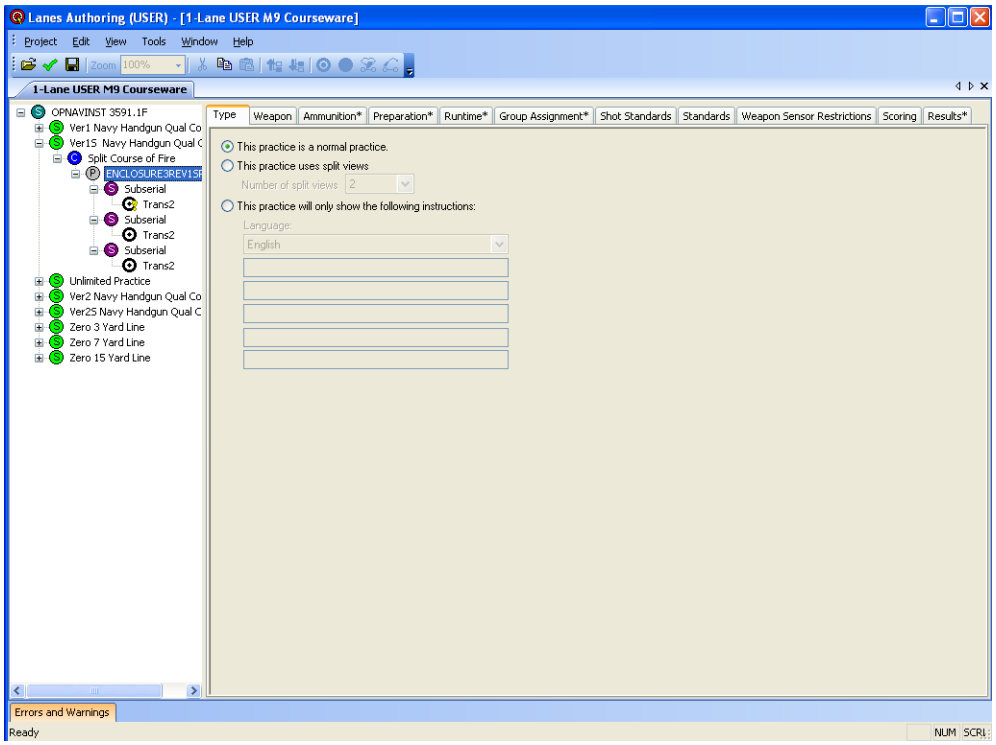
Sub Stage



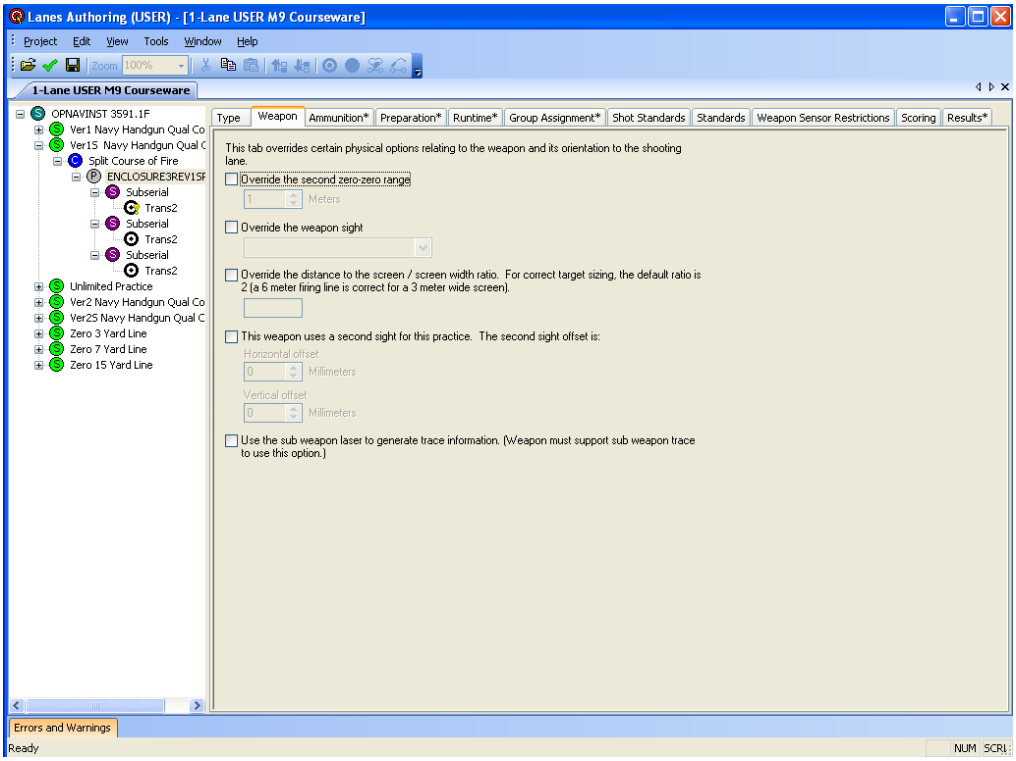
Course Name



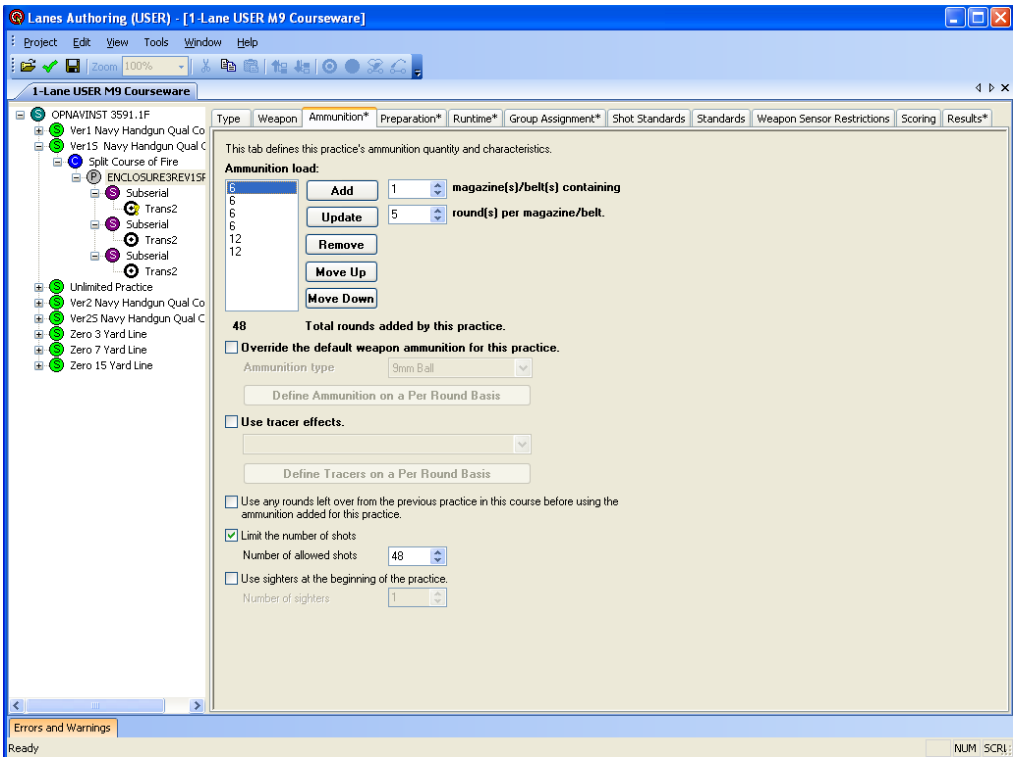
Course Standards



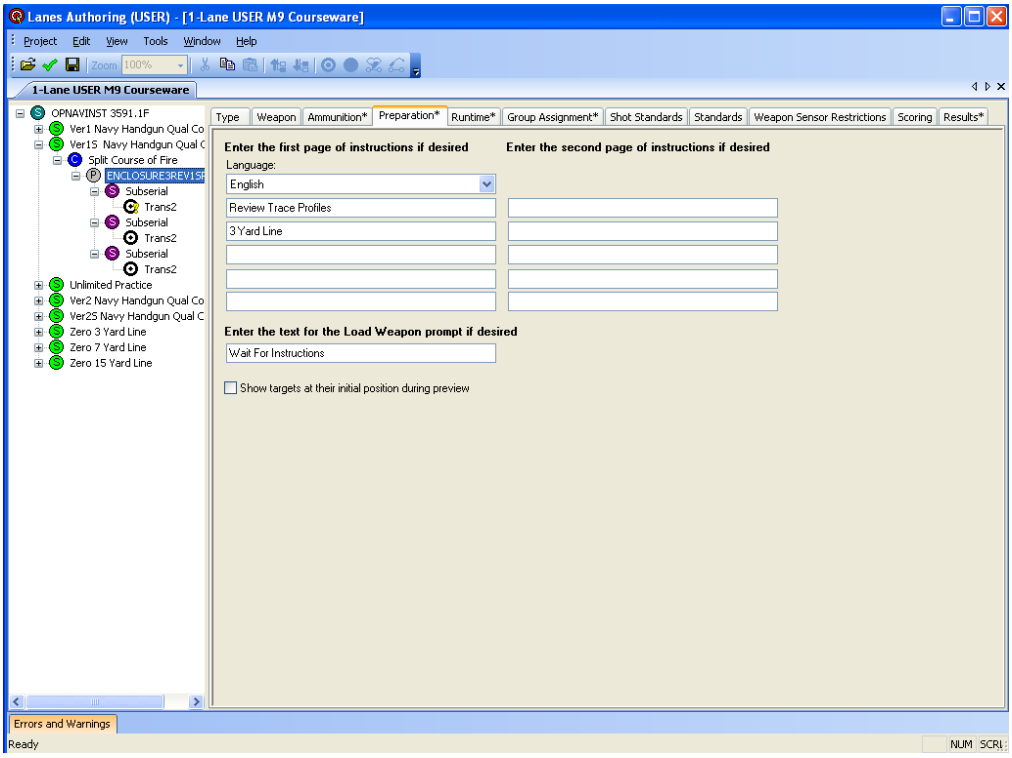
Practice Type



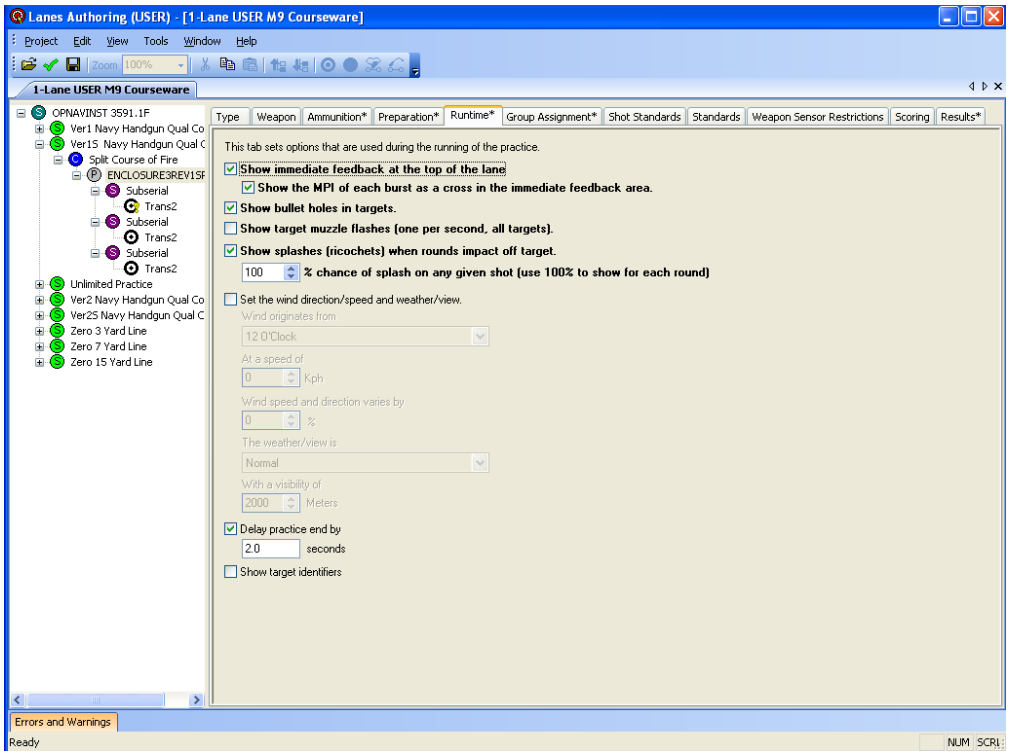
Practice Weapon



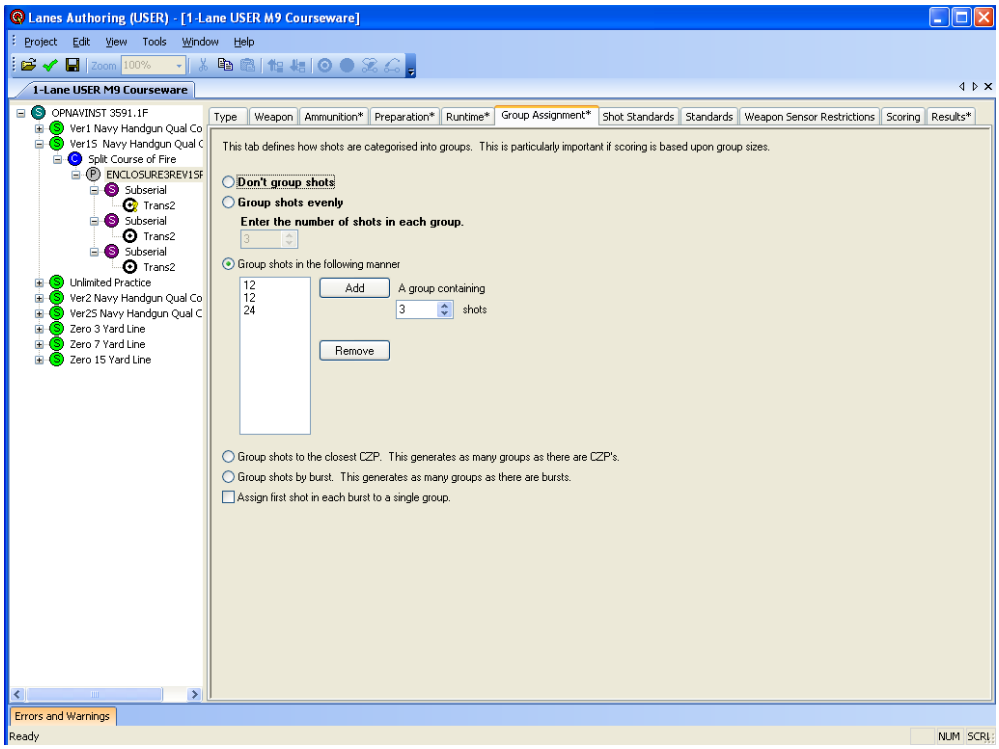
Practice Ammunition



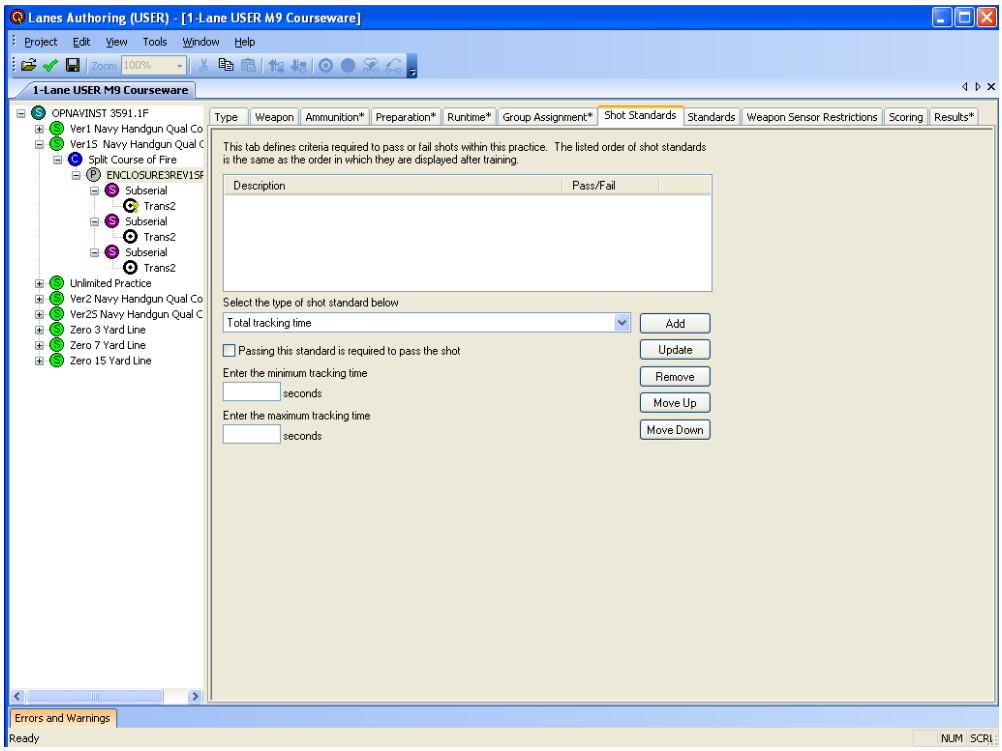
Practice Preparation



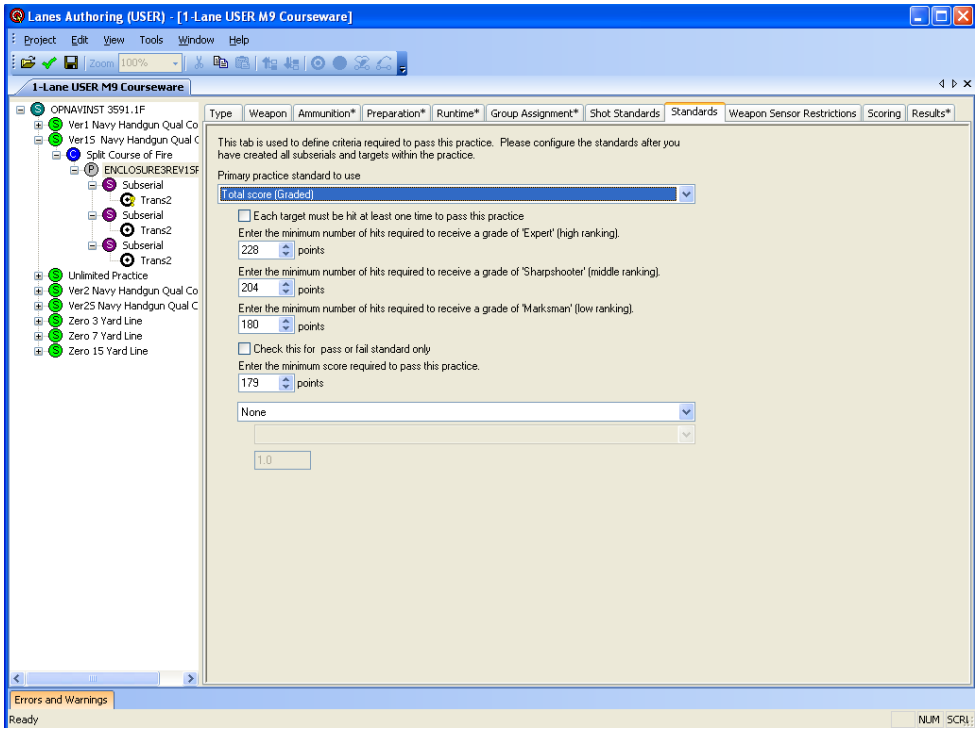
Practice Runtime



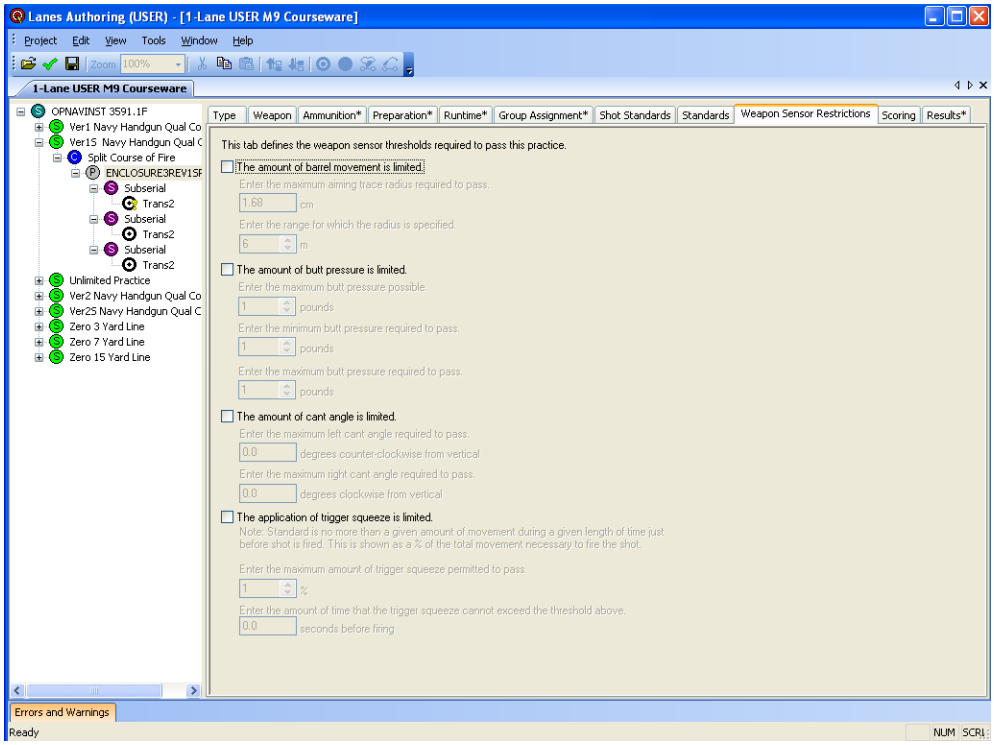
Practice Group Assignment



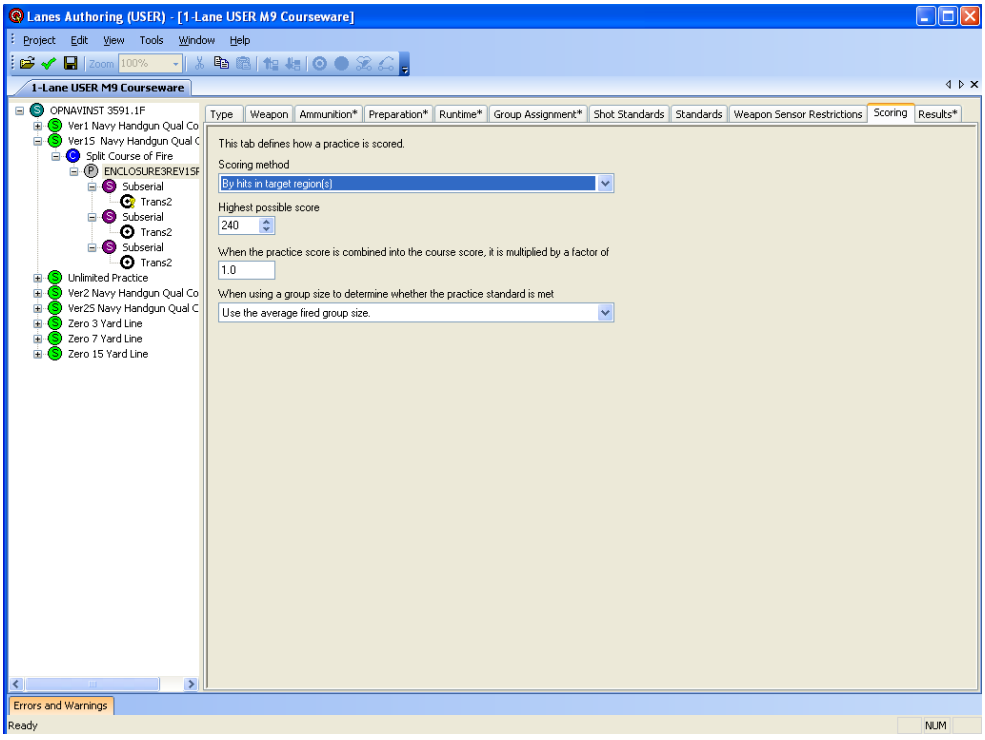
Practice Shot Standards



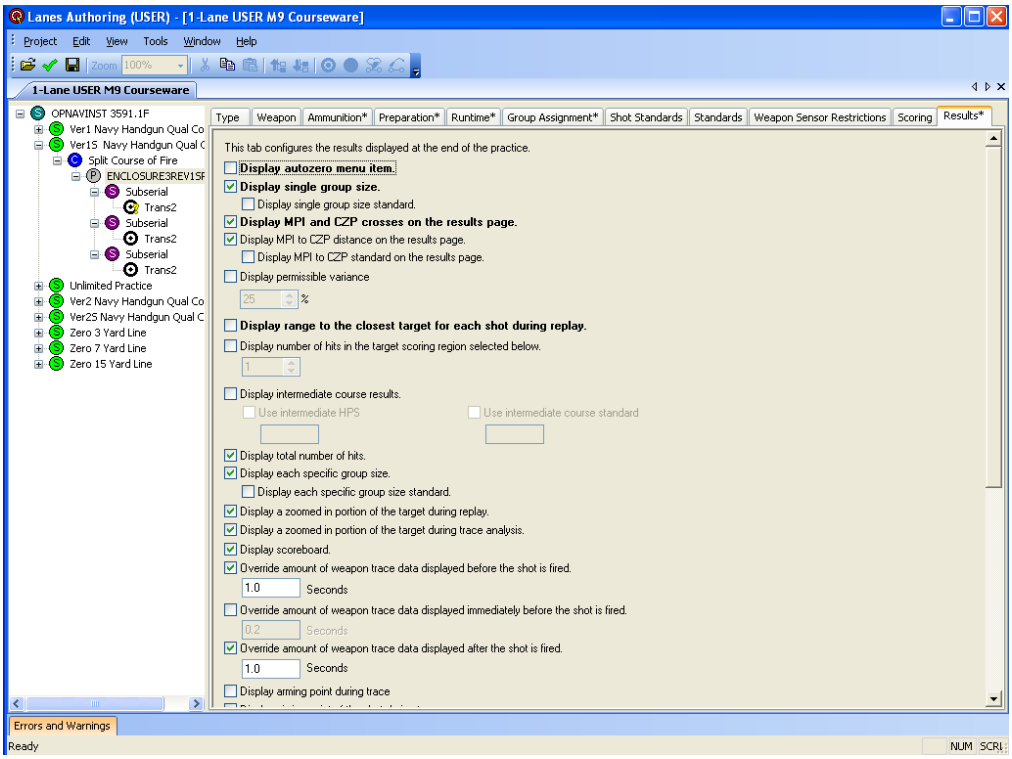
Practice Standards



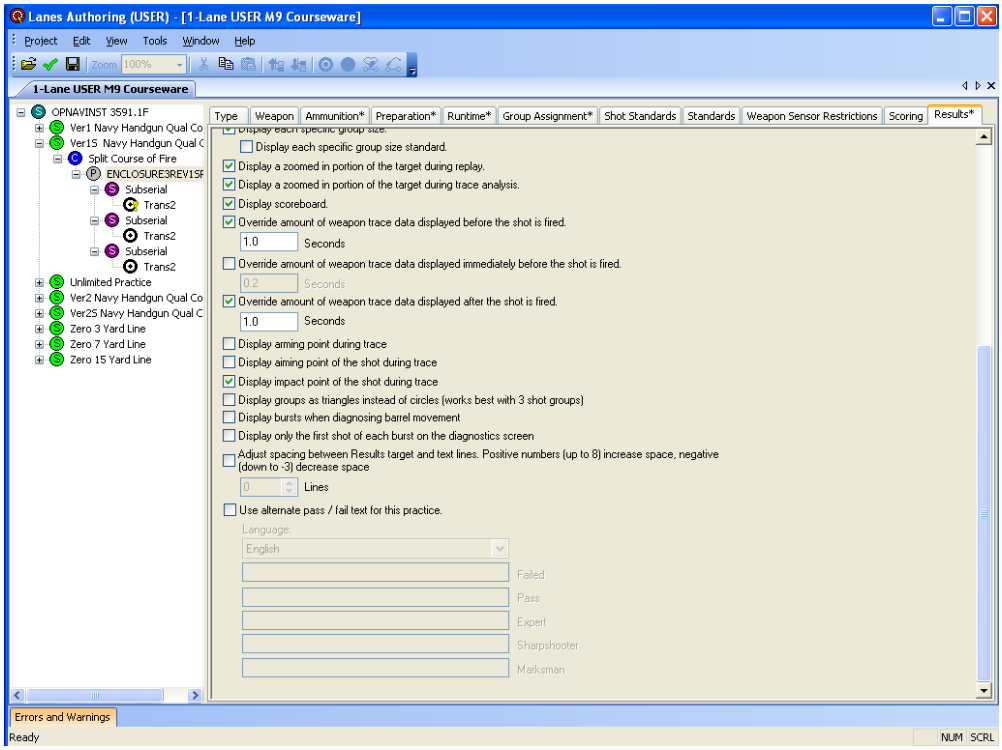
Practice Weapon Sensor Restrictions



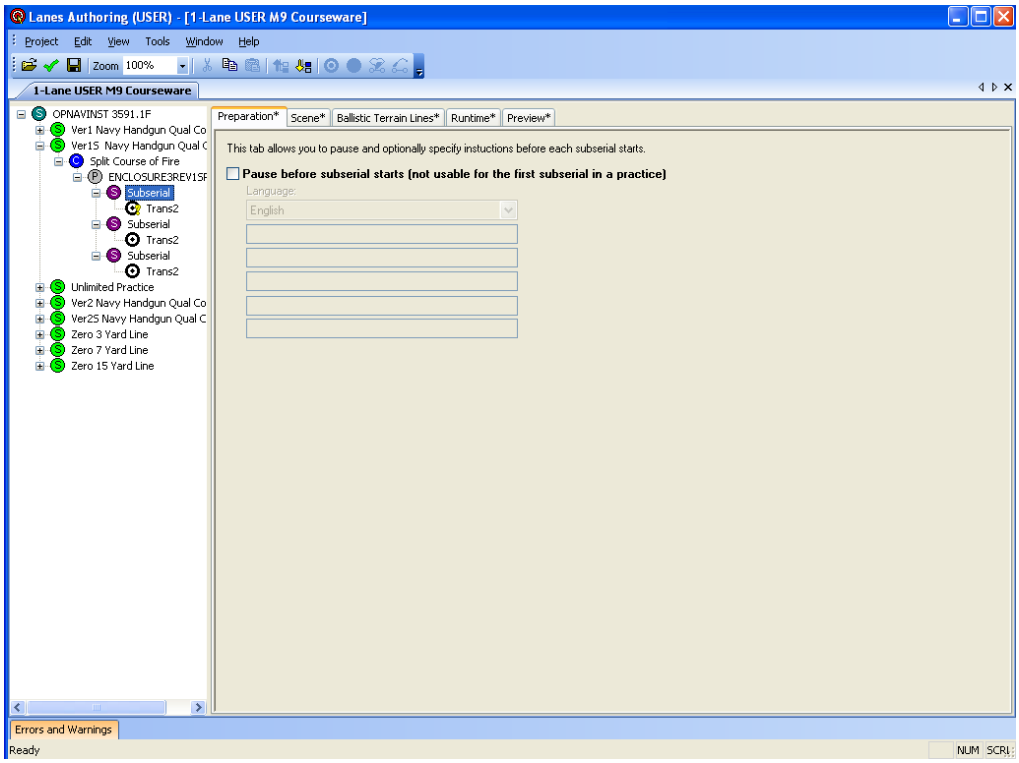
Practice Scoring



