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MONTEREY, CALIFORNIA

THESIS

**FIRST RESPONDER WEAPONS OF MASS DESTRUCTION
TRAINING USING MASSIVELY MULTIPLAYER ON-
LINE GAMING**

by

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June 2004

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**FIRST RESPONDER WEAPONS OF MASS DESTRUCTION TRAINING USING
MASSIVELY MULTIPLAYER ON-LINE GAMING**

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ABSTRACT

This thesis proposes the development of a Massively Multiplayer On-Line Game (MMOG) to deliver Weapons of Mass Destruction Training to the Nation's First Responders and civilians. MMOG technology offers a cost effective alternative to existing training methodologies. Existing first responder WMD training often uses traditional in-residence classes. These current training methods are expensive, lack standardization, and do not have provable outcomes. Scaling up existing training to meet the needs of millions of responders would be cost prohibitive. Modern information technologies such as MMOGs offer a safe, efficient, effective and fun alternative mechanism to deliver training. MMOGs could scale to meet the volume of training need at a fraction of the cost of traditional methods. The DoD has proven the effectiveness of simulation games as a training tool, and the use of gaming and simulations is recognized in academia.

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	America's Army
APR	Air Purifying Respirator
B	Billion
BVM	Bag Valve Mask
CD	Compact Disk
CDP	Center for Domestic Preparedness
CPR	Cardio Pulmonary Resuscitation
DHS	Department of Homeland Security
DoD	Department of Defense
DSL	Digital Subscriber Line
EMI	Emergency Management Institute
EMRTC	Energetic Materials Research and Testing Center
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
FAS	Federation of American Scientists
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAO	General Accounting Office
GBT	Game Based Training
GPRA	Government Performance and Results Act
GUI	Graphical User Interface
HAZMAT	Hazardous Materials
HH	High Hazard
IAFF	International Association of Fire Fighters
ICS	Incident Command System
IDSA	Interactive Digital Software Association
IT	Information Technology
M	Million
MH	Medium Hazard
MMOG	Massively Multiplayer On-line Game
MOCAP	Motion Capture
MOVES	Modeling, Virtual Environments and Simulation
NERRTC	National Emergency Response and Rescue Training Center
NIMS	National Incident Management System
NPS	Naval Postgraduate School
ODP	Office of Domestic Preparedness
OPSEC	Operational Security
OSHA	Occupational Safety and Health Administration
OSLDP	Office for State and Local Domestic Preparedness
PA	Public Address
PAPR	Powered Air Purifying Respirator

PC	Personal Computer
PPE	Personal Protective Equipment
QDR	Quadrennial Defense Review
SCBA	Self Contained Breathing Apparatus
SFD	Seattle Fire Department
SME	Subject Matter Expert
TER	Transfer Effectiveness Ratio
TOPOFF	Top Officials
VHH	Very High Hazard
VTRA	Virtual Terrorism Response Academy
WMD	Weapons of Mass Destruction
WMD1R	Weapons of Mass Destruction First Responder (Game)

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I. INTRODUCTION

A. PROBLEM STATEMENT

Current first responder Weapons of Mass Destruction (WMD) training fails to provide widely available, standardized, measurable, and cost-effective instruction to the more than 4.2 million professionals who need it. Because we lack the capacity to effectively deliver large volumes of training, first responders still do not have adequate skills to mitigate the effects of a WMD incident safely. Existing training mechanisms are extremely expensive and lack cost efficiency and scalability. Clearly, we cannot possibly attend to the demand for training using conventional methods; current courses cannot be expanded sufficiently to meet the volume of need.

Therefore, an alternative approach is required. This thesis claims that Massively Multiplayer On-Line Games¹ (or MMOGs) offer the best solution for delivery of first responder WMD training. This thesis shows that the cost of delivering five years of training using MMOG technology to the majority of the 4.2 million first responders would cost of less than \$70 as compared to a cost of over \$3,000 to expand current programs to meet this need. MMOG technology can also deliver standardized training with measurable results.

B. PROPOSED SOLUTION AND MOTIVATION

What alternatives are there to traditional training methods? Gaming and simulation technologies have now evolved to the point where they offer a better alternative to deliver standardized WMD training to first responders. While gaming technologies are not appropriate to train all WMD response² skills, they can replace much of the existing training and save billions of dollars. This training can be implemented for the expanded community of need that includes not only traditional first responders like fire fighters, emergency medical service (EMS) workers and police, but also public

¹ The terms “games” and “gaming” will typically be used in this thesis to refer to fictional WMD training simulations with rules of play that are based on physical realities. Such “gaming” is intended to encourage participation by creating a fun and instructive environment that immerses the player in the simulated world and allows them to practice response skills without typical “notional” elements that limit believability and hence the quality of the learning experience.

² The term “response” in this thesis will be used to describe the emergency actions taken by first responders to mitigate the effects of a WMD incident. The term should not be confused with military forms of “response”.

works, public health, emergency management, skilled trades, *and* civilians. This thesis proposes the development of a Massively Multiplayer On-line Game for first responder and civilian WMD training.

The proposed solution: produce a networked, multi-user, interactive training “game” for the Office of Domestic Preparedness (ODP) as a substitute and enhancement to existing WMD awareness training. Instruction currently done in a classroom setting would be replaced by an outcome-based educational simulation game. The measurable end result would be trained first responders who can demonstrate their knowledge and skill. This game can be made available to the full spectrum of first responders and civilians, resulting in an overall enhancement to national terrorism preparedness.

The cost model for this approach differs greatly from the traditional model. Costs include system development, delivery, maintenance, and updates. A significant portion of these costs are non-recurring engineering expenses, enabling this training to scale for inclusion of the entire target population. While efforts similar to this have been proposed and funded in the past, the “game” elements were missing. Merely repackaging WMD information in an interactive on-line program is insufficient; it is inappropriate to assume it effectively teaches the learner. This thesis proposes a training game - created by professional game developers and validated as a trainer for ODP learning objectives and outcomes. The Army has demonstrated through “America’s Army” (www.americasarmy.com) that games can be effective for uses other than pure entertainment. A simulation game can ingrain core WMD awareness skills and serve as a catalyst to develop policies and response playbooks.

The estimated cost of developing the first level of a WMD training game would be \$4.1M or 3.3 percent of the annual ODP Training Consortium’s budget.³ The first game level would prove the concept, and further levels could be developed at lower cost

³ The FY03 budget was \$125M.

_____, “Conference Report [Fiscal Year 2003 Appropriations]” 108th Congress 1st Session, House of Representatives, Report 108-10. U. S. Government Printing Office. Washington, DC. 2003. Database available on line at http://www.cfo.doe.gov/budget/billrept/fy03/omni_enrolled_report_hrpt_108-10.pdf [Accessed 10 March 2004]. p. 637.

(due to non-recurring costs of such items as motion capture system and equipment) to complete the project. The game has the potential to educate millions of users at a fraction of the cost of traditional methods.

What motivates the move to MMOG based training systems? Existing training and response mechanisms do not adequately capitalize on the possibilities of modern information technologies. MMOG training can scale to meet the needs of the entire first responder community at significantly less cost than through the expansion of the existing training systems. MMOGs can serve as a catalyst to move away from older hierarchical organization forms and toward newer networked types of control systems. Also, first responders need to develop IT incident management and decision support systems; MMOGs can serve as a platform for development and testing of such systems. MMOGs have the ability to meet the requirements of the Government Performance and Results Act (GPRA) by offering a platform with the capability to provide standardized training and to measure performance outputs and outcomes. MMOGs would enhance first responder safety by providing both training on proper response procedures, and a safe environment in which to practice these procedures. MMOGs used for WMD education are a natural parallel to other government programs such as the Department of Defense (DoD) simulations and games used for years to practice and refine military strategy and tactics. Experts both within and outside of the government have acknowledged the value of using IT and gaming technology to enhance instruction and student learning.

C. THESIS ORGANIZATION

This thesis examines national training methodologies for response to WMD terrorism incidents. It does not discuss the general need for WMD training, which has been addressed in numerous publications, but exams how training should be delivered. This thesis examines the costs, outputs, and outcomes associated with existing training, and suggests an alternative delivery mechanism – gaming – that promises to reach far more people, with greater effectiveness, for significantly reduced costs.

The first chapter describes WMD training issues and its major subsections cover: 1) who constitutes the first responder community, 2) scope of existing and required first responder WMD training, 3) the effectiveness of training, and 4) the cost efficiency of existing training. First responders represent a large community of need and existing

training mechanisms have failed to deliver sufficient volumes and depth of training to meet this need. Costs of existing training are very high and expansion of current programs to meet the actual need would be cost prohibitive.

The second chapter describes why gaming technologies are an appropriate alternative approach to WMD training. Its major subsections describe: 1) the general approach of using games to train, and 2) innovative motivations for using gaming solutions. Traditional teaching and response mechanisms are too reliant on face to face communications, use hierarchical organizational models and do not capitalize on modern information technologies (IT). Distributed networks should be developed to adequately prepare the nation to counter and respond to the terrorist threat. Use of games for training has been widely accepted in both governmental and scientific communities. Game based training serves not only to enhance the overall readiness of first responders to react to a WMD attack, but also to enhance the development of response policies as well as citizen's abilities to take appropriate action in the event of such an incident.

The third chapter performs an analysis of gaming applications as a solution to current WMD training dilemmas. Its major subsections 1) describe the proposed scope of game based training, 2) validate the effectiveness of the training, and 3) analyze and compare the costs of this solution. Gaming is a reasonable match for both awareness level training and the development of strategic and tactical skills. While some skills must still be taught and practiced hands-on (such as donning personal protective equipment), gaming offers a viable alternative to most existing training and exercises because it provides a realistic world in which to practice decision making. Billions of dollars can be saved by implementing gaming solutions.

The last chapter summarizes the results of this thesis and suggests major questions and possibilities for future research. While the main intent of this thesis is to improve the efficiency and effectiveness of first responder training through the use of gaming technologies, it should be noted that there is also the potential to apply these training tools to address the needs of civilians. The thesis of this work is that it is more cost efficient and learning/training effective to employ computer based games for delivery of

awareness and exercise skills, and that delivery of supplemental operational level skills could complement game based training (GBT) to fulfill first responder operations level WMD training needs.

The appendix proposes a game design document for a WMD training game. This design document includes both a general description of how the game plays, tasks that the game teaches, and relationships between the players and world objects in the game. This design document should serve as a guide to the creation of an effective WMD training game.

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II. WMD TRAINING ISSUES

This chapter defines the first responder community, and analyzes the scope, effectiveness, and cost efficiency of the current WMD training. First responders number in the millions, but current training delivery methods do not have adequate scope, effectiveness, or efficiency to provide for these responder educational needs. If the existing programs were merely expanded, the cost would be several billion dollars to meet the requirements. In fact, it is unrealistic to enlarge existing training programs because they do not have the capacity for expansion, therefore, current training methodologies are doomed to failure and alternatives must be found.

A. WHO ARE FIRST RESPONDERS?

It is important to understand what constitutes a “first responder”. The definition of first responders varies widely. The first responder community, for the purposes of this thesis, is defined as the individuals who are the first to arrive on the scene of a WMD terrorist incident in an effort to mitigate or reduce the effects of the attack. The number of first responders relates to the following sections that analyze costs of existing training and determine the cost of expanding these existing programs to include delivery to all responders. If skilled trades and others were included in calculations, the actual first responder community that needs training would be even larger than the figures used here to estimate costs. Thus the numbers offered here should be viewed as conservative in nature.

Traditionally, first responders have been considered to be firefighters, EMS workers⁴ and police officers who are dispatched to the incident scene. However, experience at events such as the 9-11 attack on the World Trade Center where a full spectrum of disciplines quickly arrived on scene to render assistance should cause us to reconsider this definition. While firefighters, law enforcement officers and EMS providers remain the core of the first response community, it is now appropriate to broaden the definition to include health care workers, public works employees, and emergency management workers as a part of the first response team.

⁴ EMS workers typically consist of people trained as paramedics, emergency medical technicians (EMTs) or in basic first aid.

There are over 4.2 million first responders⁵ in the United States (See Table 1). This figure includes firefighters, EMS personnel, law enforcement officers, public works employees, public health employees, and emergency management workers.^{6 7} While it is appropriate to expand the definition of first responders, this thesis continues to emphasize firefighters, EMS providers, and police officers because they most often are the *primary* first responders to emergencies.

B. SCOPE OF CURRENT WMD TRAINING

This section describes why existing WMD training does not have adequate scope to address the needs of first responders. It documents the nature of this problem and puts this thesis in context relative to training development efforts that have already been accomplished. To their credit, the federal government recognized the need to deliver WMD training to first responders several years ago. However, first responders have training needs that have not yet been addressed in this evolutionary process and these needs shall be examined with special attention to the level of training required and the reason that awareness training is inadequate. Civilians are also an important component of the WMD response and can do much to assist in an incident. It is helpful to discuss civilian training needs and the why civilians should be included in any comprehensive WMD training program. Finally, it is valuable to examine the needs for continuing education and reasons for requiring exercises to practice response to WMD incidents.