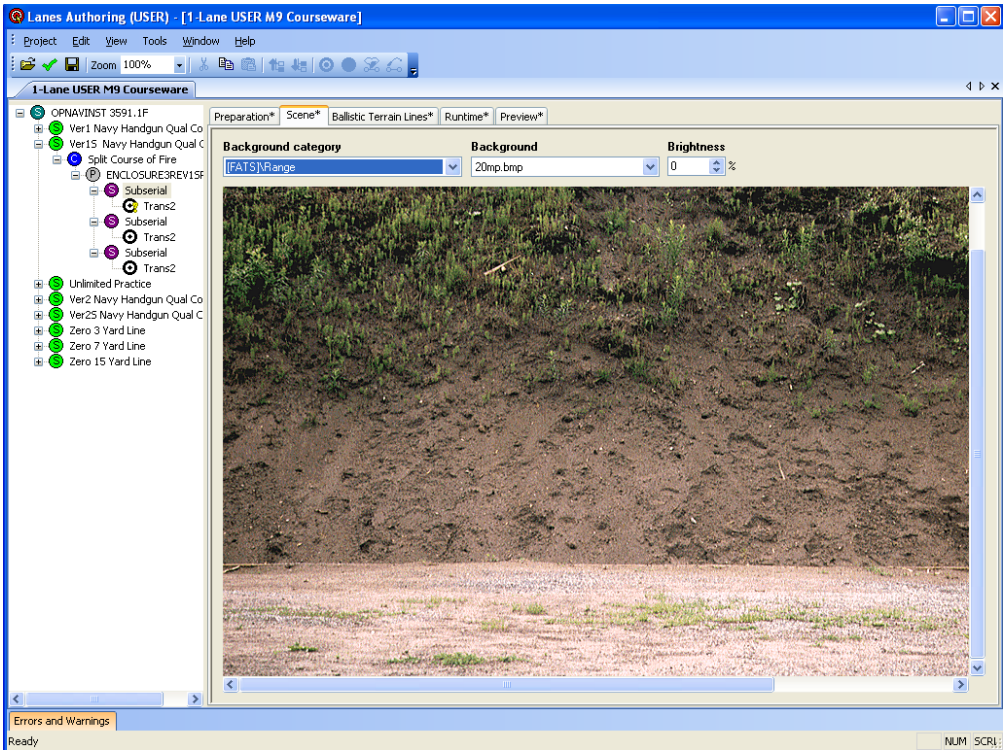
Practice Results Top



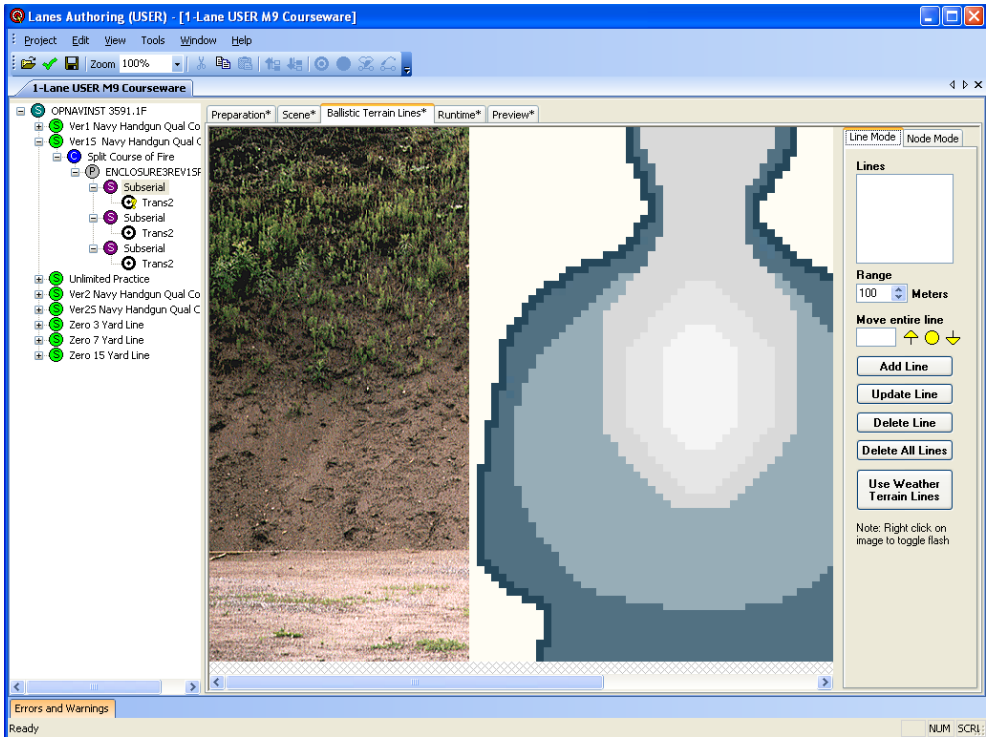
Practice Results Bottom



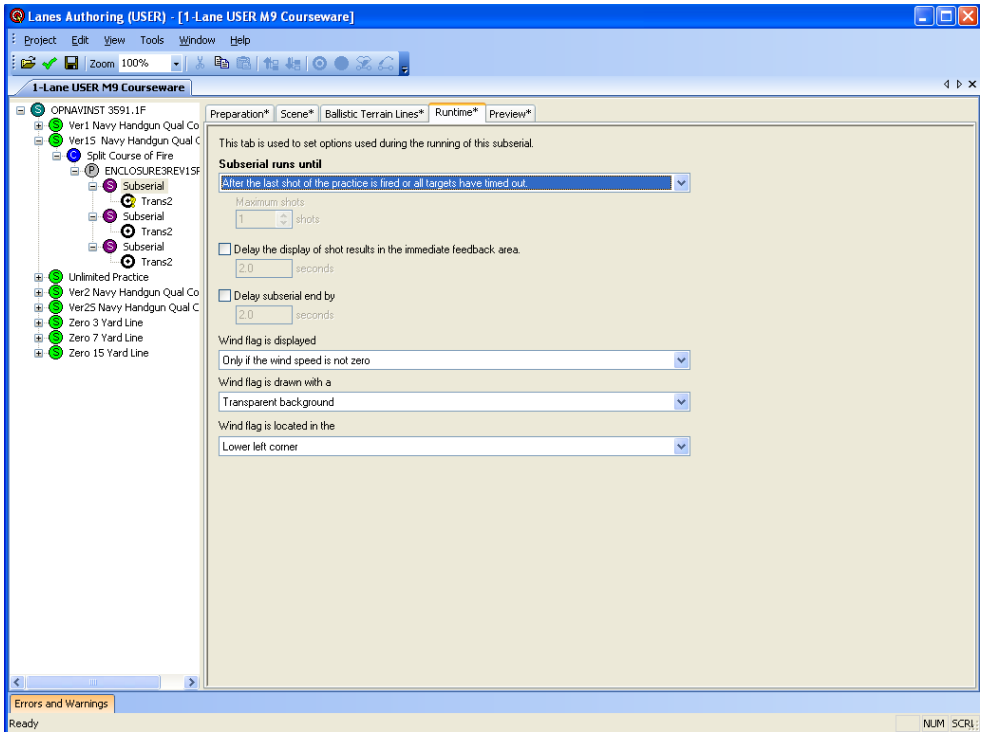
1 Sub Serial Preparation



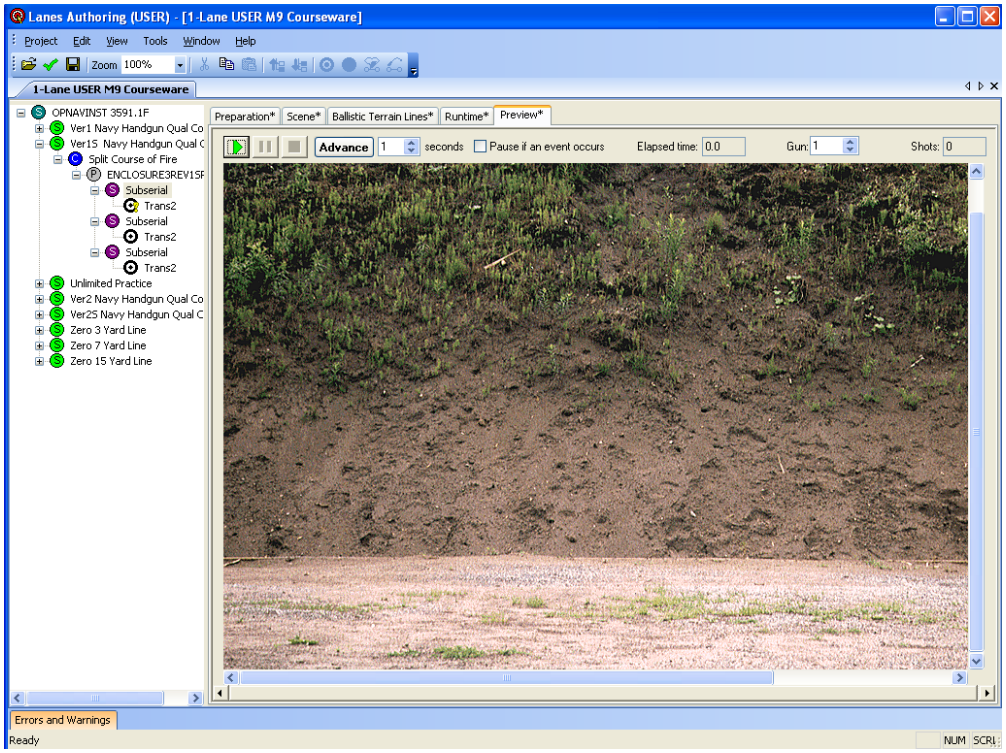
1 Sub Serial Scene



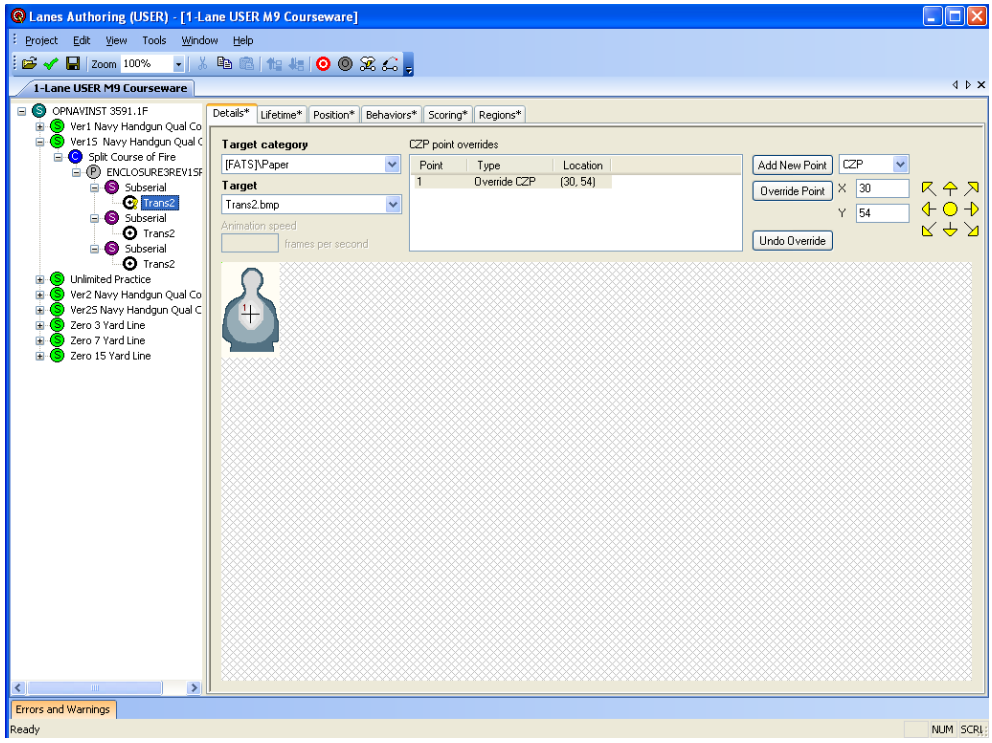
1 Sub Serial Ballistic Terrain Lines



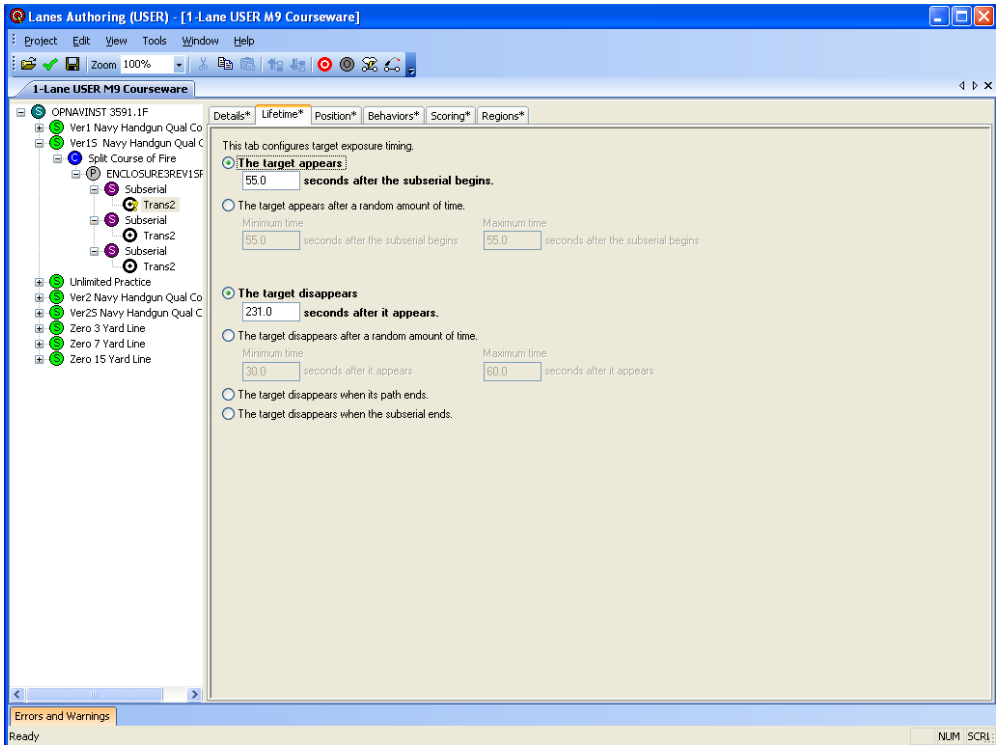
1 Sub Serial Runtime



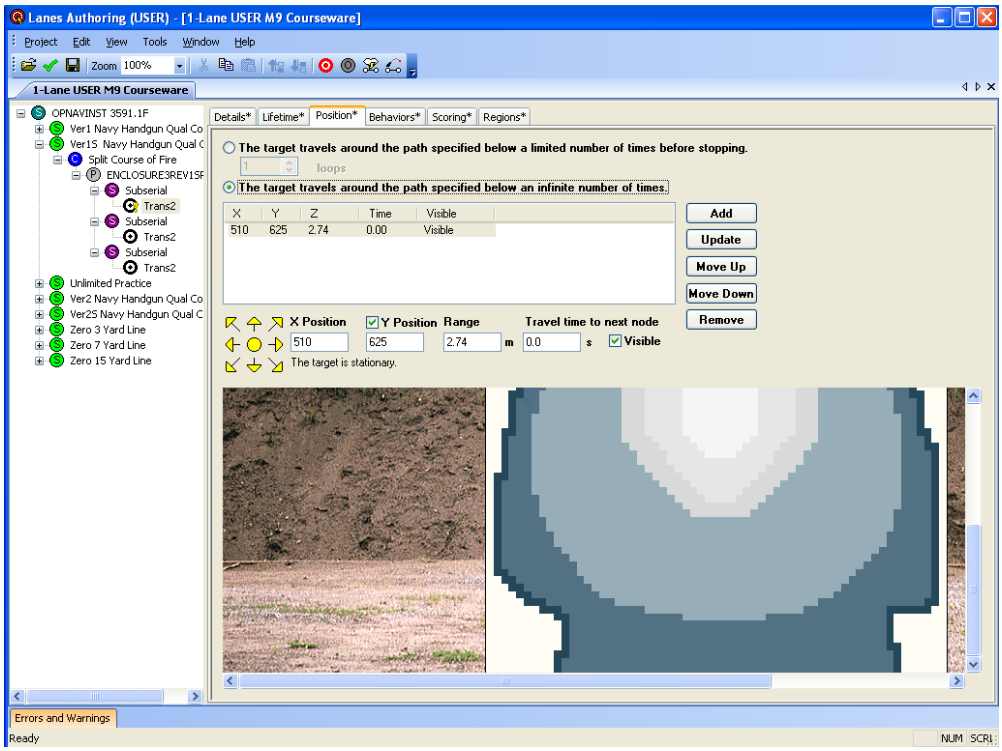
1 Sub Serial Preview



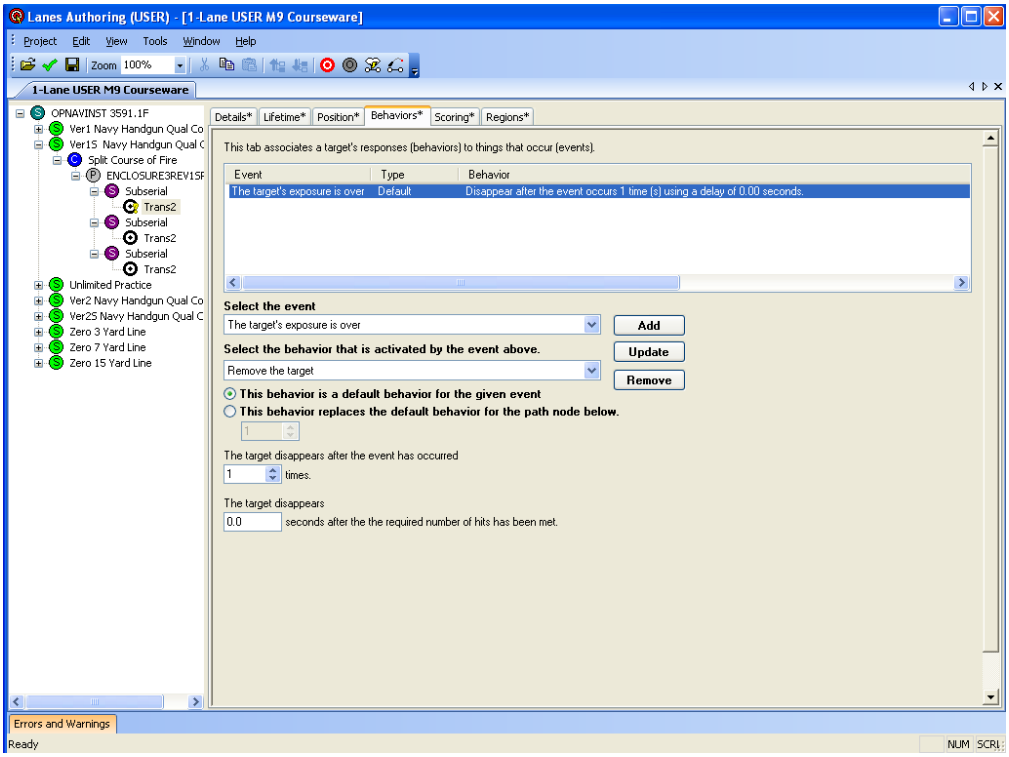
3-Yard Target Details



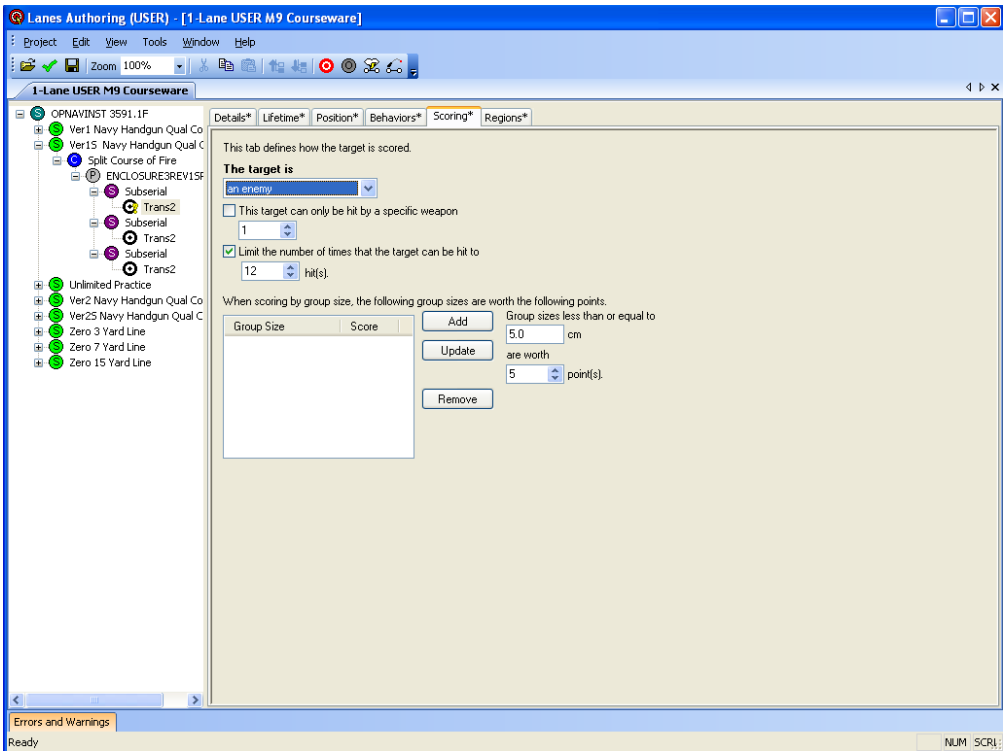
3-Yard Target Lifetime



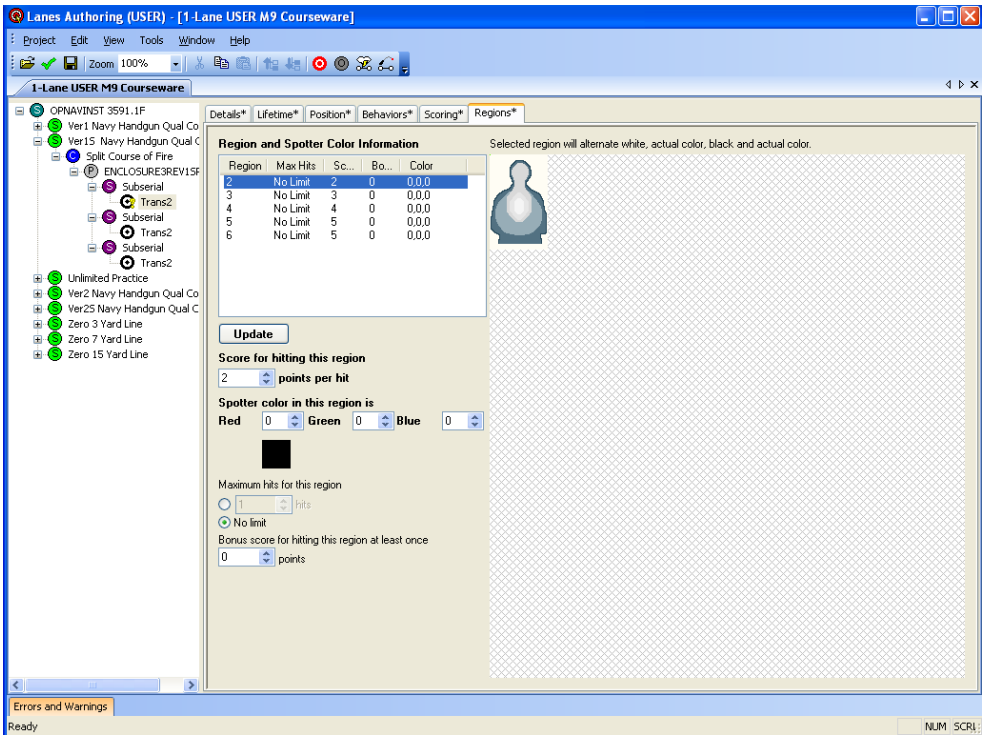
3-Yard Target Position



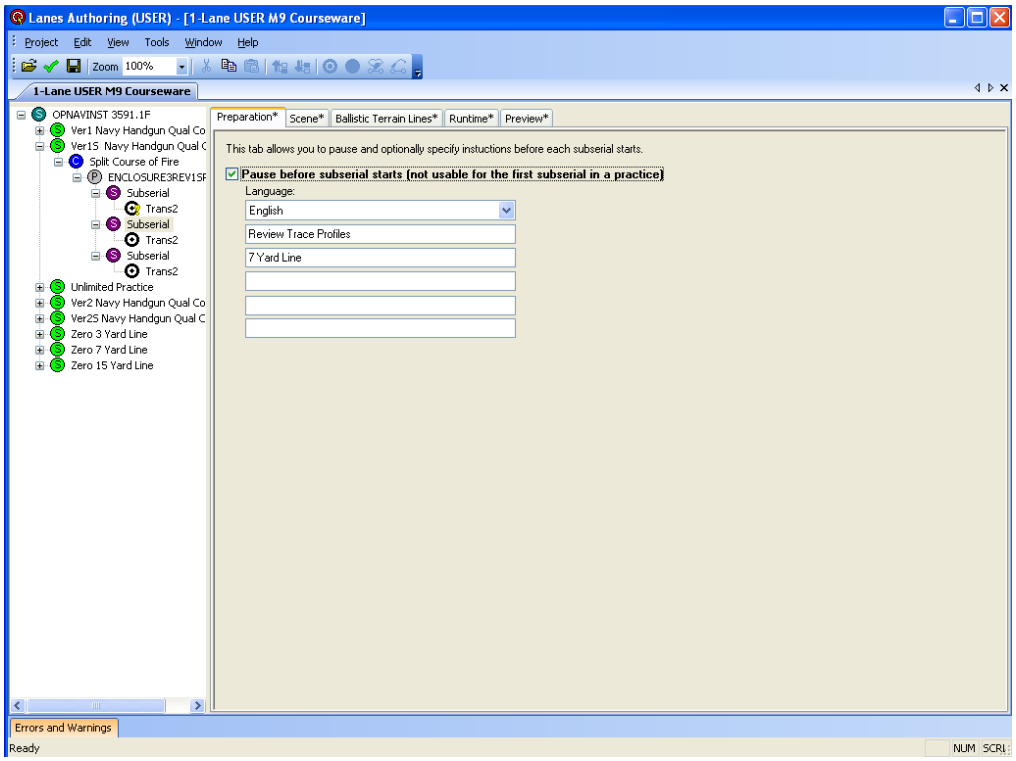
3-Yard Target Behaviors



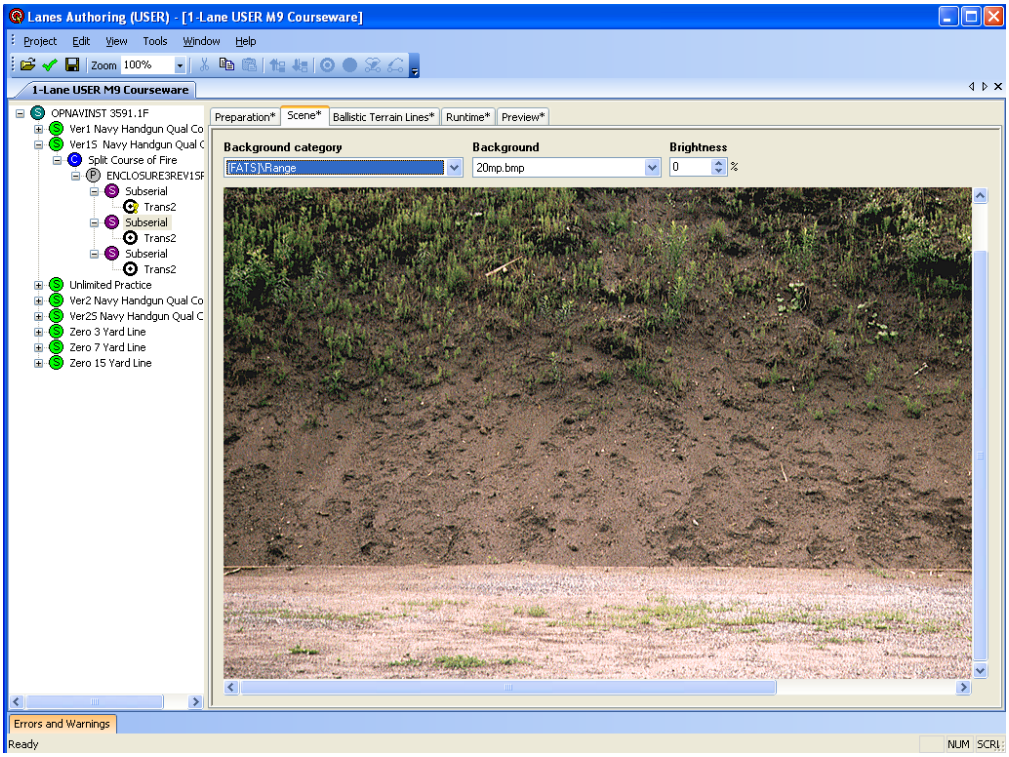
3-Yard Target Scoring