⁵ Estimates vary depending on source. Some sources estimate approximately 2M when considering only police, fire and EMS, while others estimate as high as 7.5 million using a much broader definition. This report approximates the number at around 4M. It should be noted that this figure is only an estimate, since disciplines included in the definition are in a state of flux and since sources on total employment in these different disciplines vary.

⁶ _____, "First Responders Matrix Analysis Website Draws." Plexus. October 2003. p. 1.

⁷ If members of the private security and the skilled trades like iron and steel workers who demonstrated their important role in mitigating the effects of a terrorist attack during the 9-11 response were included in the definition the number will be even higher (private security professionals alone number 964,260) _____, "May 2003 National Occupational Employment and Wage Estimates." U. S. Department of Labor, Bureau of Labor Statistics. Database available on line at http://www.bls.gov/oes/2003/may/oes_33pr.htm [Accessed 9 May 2003].

Table 1. U.S. First Responders⁸

Firefighters & First Line Supervisors ^{9 10 11}	1,064,150
Law Enforcement ¹²	804,650
Emergency Medical Service Providers ¹³	181,750
Public Works Employees ¹⁴	744,528
Public Health Employees ¹⁵	1,465,010
Emergency Management Workers ¹⁶	21,811
Total	4,281,899

1. Background

Before September 11, 2001, the Office for Domestic Preparedness' (ODP) Office for State and Local Domestic Preparedness (OSLDP) was already engaged in an effort to

⁸ Occupations taken from ODP Definition of first responders. _____, "Demographic Data and Draw Feature Report." Plexus Scientific Corporation. October 2003. p. 3.

⁹ According to NFPA as cited in: Comeau, Ed "Firefighter Fatalities in the United States." Society of Fire Protection Engineers New England Chapter. 2002. Database available on line at <http://www.sfpe-newengland.org/Firebrand-02-03/ff%20fatalities%202001%20aug%201%2002.pdf> Accessed 7 March 2004

¹⁰ There are 344,440 full time fire service professionals consisting of 59,000 First line firefighting supervisors/managers, 273,120 firefighters. _____, "May 2003 National Occupational Employment and Wage Estimates."

¹¹ Approximately 22% are paid firefighters and 78% are volunteers. _____, "Supporting First Responders Strengthening Homeland Security." Department of Homeland Security Press Release. January 2002. Washington DC. Database available on line at <http://www.dhs.gov/dhspublic/display?content=119> [Accessed 6 March 2004].

¹² There are 804,650 law enforcement and security professionals consisting of 101,740 first line supervisors, 87,480 detectives and criminal investigators, 609,960 police and sheriff's patrol officers, and 5,470 transit and rail police. _____, "May 2003 National Occupational Employment and Wage Estimates."

¹³ There are 181,750 emergency medical technicians (EMTs) and paramedics according to U. S. Dept. of Labor. _____, "May 2003 National Occupational Employment and Wage Estimates." Ibid. According to the National Association of EMS Educators (NAEMSE), there are 133,844 First Responders, 504,078 Basic EMTs, 65,680 Intermediate EMTs, and 119,488 Paramedics, however, since many full time firefighters are also first responders, EMTs or paramedics, there is the possibility that this number counts personnel in these professions a second time, therefore, the bureau of labor statistics number for full time emergency medical technicians and paramedics is used because these are presumed not to have been double counted against those whose primary occupation is firefighting. There does remain some possibility that these numbers still represent a double count, since many full time EMTs and paramedics also volunteer as firefighters. The veracity of this figure is open to challenge and should be considered with due skepticism. _____, "First Responder Demographic Report." p. 16

¹⁴ _____, "First Responder Demographic Report." p. 8.

¹⁵ Kelly, Henry et al. "Training Technology Against Terror: Using Advanced Technology to Prepared America's Emergency Medical Personnel and First Responders for a Weapon of Mass Destruction Attack." Federation of American Scientists. September 2002. Database available on line at http://www.fas.org/terrorism/wmd/docs/wmd_resp.pdf [Accessed 7 March 2004] p. 4.

¹⁶ _____, "First Responder Demographic Report." p. 8.

prepare firefighters, police officers and others to respond to WMD terrorism. The ODP formed a consortium of educational institutions to deliver WMD Terrorism training to first responders (Figure 1).¹⁷



Figure 1. National Domestic Preparedness Consortium [From ODP Presentation]¹⁸

In addition, ODP served as the catalyst and focal point for distribution of hundreds of millions of dollars in training, exercise and equipment grants.¹⁹ Other agencies, such as the Federal Emergency Management Agency (FEMA), also were engaged in terrorism training efforts pre 9-11. Following 9-11, the intensity of effort and

¹⁷_____, Center for Domestic Preparedness Website. U. S. Department of Homeland Security. Washington DC. Database Available on line at <http://www.cdptraining.com/consortium.htm> [Accessed 7 May 2004].

¹⁸ Thomas, Kerry. "Office for Domestic Preparedness: Supporting Homeland Defense." Office for Domestic Preparedness. Database available on line at <http://hps.org/documents/1> [Accessed 10 March 2004].

¹⁹_____, Department of Homeland Security Website. Department of Homeland Security. Washington DC. Database Available on line at http://www.dhs.gov/interweb/assetlibrary/ODP_State_Homeland_Security_Grant_Program.pdf [Accessed 7 May 2004]

amount of support by ODP was dramatically increased.²⁰ Today, ‘WMD’ is practically a household word. The programs sponsored by ODP have trained thousands of first responders in awareness and hands-on skills for handling WMD incidents and these programs have provided specialized equipment for cities throughout the nation.²¹ The ODP and FEMA have become key providers of WMD training, but while they do provide hands-on operational and technical WMD training, most first responders remain unprepared to operate in a WMD environment.²² One must ask “why?”

2. First Responder Training Needs

Current programs emphasize awareness training for first responders in line with past recommendations from various authorities; however, first responders actually need higher levels of training. This section will show that while operational and technical level training is available, awareness training has been a primary area of emphasis, and the scope of training in awareness programs is not adequate to meet the needs of first responders who are expected to respond to and mitigate the effects of a WMD attack.

What level of training is needed for first responders? It is the premise of this thesis that while first responders do need awareness training to introduce them to WMD hazards, the minimum training should actually be operations level with some specialists trained to the technician level. Unfortunately, most first responders have not received the higher levels of training.²³

The Federation of American Scientists (FAS) asserted that the minimum training that should be offered to the first responder community is awareness level,²⁴ but they have set the standard too low. Awareness training can be from 4 to 16 hours and typically focuses on hazard recognition and self protective actions - essentially skills

²⁰ _____, Department of Homeland Security Website.

²¹ Silverberg, David. “Crucial Coordinator.” [Interview with Joshua Filler, Director of the Office of State and Local Government Coordination]. Homeland Defense Journal. September 2003. Arlington, Virginia. p. 29.

²² “Almost all of these [WMD] capabilities and resources are missing or inadequate in almost all American cities.” Falkenrath, Richard A., Robert Newman and Bradley Thayer. “America’s Achilles’ Heel. Nuclear, Biological and Chemical Terrorism and Covert Attack.” The MIT Press. Cambridge. 2001. p. 303.

²³ [City of San Jose is typical of many U.S. cities where the bulk of WMD training provided is awareness level with smaller numbers trained to operations level.]_____, “City of San Jose Response Plan for Terrorist Incidents Involving NBC/WMD.” City of San Jose. San Jose. October 2000. p. 10.

²⁴ Kelly, Henry et al., p. 11.

helpful to survive a WMD incident. But awareness training is not designed to allow you to respond and operate at such an event.^{25 26} A representative of the International Association of Fire Fighters (IAFF) criticized WMD training programs in 1998 for their inappropriate focus on awareness instead of operational and technical levels.²⁷ While provision of awareness training to more than four million responders is no small task, it does not come close to addressing the actual need.

The first responder community by definition should be considered to be personnel who respond to and operate in and around a WMD environment. Operations level training is designed to teach these skills to first responders. Technician level training is the highest level of training designed for personnel who enter the hot zone and deal directly with the WMD agent. Higher level operations type skills are essential to first responders who work to rescue, decontaminate, and treat the patients of a WMD incident.

The Occupational Safety and Health Administration (OSHA) requires operations level training as a minimum for medical staff engaged in decontamination for every day hazardous materials.²⁸ Certainly the level of training for ultra-dangerous WMD HAZMAT incidents should equal, if not exceed the OSHA standard for everyday HAZMATs. Therefore, in addition to awareness training, first responders should actually be required to obtain operations level training (up to 40 hours)^{29 30} and in some cases

²⁵ _____, "ODP Fact Sheet. New Mexico Institute of Mining and Technology. Energetic Materials Research and Testing Center." Office for State and Local Domestic Preparedness Support. Washington, DC. 2004. Database available on line at <http://www.ojp.usdoj.gov/odp/docs/fs-nmt.htm> [Accessed 4 March 2004].

²⁶ _____, "Law Enforcement Response to WMD Incidents. Awareness Level (Train-The-Trainer" [Course Announcement] National Center for Biomedical Research and Training Website. Louisiana State University. Database available on line at <http://www.ace.lsu.edu/LE201.html> [Accessed 4 March 2004].

²⁷ [It should be noted that considerable changes have occurred in the ODP programs as they have evolved since 1998, and there appears to be an increasing emphasis on hands-on tasks. This thesis will show that there is a concern today about the ability of these programs to scale adequately to deliver this improved training. The net result of dissatisfied firefighters may still be the same.] _____, "Firefighters Say DoD CT Training Program 'Surprisingly Ineffective'" Emergency Preparedness News. October 13, 1998. Business Publishers, Inc. Silver Spring, MD. p. 197.

²⁸ _____, "Frequently Asked Questions: HAZWOPER." U. S. Department of Labor Occupational Safety & Health Administration Web Site. Database Available on line at <http://www.osha.gov/html/faq-hazwoper.html> [Accessed 27 April 2004].

²⁹ _____, "ODP Fact Sheet. New Mexico."

³⁰ _____, "ODP Fact Sheet. Texas A&M University. Texas Engineering Extension Service. National Emergency Response & Rescue Training Center." Office for State and Local Domestic Preparedness Support. Washington, DC. 2004. Database available on line at <http://www.ojp.usdoj.gov/odp/docs/fs-teex.htm> [Accessed 4 March 2004].

technician level training (up to 40 more hours).³¹ These additional hours over those recommended by the FAS present a training challenge that is orders of magnitude greater (up to 20 times)³² than previously suggested.

Statistics from the City of San Jose are likely reflective of national training trends. San Jose reported in October 2000, that 2,000 of their first responders had received WMD Awareness training compared to 150 receiving Operations level training and only 45 receiving Technician Level Training.³³ The San Jose Fire department has 750 firefighters, so this statistic indicates that even if firefighters were the only responders to receive operations level training, San Jose still only trained one fifth of their staff to the needed levels.³⁴

3. Civilian Training Needs

Chemical weapons act very quickly, often within a few seconds. As a result, government officials are unlikely to be able to give warning or guidance. Individuals must act almost instantly and on their own to minimize exposure.³⁵

Terrorism's influence on the civil community is a variable quantity, and in order to ensure the optimal outcome from a WMD incident it is critical that any training and education program on WMD terrorism and response include civilians. The Gilmore Report recommended "[...] education of the public on the prevention, risks, signs, symptoms, treatments, and other important health and medical information before, during and after an attack or large scale naturally occurring outbreak occurs."³⁶ Information on how to respond must be taught in advance of a WMD incident so that civilians can react

³¹ _____, "Weapons of Mass Destruction Tactical Operations. Technician Level (Direct Delivery)" [Course Announcement] National Center for Biomedical Research and Training Website. Louisiana State University. Database available on line at <http://www.ace.lsu.edu/LE220.html> [Accessed 4 March 2004].

³² As mentioned previously, awareness courses can last 4 hours while operations and technician level courses can last 40 hours each. If a responder attends operations and technician level courses in addition to the awareness training, they will have invested twenty times as many training hours.

³³ _____, "City of San Jose Response Plan for Terrorist Incidents Involving NBC/WMD." City of San Jose. San Jose. October 2000. p. 10.

³⁴ _____, "San Jose Firefighters – IAFF Local 230." IAFF Local 230 Website. Database available on line at <http://sjff.org/index.cfm?Category=1&Section=2> [Accessed 28 April 2004].

³⁵ Davis, Lynn E., Tom La Tourrette, David E. Mosher, et al. "Individual Preparedness and Response to Chemical, Radiological, Nuclear and Biological Terrorist Attacks." RAND. Santa Monica, California. 2003. p. xv.