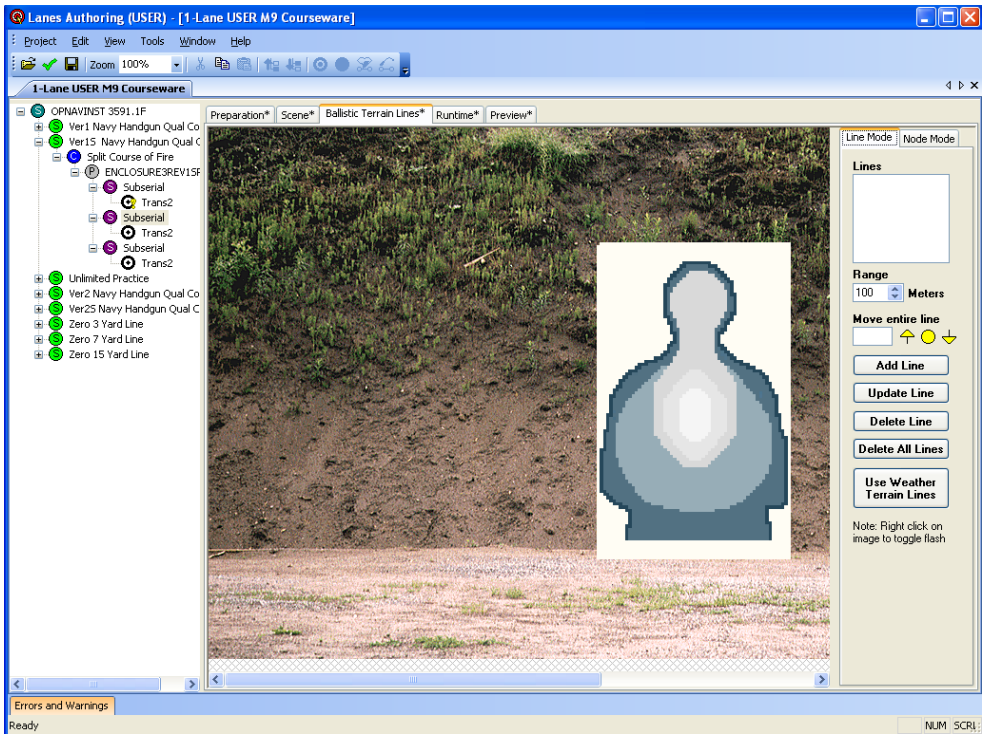
3-Yard Target Regions



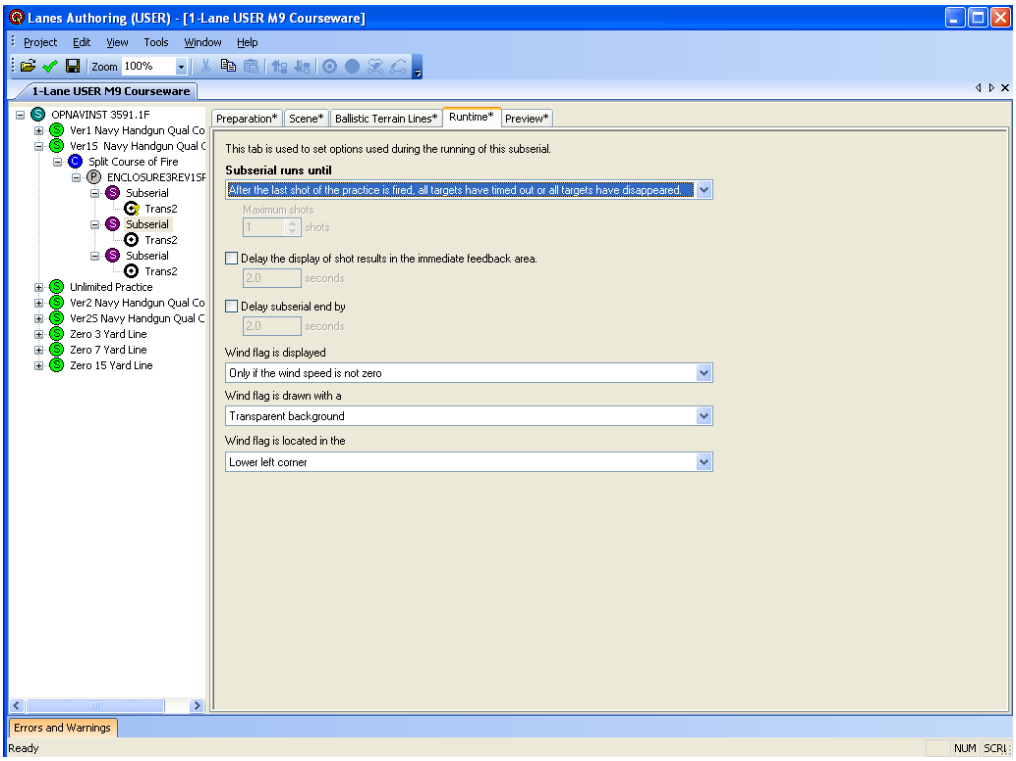
2 Sub Serial Preparation



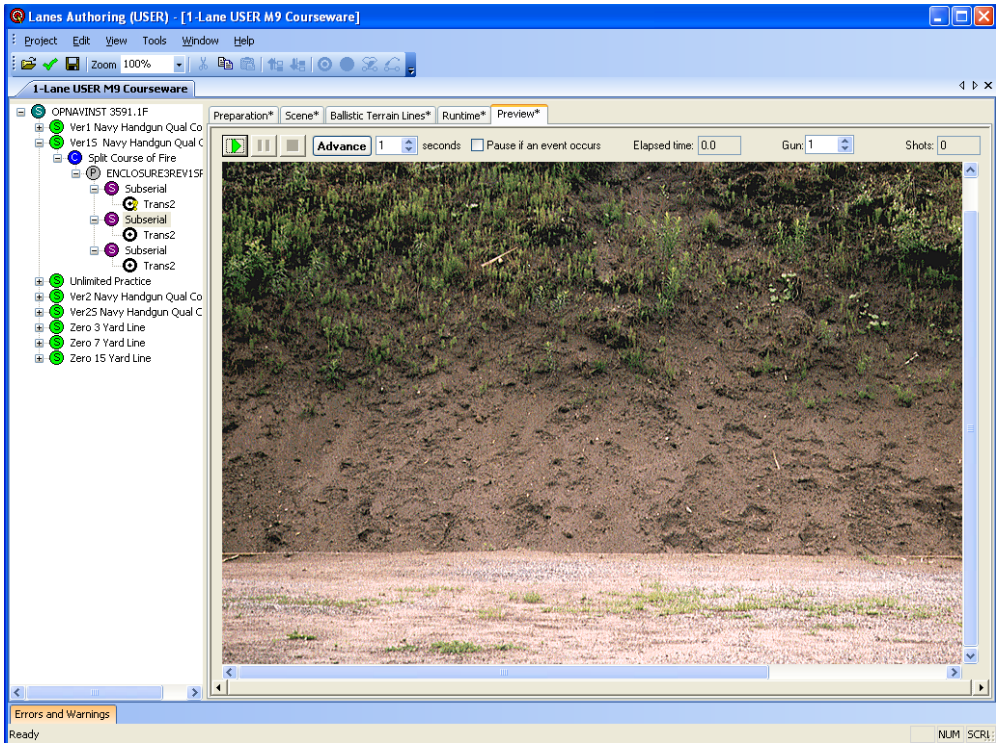
2 Sub Serial Scene



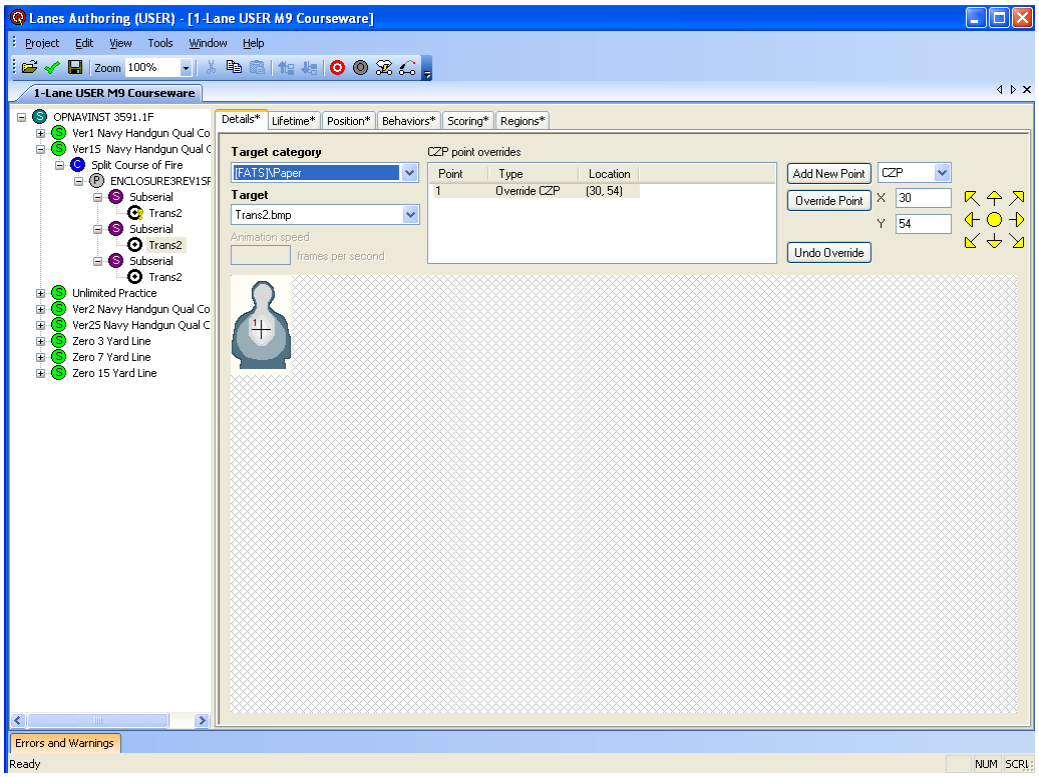
2 Sub Serial Ballistic Terrain Lines



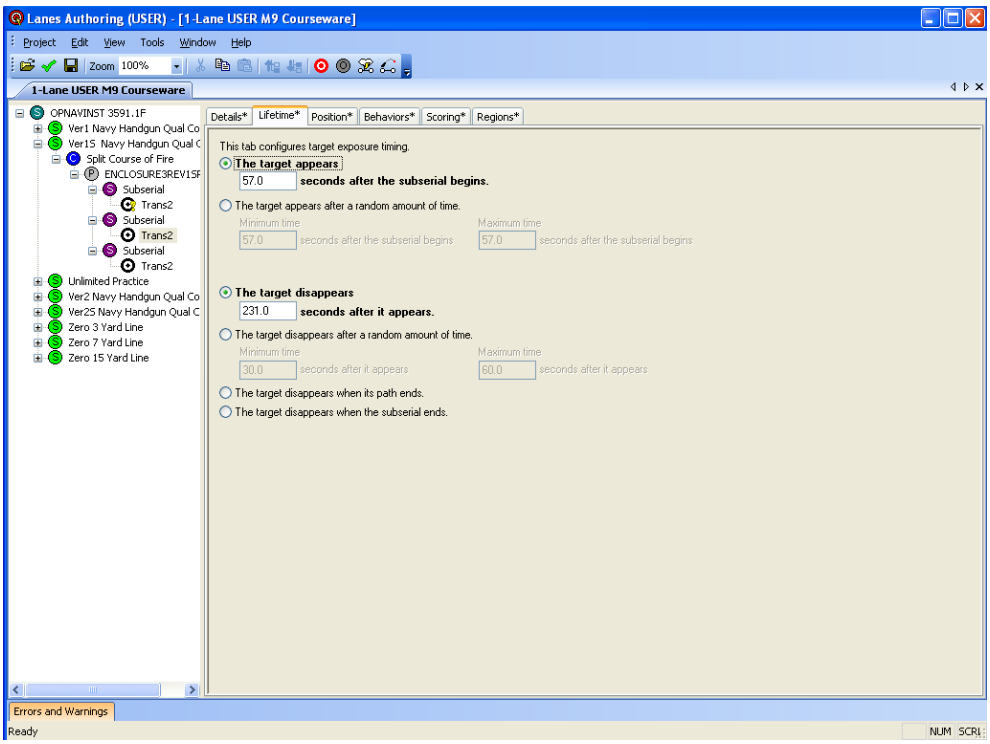
2 Sub Serial Runtime



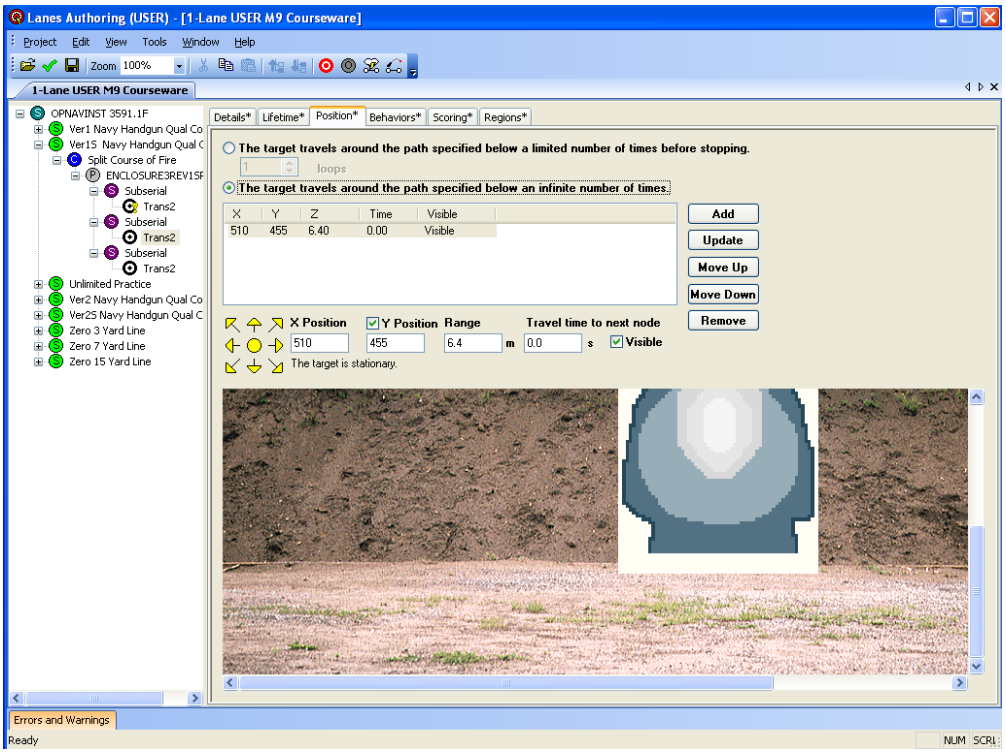
2 Sub Serial Preview



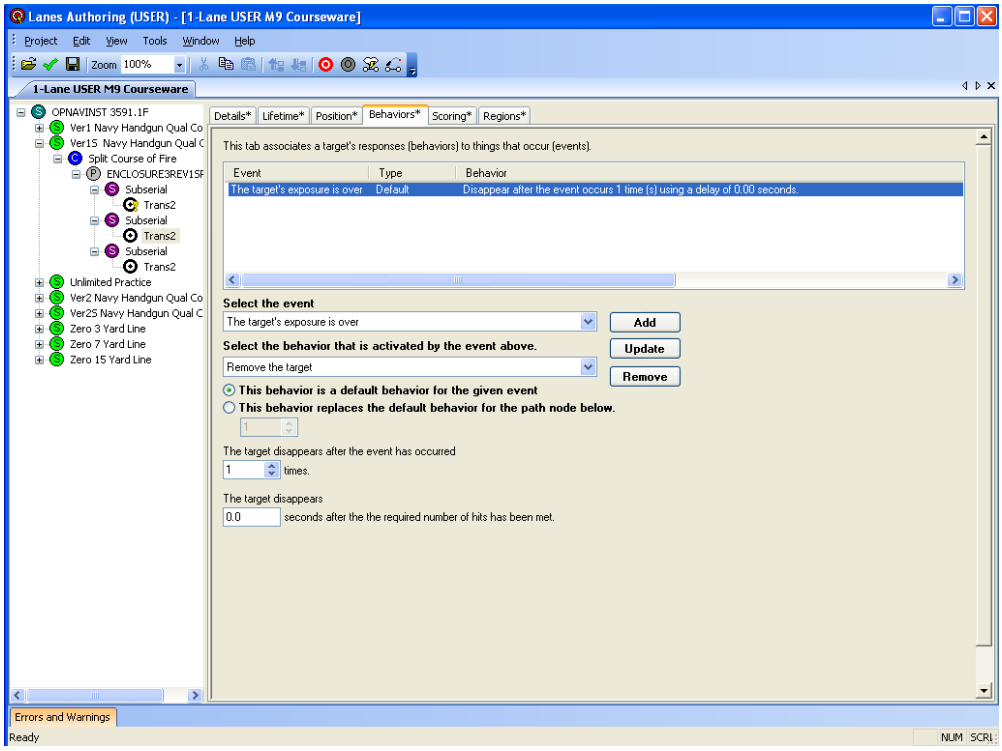
7-Yard Target Details



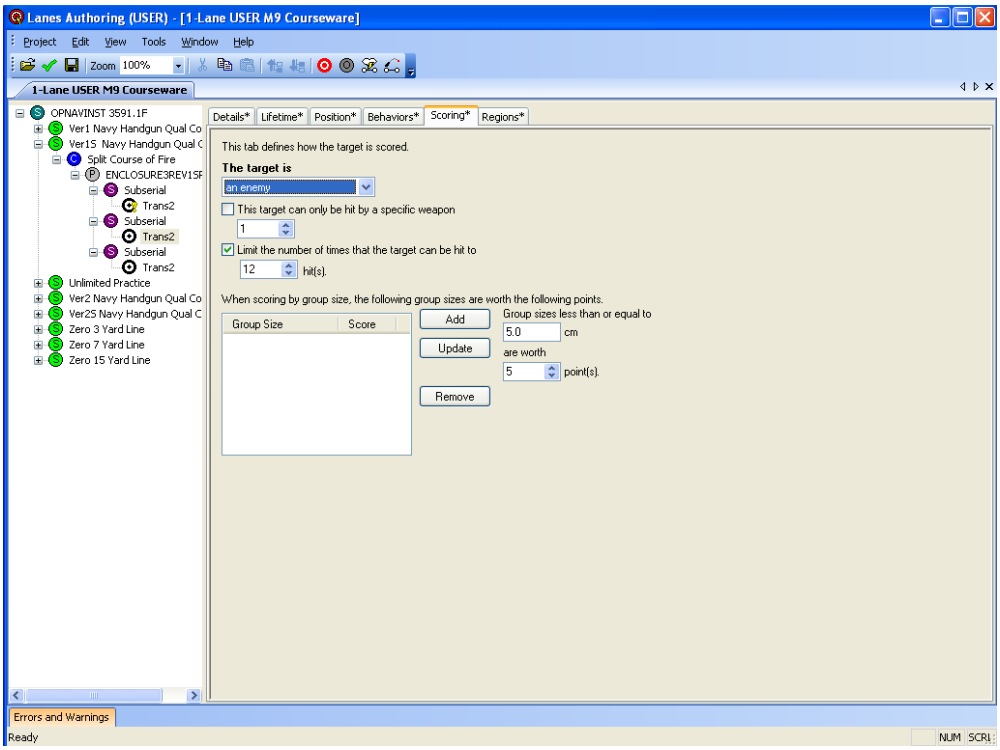
7-Yard Target Lifetime



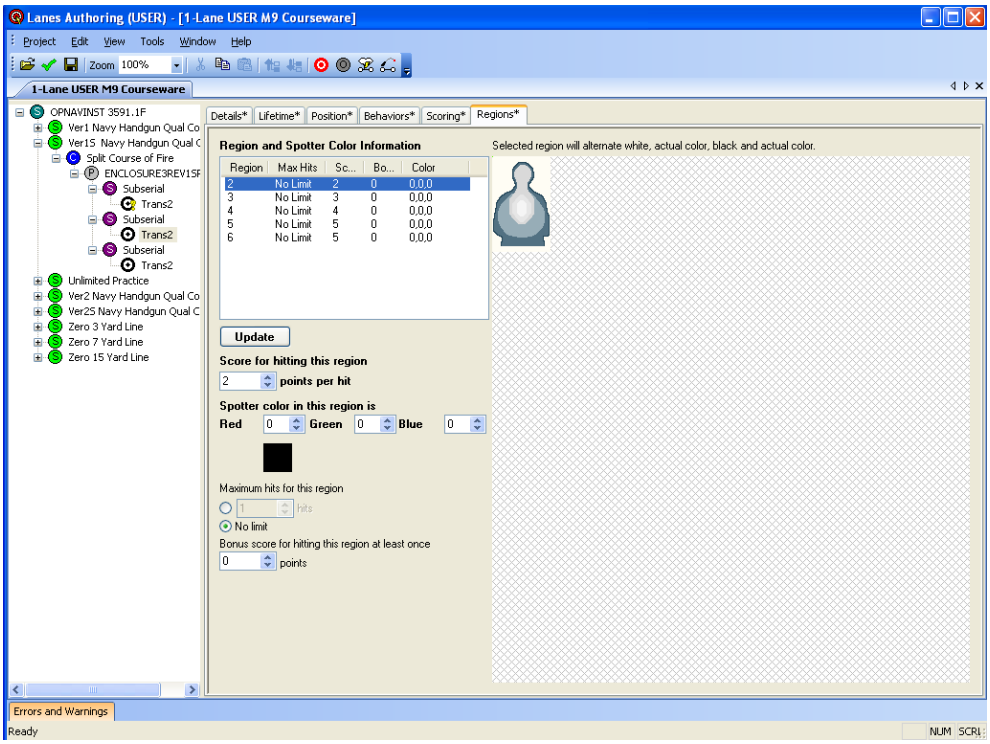
7-Yard Target Position



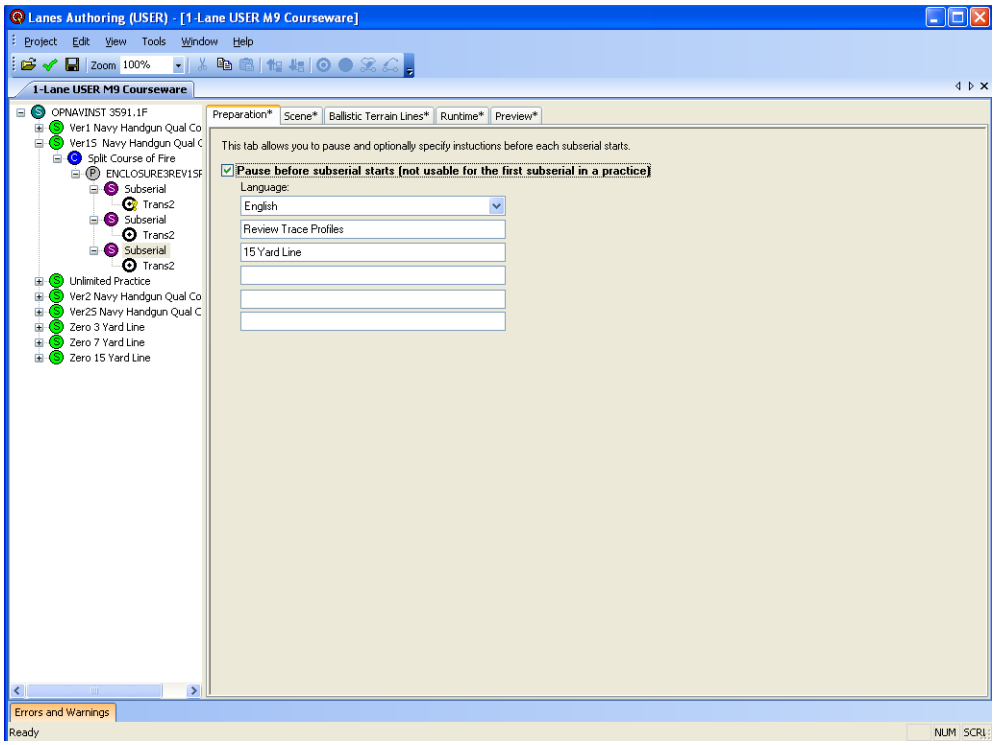
7-Yard Target Behaviors



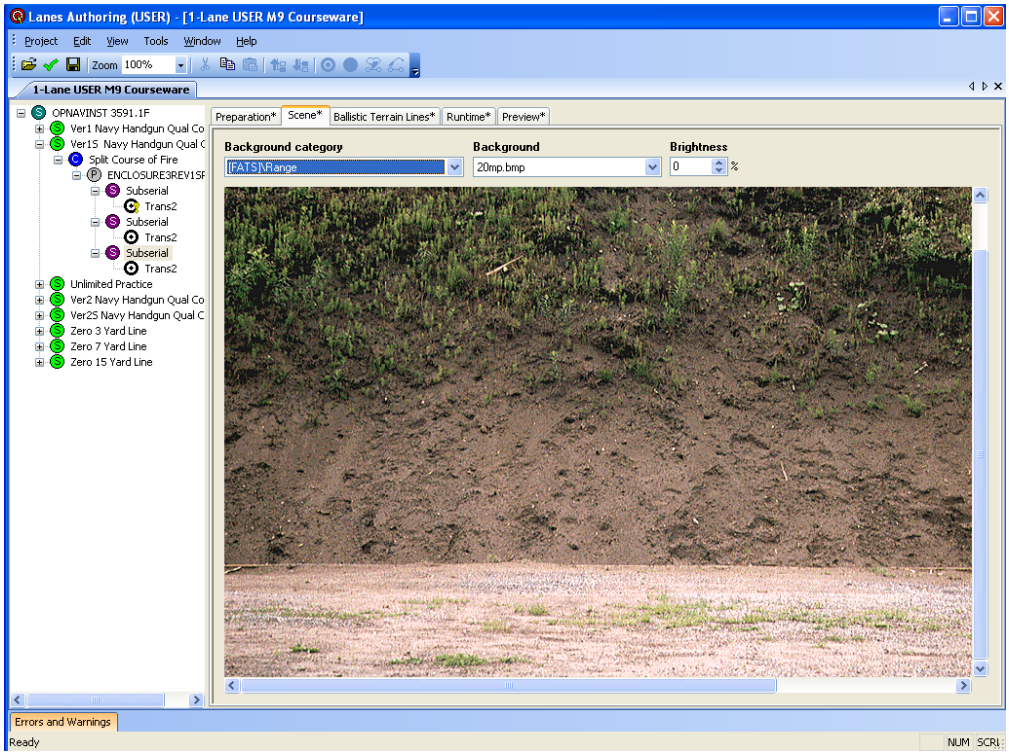
7-Yard Target Scoring



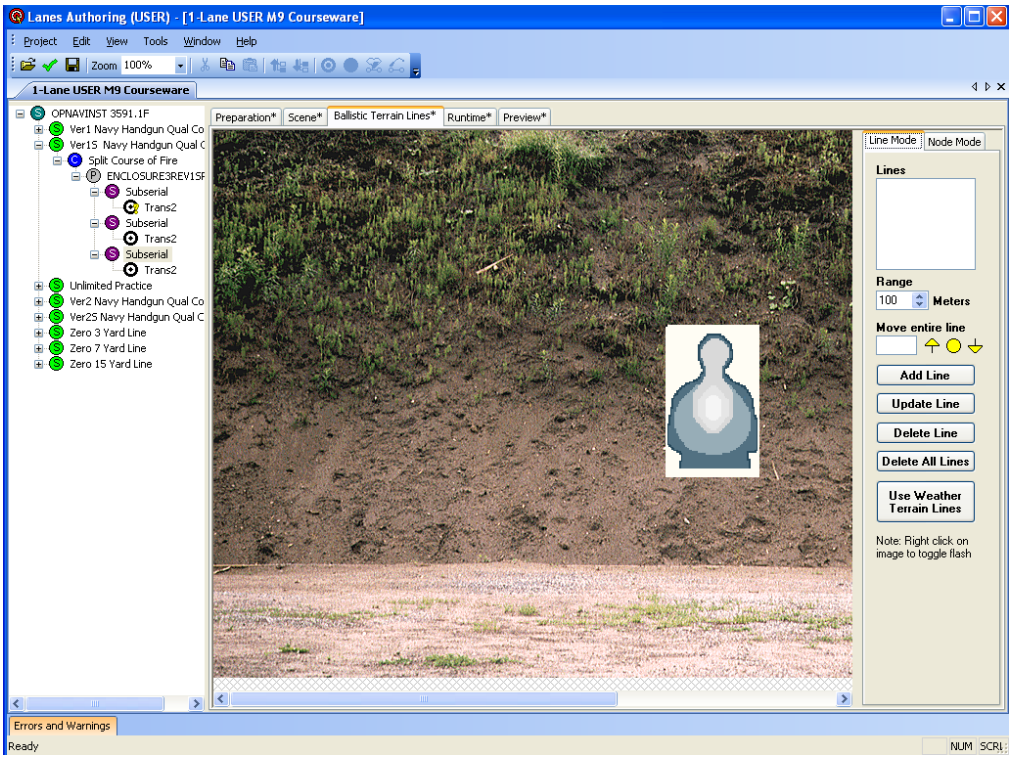
7-Yard Target Regions



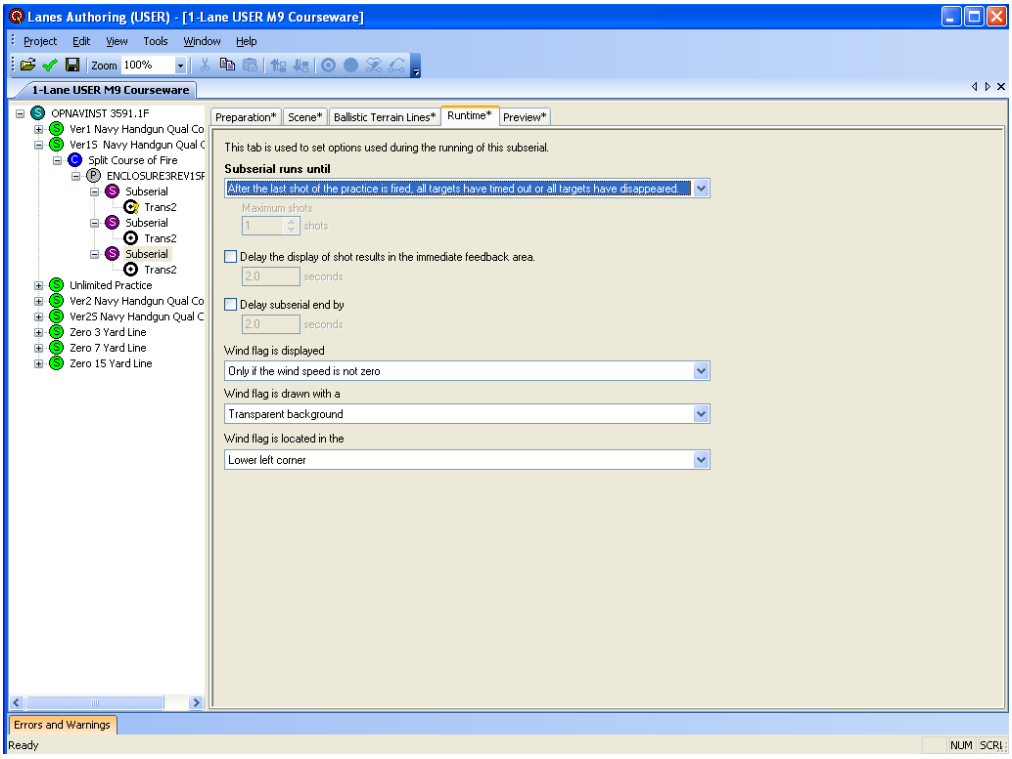
3 Sub Serial Preparation



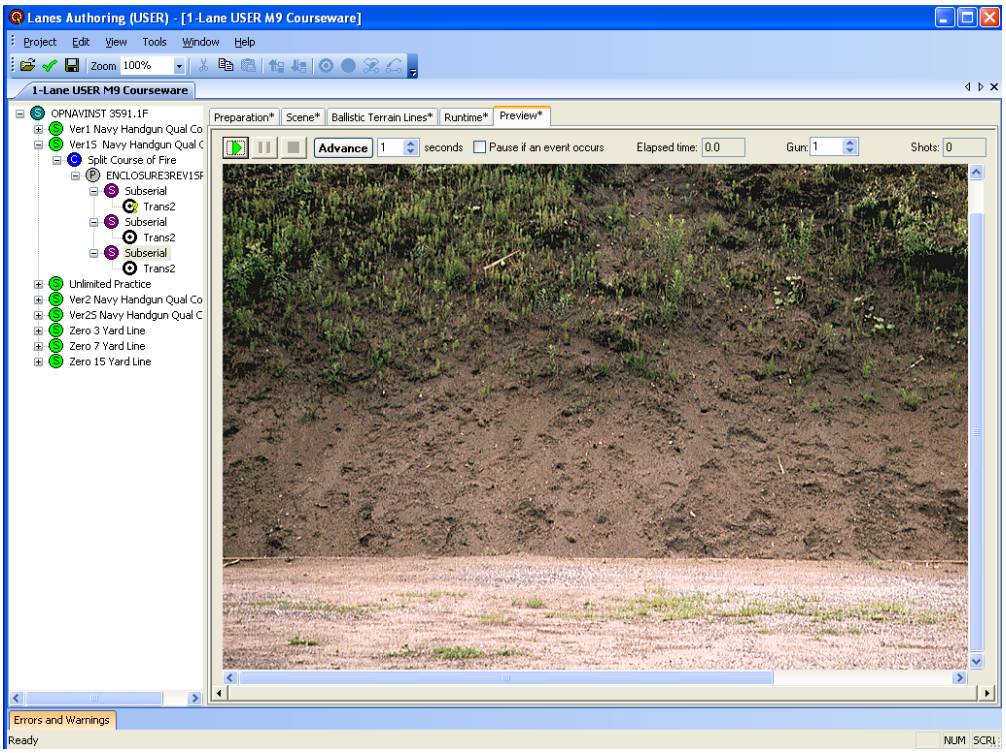
3 Sub Serial Scene



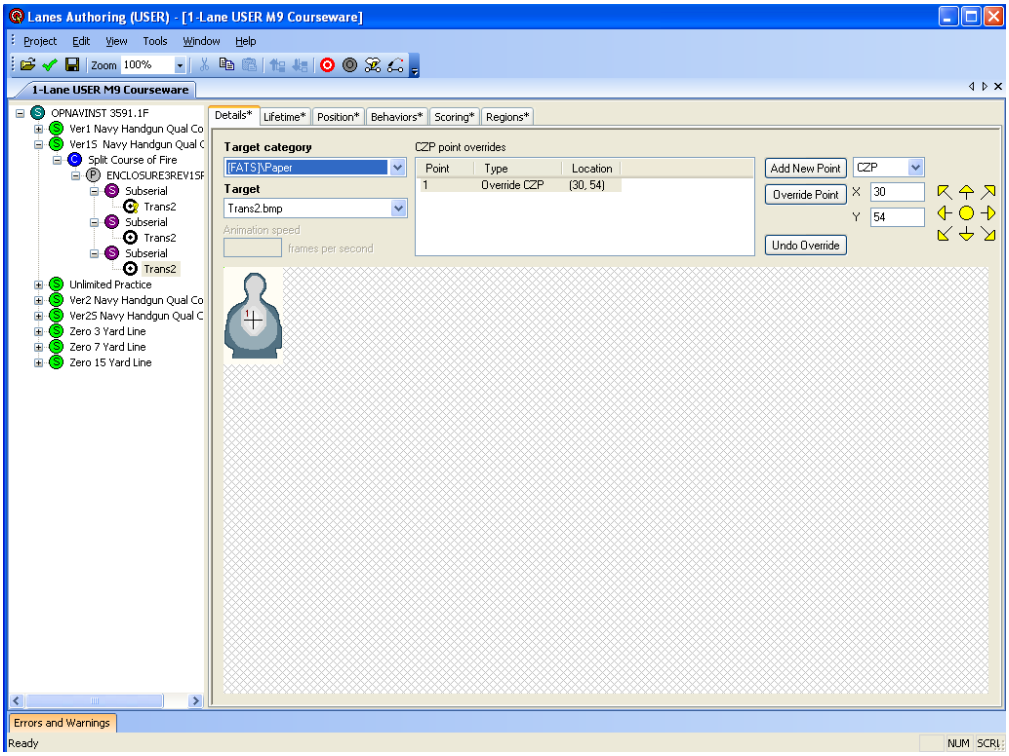
3 Sub Serial Ballistic Terrain Lines



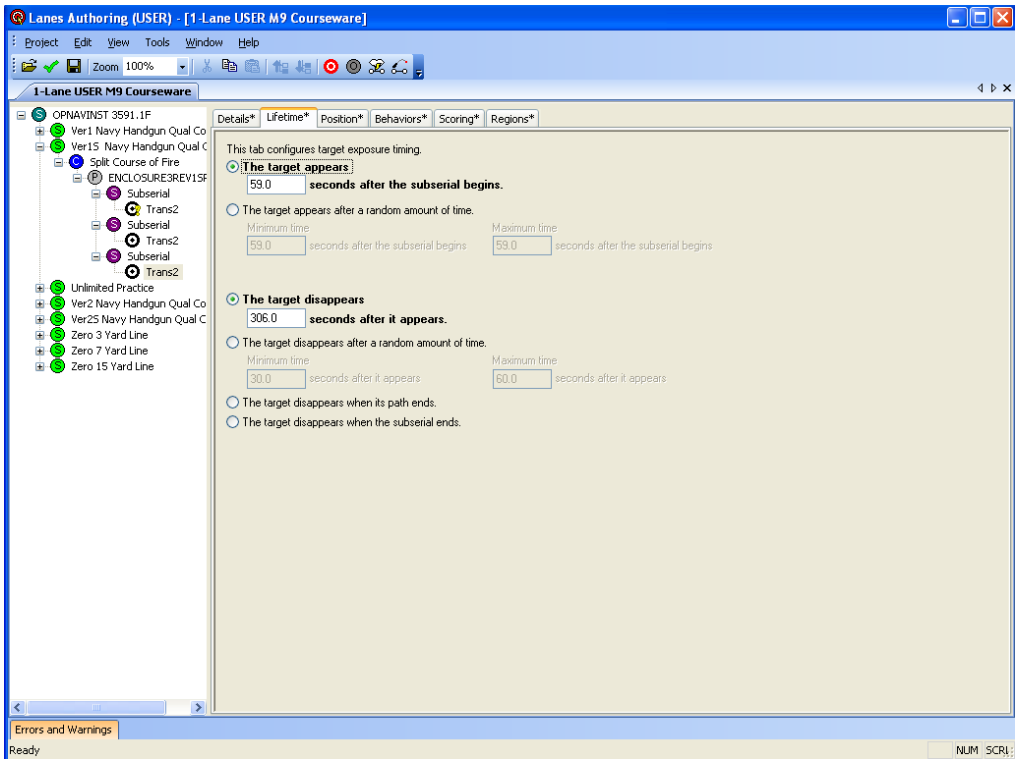
3 Sub Serial Runtime



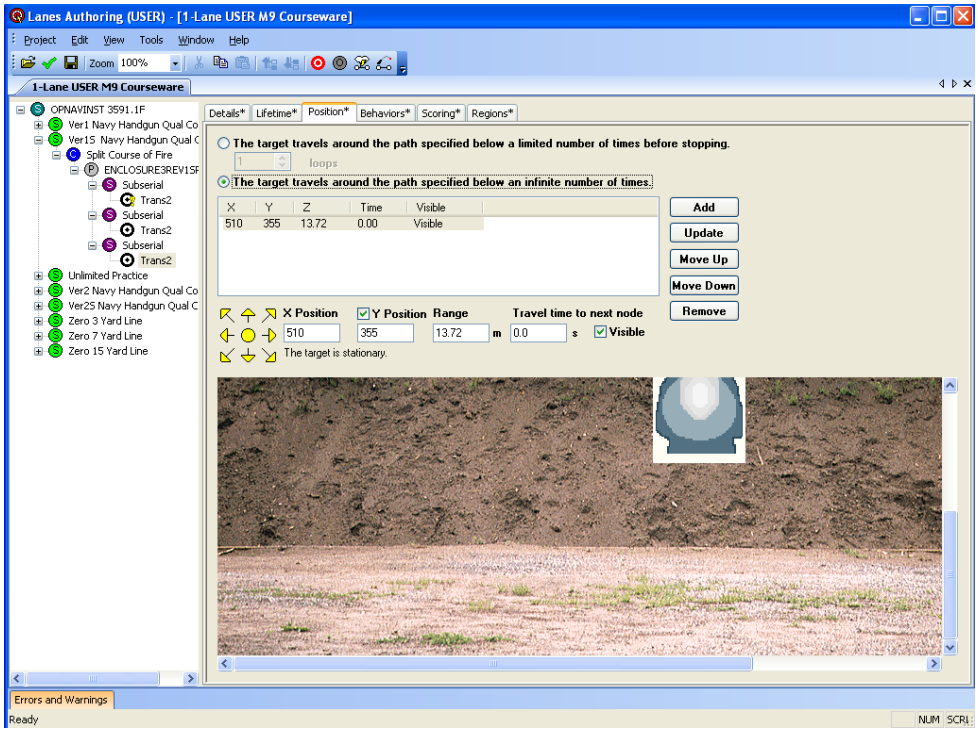
3 Sub Serial Preview



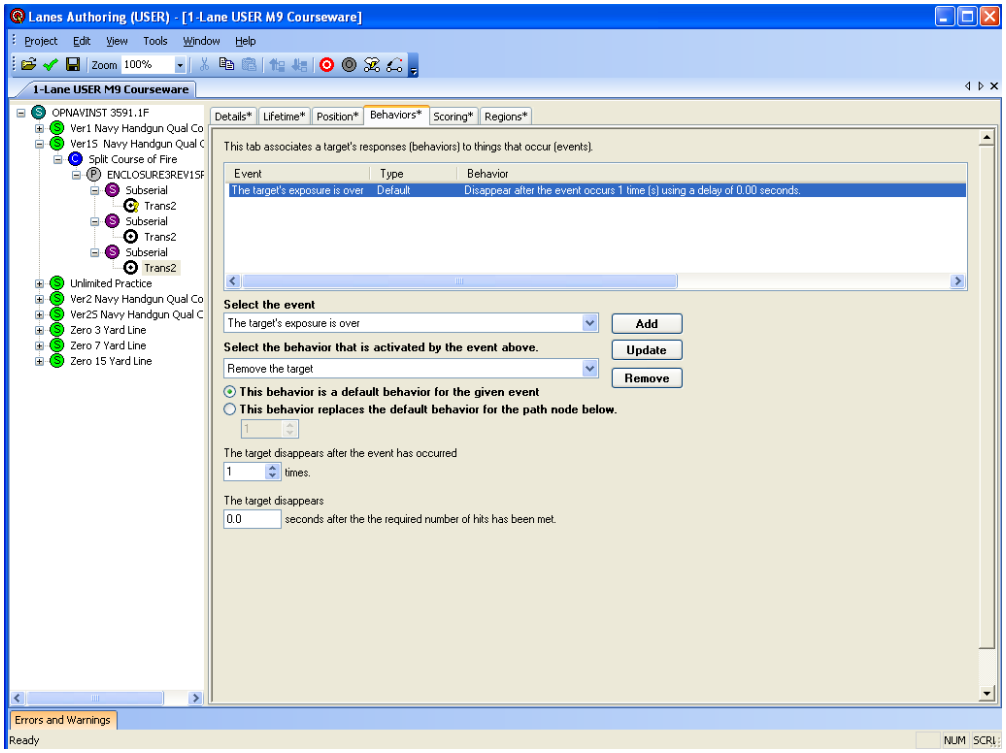
15-Yard Target Details



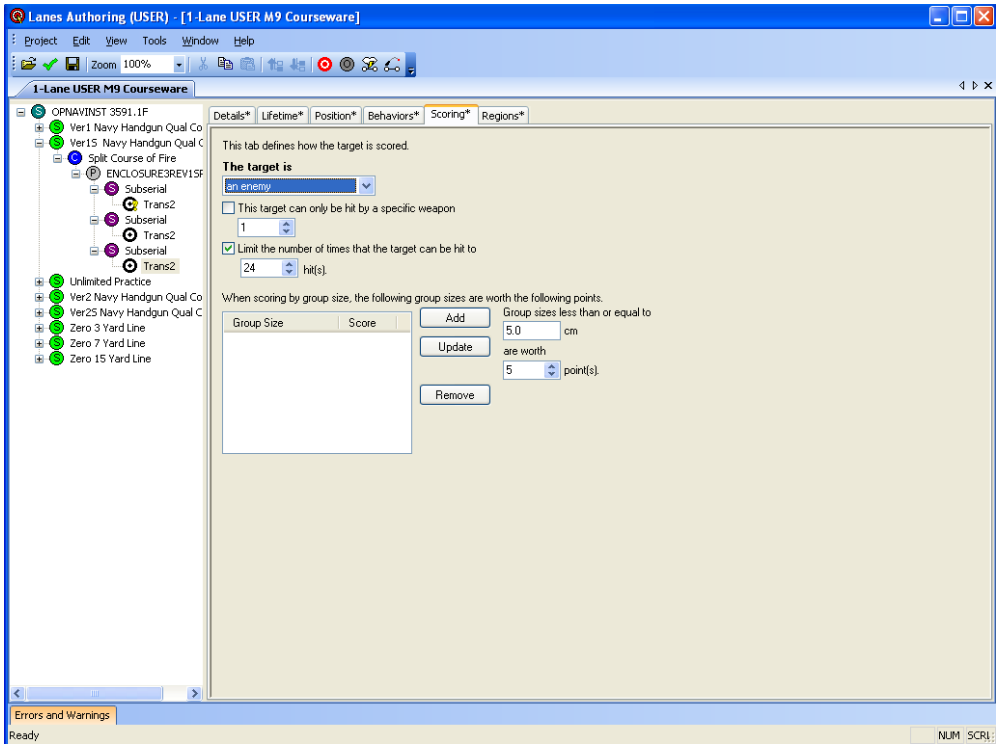
15-Yard Target Lifetime



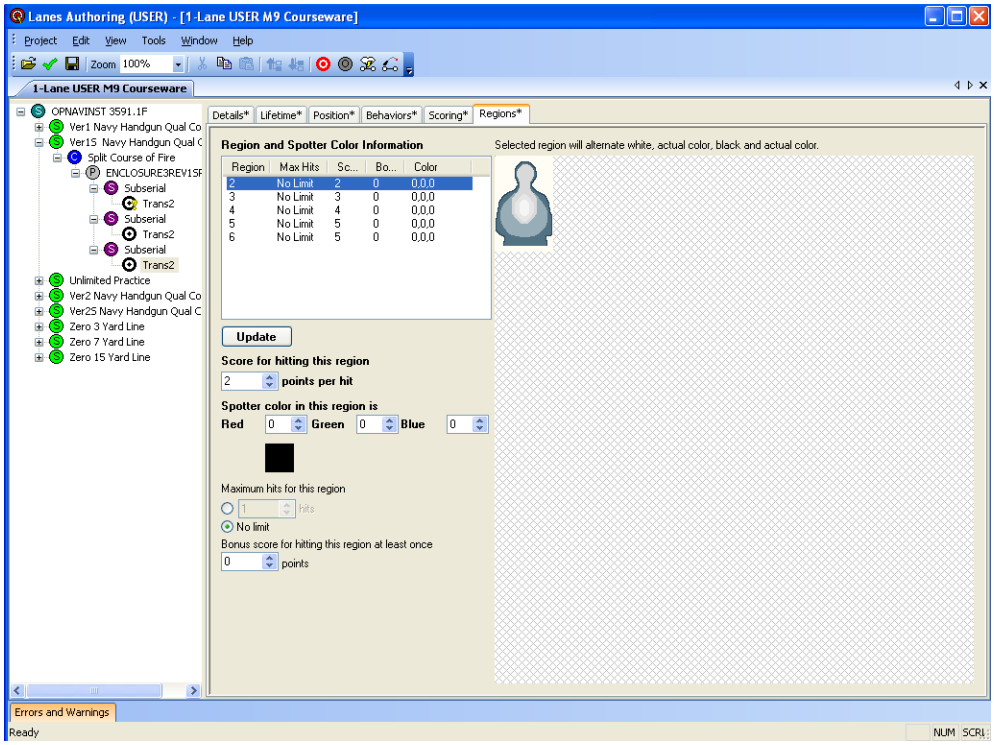
15-Yard Target Position



15-Yard Target Behaviors



15-Yard Target Scoring



15-Yard Target Regions

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APPENDIX G. DEMOGRAPHIC SURVEY

A Comparison of Current Naval Marksmanship Training VS Simulation Based Marksmanship Training with the use of Indoor Simulation Marksmanship Trainer (ISMT)