³⁶ _____, "Fourth Annual Report to The President and The Congress of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction." RAND. Arlington. 15 December 2002. [aka Gilmore Report 2002]. p. vii.

with the speed necessary for self preservation. It is important to address the reasons why civilians should be included in WMD training: 1) the WMD environment presents great risk to life - safety and self preservation actions must be taught, 2) civilians can help first responders save the lives of others, and 3) education can reduce fears and thus the impact of terrorism.

Civilians need WMD awareness training to engender the skills necessary to survive in such high risk environments. Civilians are not helpless victims in a disaster, but are typically very resourceful.³⁷ However, their first instincts may not improve outcomes. Civilians who bypass decontamination and rush to hospitals for medical care may cause secondary contamination and injury to the very people who wish to help them. Civilians confronted with fires on lower levels of buildings may go up the stairs to evade the danger only to be overcome by rising smoke and toxic gases. Civilian training can ensure that they avoid incorrect actions and instead achieve maximum possible survival rates.³⁸

Statistically, civilians “[...] have saved the majority of people rescued in disasters, greatly aiding the work of the professionals who respond.”³⁹ Training should include civilians so that they are used to their maximum effectiveness and are able to work together with responders toward common goals.

By demystifying WMD agents and educating civilians about WMD properties and effects, self protection actions, and response preparations, training can reduce fear and anxiety of the unknown and increase sense of control.⁴⁰ Paul Pillar suggests the extent that WMD terrorism impacts the target population is more an issue of psychological than physical harm, concluding “Their impact will be less a matter of the direct physical

³⁷ Glass, Thomas A. and Monica Schoch-Spana. “Confronting Biological Weapons. Bioterrorism and the People. How to Vaccinate a City Against Panic.” Infectious Disease Society of America. 2002. p. 222.

³⁸ This thesis envisions that civilians would be encouraged to play the first responder WMD training MMOG. While there are different expectations of civilians in a WMD incident, by availing the game to them, they would be able to learn higher level first responder skills. The purpose of allowing civilians to play the game as a first responder is to gain an appreciation for the expectations that responders have of civilians in a WMD attack and to understand the limitations of operating in a WMD environment without the benefit of PPE. The result could be educated civilians that are proactive and comply with first responder instructions, and who avoid WMD contamination.

³⁹ Ibid., p. 219.

⁴⁰ Ibid., pp. 218-221.

effects than the indirect psychological effects on the target population. How government conditions its public to think about such an attack [...] thus is critical in determining what the impact will be.”⁴¹

It is clear that any effective WMD training program must include civilian training as a core component. Civilians who know how to act and react have less anxiety, are more empowered, and can help first responders during the event. There is agreement on this issue in state government also; Washington State, for example, intends to include civilians in WMD training and exercises.⁴²

4. Need for Continuing Education

In addition to the initial training requirement, first responders need continuing education to maintain knowledge, skills, and abilities that are infrequently used. Since WMD events are exceedingly rare, there is a potential problem of retention of the information presented in the existing courses.

Currently, there are few measures that ensure first responders have retained knowledge the classes attempt to impart, and even less effort to prevent skill degradation. The FAS observes: “There is neither a provision [in the Defense Against Weapons of Mass Destruction Act of 1996 – a.k.a. the Nunn Lugar Act] that requires refresher courses, nor a provision to monitor their content.”⁴³ The IAFF has also expressed concern about lack of training to maintain WMD response skills.⁴⁴

5. Need for Exercises

Merely exposing people to the content of courses on WMD is not enough; terrorism response skills are applied in rare high risk situations and must be practiced to be maintained. Physical, table top or virtual reality multi-person exercises can 1) provide support for training and improve response capabilities, and 2) assist in developing response policies or playbooks. But conventional exercises have limitations that must be overcome.

⁴¹ Howard, Russell D. and Reid L. Sawyer. “Terrorism and Counter-Terrorism.” Guilford, Connecticut. McGraw-Hill/Dushkin. 2002. p. 32.

⁴² _____, “The Washington Statewide Homeland Security Strategic Plan.” Team Washington. A Statewide collaborative partnership. 2003. pp. 6, 38.

⁴³ Kelly, Henry et al., p. 19.

⁴⁴ _____, “Firefighters Say DoD CT Training Program ‘Surprisingly Ineffective’” Emergency Preparedness News. 13 October 1998. Business Publishers, Inc. Silver Spring, MD. p. 198.

Exercises keep skills honed and available for use in a WMD response, and there is broad support for using exercises to ingrain and practice training lessons. Falkenrath (et al) were very critical of the lack of responder coordination, planning and exercise in *America's Achilles' Heel*, and they recommended frequent, realistic and challenging WMD exercises as a tool to improve cooperation and response capabilities.⁴⁵ Similarly, the Gilmore Report noted: “[...] we recognized that exercises are critical to ensure adequate training, to measure readiness, and to improve coordination among all responding entities.”⁴⁶ Beering (et al) in “Winning Plays: Essential Guidance from the Terrorism Line of Scrimmage” agreed, and emphasized the need for first responders to be familiar with response policies and plans through practice.⁴⁷ Military assessments of exercises show them to be highly effective at reducing casualty rates; the opportunity to repeatedly practice WMD exercises significantly reduced casualty rates in military exercises from 75 percent in the first exercise to as low as 10 percent in later evolutions.⁴⁸

Experience gained in exercises can help the nation's responders develop policies and playbooks guiding terrorism response. Clear policies written in advance, and practiced and refined through exercises, are a proven tool to enhance response efficiency. On the other hand, failure to develop such response policies and playbooks can lead to confusion and poor coordination on the emergency scene. Fortunately, most first responders have not had the opportunity to work at a WMD incident; however, real-life terrorism experiences cannot then be used to develop jurisdictional response policies. Exercises offer an opportunity to practice in a simulated environment and estimate the most efficient and effective means of handling the response.

However, today's large scale physical exercises have many shortcomings. Physical exercises often contain “notional” elements that reduce realism and validity.

⁴⁵ Falkenrath, Richard A., Robert Newman and Bradley Thayer. “America's Achilles' Heel. Nuclear, Biological and Chemical Terrorism and Covert Attack.” The MIT Press. Cambridge. 2001. pp. 268, 301, 321-322.

⁴⁶ _____, “Fourth Annual Report to The President...” p. 59.

⁴⁷ Beering, Peter S. et al. “Winning Plays: Essential Guidance from the Terrorism Line of Scrimmage.” BCSIA Discussion Paper 2002-6, ESDP Discussion Paper ESDP-2002-02, John F. Kennedy School of Government, Harvard University, February 2002. p. 1.