Purpose: This research is intended to provide naval personnel with the option to using simulation for the purpose of basic training necessary to meet a qualification standard. The purpose for doing this research is to provide a more robust method for conducting marksmanship training in the Navy.

#_____ Note: Please choose a four digit number for data recording purposes. Do not use the last four of your social. This information will keep your identity anonymous

Demographic questions:

Directions: Answer the following questions or circle the answer that applies to you.

1. Are you (circle one age group): 18-25 26-30
   31-35 36-40 41+
2. What is your height?(ex. 5’ 8”) _____
3. What is your weight? (180 lbs)_____
4. Are you a (circle one): Male Female
5. Are you (circle one): Right Handed Left Handed Both/Ambidextrous
6. Do you wear corrective lenses, ex. glasses or contacts (circle one): Yes No
7. Are you color deficient? (circle one): Yes No
8. Are you (circle one): Active duty Reserves Veteran Civilian
   a. If you are Active duty, which branch of service (circle one):
      Navy Marine Corp Air force Army International Student
   b. What is your Rank? (ex. LT)_____
   c. Years of Service? (ex. 6yrs)_____
   d. What is your specialty (ex. SWO, Pilot, etc.)?
   _____
9. Have you ever fired a gun? (circle one): Yes No
   a. If you answered yes, describe what kind:_____
10. How would you rate your level as a marksman right now? (circle one):
    i. Novice
    ii. Marksman
    iii. Sharpshooter
    iv. Expert
11. Have you ever received any formal marksmanship training? (circle one): Yes No
    a. When was your last training? (MMM/YY)_____
12. Have you ever fired a gun on a scored course of fire? (circle one): Yes No
    a. If you answered yes, when was the last time: (MMM/YY)_____
    b. What type of gun was used? (ex. 9M qual, M-16 qual)_____
    c. What was your performance level/score? (ex. Expert, or 240)_____
13. Have you ever used a Marksmanship simulator? (circle one): Yes No

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APPENDIX H. POST SURVEY

A Comparison of Current Naval Marksmanship Training VS Simulation Based Marksmanship Training with the use of Indoor Simulation Marksmanship Trainer (ISMT)

Purpose: This research is intended to provide naval personnel with the option to using simulation for the purpose of basic training necessary to meet a qualification standard. The purpose for doing this research is to provide a more robust method for conducting marksmanship training in the Navy.

#_____ Note: Please choose a four digit number for data recording purposes. Do not use the last four of your social. This information will keep your identity anonymous

Post Critique

Directions: Write a short answer for the following questions. **Please print clearly.**

1. How useful do you think simulators, like the Indoor Simulated Marksmanship Trainer, would be for marksmanship training?

2. Do you think simulated training will ever replace "real" training?

3. Explain your experience with using **ANY** simulations for formal training? (ex. Ship handling, simulator, flight simulator, motorcycle simulator)

4. Any additional comments.

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