⁴⁸ _____, “Chemical and Biological Defense. DoD Needs to Clarify Expectations for Medical Readiness.” U. S. GAO. Washington, DC. October 2001. p. 31.

Agencies may be unable to spare resources to participate in full scale exercises, because they are either needed for the day to day operations or it is too expensive or logistically difficult to hire an entire shift of responders on overtime.⁴⁹ While some grants now allow overtime and backfill costs, this does not address the fact that some agencies cannot spare the personnel. Hospitals, for example, are among those who have indicated their staffs are simply unavailable for large scale drills.⁵⁰ Some cities may be reluctant to commit to full scale exercises because of the fear of embarrassment. Cities may try to preload exercises to ensure success, but thus fail to test the system as it exists on any given ‘game-day’. The logistical need for prior notice of large exercises creates situations where knowledgeable members are pre-loaded into the system in positions they do not normally occupy. Exercises typically do not test the availability of key personnel and how substitutes are chosen when officials are absent due to vacations, leave, illness, etc.

While physical exercises are a valuable aid in practicing WMD response and management skills and can help develop more effective policies, alternatives like virtual reality exercises or gaming must be developed to enable participation by agencies with resource or logistical limitations. “No notice” and “red team” tests should be included to reduce notional elements and increase realism.

C. EFFECTIVENESS OF CURRENT WMD TRAINING

There are many WMD training courses available, but how effective are these courses at preparing the nation to respond to a WMD incident? To answer this question it is important to examine: 1) the ability of current programs to accommodate teaching the tasks and skills needed by responders and civilians, 2) the capacity of existing programs to deliver training, 3) standardization among current programs, and 4) ability to evaluate current training. It is evident that the current system needs significant overhaul.⁵¹ While

⁴⁹ Peckenpau, Jason. “Emergency Assistance.” Government Executive. Washington DC. November 2002. p. 19.

⁵⁰ Peters, Katherine McIntire. “In the Line of Fire.” Government Executive. Washington, DC. July 2002. p. 42.

⁵¹ “However, without rapid action the US investment in WMD training will not take advantage of this new approach [using virtual environments]. The groups most knowledgeable about medical treatment of WMD casualties and managing incidents are largely unfamiliar with these training methods and, absent a new federal strategy, will not use them for years.” Kelly, Henry et al. “Training Technology Against Terror: Using Advanced Technology to Prepared America’s Emergency Medical Personnel and First Responders for a Weapon of Mass Destruction Attack.” Federation of American Scientists. September, 2002. Database available on line at http://www.fas.org/terrorism/wmd/docs/wmd_resp.pdf [Accessed 7 March, 2004]. p. 5

training is said to be “accommodated” for a major percentage of WMD response tasks, the current programs lack the capacity for expansion, lack standards, and do not have productive evaluation measures.

1. Accommodation of Training Needs

The first aspect of existing programs that should be examined is their content. WMD education should impart certain core knowledge, skills, and abilities. Failure to include these core deliverables in curricula and accommodate these training needs leads to inadequate preparations and insufficient response capabilities. It is imperative that such knowledge be imparted to the learner. How well do current courses accommodate training? At first glance, it appears that current programs actually do quite well at including essential deliverables in the curriculum. In fact, with rare exceptions, they do not.

Curriculum from existing ODP courses has been examined by William Pelfrey (et al), and they concluded that the content and quality of the training is excellent. The Executive Summary for ODP by Pelfrey (et al) notes that the “[...] ODP has accommodated or is accommodating 73.1 percent of the tasks unique to WMD identified by different, independent groups of [Subject Matter Experts] SMEs [...]” and that the “[...] ODP is the dominant provider of training on all tasks associated with WMD and that it has been accomplishing its mandate appropriately.”⁵² While this report is a positive reflection on the content of ODP’s training programs, it should still be a concern that more than one fifth of the tasks are *not* being accommodated.⁵³

However, a closer examination is merited. The term “accommodation” can be misleading. “Accommodation” in this case is a cumulative assessment that *some* training for each of the core tasks is provided in *some* of the courses in the system. While the aggregation of these tasks in a list suggests accommodation of the bulk of needed response skill education, readers should not infer that all the skills are learned by people taking one course. And, since existing training is not outcome-based, it is difficult to know for certain if skills needed have been acquired by responders.

⁵² Pelfrey, William V., William D. Kelley, Jr. and John W. May Jr. “Executive Summary. Office for Domestic Preparedness Training Strategy.” Office for Domestic Preparedness. Washington, DC. 2003. p. 14.

⁵³ Ibid., p. 14.

2. Training Capacity

An analysis of the capacity of the training system can aid in understanding the accommodation dilemma. One problem with the current training is that the existing system simply does not have the capacity to provide training to the responders and civilians who need it. The many criticisms of current training programs provide anecdotal evidence of the shortcomings. An analysis of the productivity of federal training programs validates these expressed concerns.

First responders surveyed by the Gilmore commission indicated they were unprepared to respond to a WMD event because not enough training had been provided.⁵⁴ Harold Schaitberger, general president of the International Association of Firefighters union stated that “Nearly every fire department across this nation lacks specialized training and the appropriate equipment [...] to effectively respond to the aftermath of a terrorist attack involving chemical, biological, radioactive or nuclear agents [...]”⁵⁵ A 2003 RAND report similarly notes that “Police commanders [...] openly questioned the merit of sending their personnel into zones with unknown hazards given that *most personnel lack critical personal protection equipment and training*”⁵⁶ [italics added]. In a report to the ODP, Dr. William Pelfrey (et al) also acknowledged that “Numerous needs assessments, across disciplines and jurisdictions, have consistently identified a lack of training as a major obstacle to domestic preparedness.”⁵⁷ Even cities that have received significant federal support and first responder WMD training, like Denver, have significant gaps. Denver was a Nunn-Lugar-Domenici grant city and the first to host a TOPOFF exercise, yet “[...] some first responder groups, such as police and public health workers, still are largely untrained.”⁵⁸

⁵⁴ Kelly, Henry et al., p. 7.

⁵⁵ Kimery, Anthony. “Budget Battle.” Homeland Defense Journal. September 2003. Arlington, Virginia. p. 22.

⁵⁶ LaTourrette, Tom, D.J. Peterson, James T Bartis, et al. “Protecting Emergency Responders. Vol. 2. Community views of Safety and Health Risks and Personal Protection Needs.” RAND. Santa Monica, California. 2003. p. 123.

⁵⁷ Pelfrey, William V. p. 3.

⁵⁸ Peckenpugh, Jason. p. 20.

However, aren't there scores of WMD training courses currently being offered by federal agencies? The Department of Homeland Security's (DHS) Compendium of Federal Terrorism Training for State and Local Audiences lists over 170 terrorism training courses offered by eight different agencies.⁵⁹ Among these courses are those offered by ODP's Training Consortium, which include awareness, operations, and technician level courses and are available both as on-line or on-site training.

With so many agencies providing training, and so many courses available, it seems that capacity should not be a problem. A closer look at the total delivery volume and at *which* training was delivered helps establish an understanding. Between 1996 and 1999 only 134,000 first responders received federal WMD training, of these only 2 percent had training with live chemical agents.⁶⁰ Between September 2001, and September 2003, FEMA and ODP still only trained an additional 400,000 responders.⁶¹ This cumulative effort still has reached less than 13 percent of the first responder community (Figure 2).

To date, the focus has been on awareness training: most of those trained have only received 4 hour WMD awareness course and not the more extensive hands on training offered by ODP. Therefore, in addition to 87 percent of first responders who have received no training whatsoever, even higher percentages need training in the operations and technician level programs.

⁵⁹ _____, "Compendium of Federal Terrorism Training for State and Local Audiences." Department of Homeland Security. Washington DC. November 2003.

⁶⁰ Stephen E. Flynn, Project Director. "America – Still Unprepared, Still in Danger: Report of an Independent Task Force." Council of Foreign Relations. New York. 2002. p. 15.

⁶¹ Silverberg, David. p. 29.

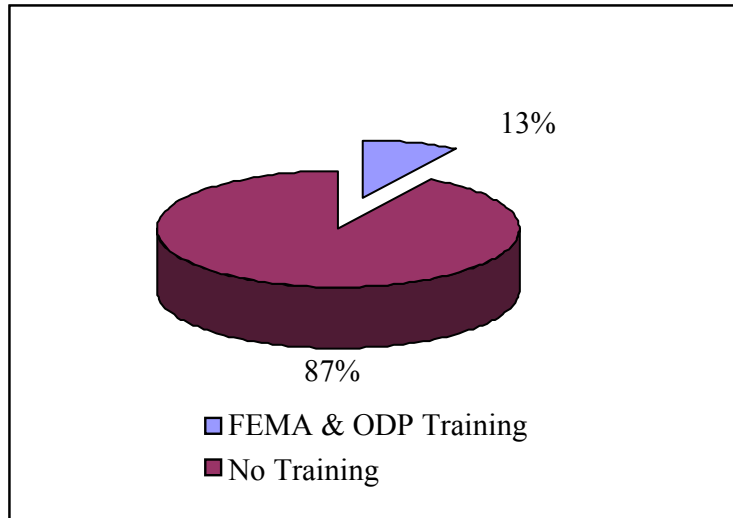


Figure 2. FEMA and ODP Training Delivered to First Responders

One of the few places that operations and technician level training is available is through the ODP Consortium at locations like Center for Domestic Preparedness (CDP). The CDP is the most prolific training body of the ODP consortium. It is one of the few places in the nation “[...]where individuals can be trained in a contaminated environment using “live agents”[...]”⁶² The CDP proudly and appropriately claims: “We provide the very best in Advanced Hands On Training for America’s Responders.”⁶³ But for FY03, the CDP only trained 26,958 first responders and to date they have only trained 53,988 through all of their programs (on and off site).⁶⁴ While the CDP provides excellent training, the FY03 output matched less than one percent of the need (4.2M responders).

Training outputs need to dramatically increase. But does the existing system have the capacity to expand to provide for the additional training needs? Typical in residence Incident Command, Awareness, Operations, and Technician level types of courses at the ODP Training Consortium sites last from three to five days, and with travel time students

⁶² _____, “ODP Fact Sheet. Center for Domestic Preparedness in Anniston, Alabama.” Office for State and Local Domestic Preparedness Support. Washington, DC. 2004. Database available on line at <http://www.ojp.usdoj.gov/odp/docs/fs-cdp.htm> [Accessed 4 March 2004].

⁶³ _____, “WMD Training” Center for Domestic Preparedness. Anniston, AL. 2004. Database available on line at <http://www.cdptraining.com/cdp.htm> [Accessed 4 March 2004].

⁶⁴ Darnell, Darrell. Personal correspondence with author. Darrell Darnell, Division Director, Local Programs – Office for Domestic Preparedness, Department of Homeland Security. [E-mail correspondence with author]. 5 March 2004. Washington DC – Seattle.

often commit a week to participate.^{65 66 67 68 69} The classes have a maximum student capacity ranging from 24 to 60 students^{70 71} and they are only offered a few times a month. Most of the 400,000 responders trained from 2001-2003 have *not* been educated using on-site hands-on training. For example, in FY2001 FEMA only trained 8,000 people at the Emmitsburg Emergency Management Institute.⁷² And the system does not appear to have the ability to adequately expand. A 2002 study indicated that the peak capacity of the CDP for hands-on responder training is only 10,000 per year.⁷³ Plus, funding, turnover and staff rotation limitations limit the ability to scale up to the needs of 4.2 million responders.⁷⁴ Thus, while it appears that there are plenty of quality on-site training opportunities for first responders, the actual situation for such training is one of paucity.

Clearly, the fact ODP has “accommodated” training tasks does not equate to delivery of such tasks. It is in the area of quantity and availability of the training that the problem exists: there are inadequate outputs from existing programs to match the need, that is, current programs lack the capacity to train all of the responders.

3. Training Standards

Today, there are neither national training standards nor standardized national training for first responders. On the one hand, the Gilmore report recommends the establishment of training standards or “[...] minimal proficiency levels that first

⁶⁵ _____, “ODP Fact Sheet. New Mexico ...”.

⁶⁶ _____, “ODP Fact Sheet. U.S. Department of Energy Nevada Test Site.” Office for Domestic Preparedness. Washington, D. C. Available on line at <http://www.ojp.usdoj.gov/odp/docs/fs-nts.htm> [Accessed 4 March 2004].

⁶⁷ _____, “ODP Fact Sheet. Center for ...”.

⁶⁸ _____, “ODP Fact Sheet. Texas A&M ...”.

⁶⁹ _____, “Law Enforcement Response to WMD Incidents. Awareness Level (Direct Delivery)” [Course Announcement] National Center for Biomedical Research and Training Website. Louisiana State University. Database available on line at <http://www.ace.lsu.edu/LE202.html> [Accessed 4 March 2004].

⁷⁰ _____, [Center for Domestic Preparedness Training Calendar] Center for Domestic Preparedness. Anniston, AL. 2004. Database available on line at <http://www.cdptraining.com/calfeb04/slide3.jpg> [Plus slides 4,5 and 6] [Accessed 4 March 2004].

⁷¹ _____, “EMRTC Events Schedule” New Mexico Institute of Mining and Technology. Database available on line at <http://www.emrtc.nmt.edu/events/schedule.php> [Accessed 4 March 2004].

⁷² _____, “Fourth Annual Report to The President...” p. I-11.

⁷³ Stephen E. Flynn, p. 15.

⁷⁴ LaTourrette, Tom p. 111.

responders should be expected to achieve [...]”⁷⁵ On the other hand, responders have recommended a standardization of content in the plethora of federal training programs.⁷⁶ Neither exists today.

It is important that first responders demonstrate minimum proficiency in certain WMD response tasks, that is, they must meet a minimum standard of training. For example, failure to recognize a WMD incident and use appropriate personal protective equipment (PPE) may result in injury or death of the responder and further complicate the situation. There have been efforts in the past by OSLDP to ensure first responder tasks are addressed in training programs that are offered, and there is an on going effort to establish minimum proficiency requirements for first responders, however, the results of this effort have not yet been realized.⁷⁷ Some minimum task proficiencies are available for firefighters, EMS workers, and law enforcement, but are not as available for public works, public health, and emergency management. The result is that first responders are not equally required to demonstrate proficiency in WMD task skills, and thus minimum proficiency cannot be verified.

Another significant problem with the delivery of current training is lack of standardization between programs. In addition to the myriad of state, local and private companies who offer some form of training, as it was previously noted, eight federal agencies also offer over 170 courses.⁷⁸ The problem is that as information and technology changes, there is no process to ensure that the variety of different programs include the new information and discard inaccurate material. A General Accounting Office (GAO) report documented this as a concern of local officials in 1998.⁷⁹ Unfortunately, the problem has gotten worse, as more responders are conducting training following the train the trainer program, additional agencies have begun WMD training,

⁷⁵ _____, “Fourth Annual Report to The President...” p. I-11.

⁷⁶ _____, “Domestic Preparedness Stakeholders Forum – Executive Summary Report.” Responder Magazine. Volume 5, Number 9. Tampa. September 1998. p. 17.

⁷⁷ The author is currently participating in the revision of the ODP Training Strategy which will include specific measures and skill proficiency recommendations for first responders. This revised strategy has yet to be implemented in federal training programs.

⁷⁸ _____, “Compendium of Federal Terrorism Training for State and Local Audiences.” Department of Homeland Security. Washington DC. November 2003.

⁷⁹ _____, “Combating Terrorism. Opportunities to Improve Domestic Preparedness Program Focus and Efficiency.” United States General Accounting Office. GAO/NSIAD-99-3. Washington DC. November 1998. p. 20.

and private parties create for profit WMD training curricula.⁸⁰ Among the problems with using these kinds of commercial off-the-shelf training solutions are the lack of quality control of the material presented and the fact that the training may not represent the latest information and thus has the potential to mislead or misinform responders. The need for standardization of first responder training has been noted by such agencies as the State of Washington.⁸¹

In addition to the federal government's initiative to develop minimum skill proficiency requirements (training standards) for first responders, they must also standardize the national training programs. These efforts must be coordinated.

Standardization alone is not the solution, because there is still the need to ensure compliance with the standards. Any solution to this issue must have the ability to coordinate training across disciplines and the capacity to ensure compliance.

4. Evaluation of Training

While the previous discussions focused on the nature, quality and quantity of training outputs, the *outcomes* that result from this training are far more important. Training outcomes, or the effectiveness of training at enabling first responders to accomplish key mission tasks must be evaluated. In other words, will the training that has been delivered result in a different outcome for a WMD incident?

Unfortunately, while evaluations are critical for continuous improvement and to ensure training effectiveness, there has been minimal effort to evaluate the training programs that exist today. Certainly the inputs or amount of resources dedicated to various projects can be determined, but the outputs of the projects are often not available to the public. The CDP and DHS have released some data on the number of first

⁸⁰ For example, some entrepreneurs have developed WMD Awareness training CDs that are based on government courses. These CDs are sold for prices ranging from \$90 to \$120 dollars.

_____, "Responder 911 – Terrorism Response Training Software." Responder 911. Database available on line at <http://www.responder911.com/html/products.htm>, and _____, "Weapons of Mass Destruction: Basic Awareness Training." Paratus Associates. Database Available on line at <http://www.paratusassociates.com/Paratus>. [Accessed 13 April 2004]

⁸¹ _____, "The Washington Statewide Homeland Security Strategic Plan." Team Washington. A Statewide collaborative partnership. 2003. p. 69.

responders trained, but breakdowns into levels of training received are hard to acquire. Even more difficult is determining the outcomes of this training, that is, the effectiveness of the training and achieving positive results in first response.

As Pelfrey (et al) noted: “A dominant theme in the literature, as well as in the policies and practices of ODP, is the need to evaluate training. If there are no expectations for the competency or performance of those being trained, there is little chance of determining the degree to which needs are being met.”⁸² The FAS suggest this is not being done in the federal programs: noting that “No provision was made to monitor what actually happened after the federal training programs were complete, i.e. whether the trainers actually went on to train other individuals, or to evaluate the quality the initial training provided.”⁸³

Thus, the outcomes of the training are as yet undetermined. The best assessment of the situation may depend on the subjective comments of first responders who it has previously been noted have expressed concern over being inadequately prepared.⁸⁴ The few national exercises like TOPOFF that have been held suggest the training outcomes are not achieving desired levels. In any case, an unprepared responder is likely to make costly mistakes in a WMD incident.

Measures of the effectiveness of WMD training must be implemented to ensure the outcome of the training is enhanced competency in a WMD response. Evaluations help find shortcomings, guide program development, and ensure consistency between programs. Standardized evaluations validate if the training provided has effectively imparted the needed skills in the targeted learners – the first responders and civilians.

D. COST EFFICIENCY OF CURRENT WMD EDUCATION

What is the cost effectiveness of the existing WMD education effort? WMD education typically includes two parts: training and exercises. Training includes both classroom teaching and hands on education provided through a variety of curricula both on-site and on-line. Exercises are both small and large scale drills conducted to evaluate the outcome of the training; that is, exercises are drills where the education is put to the

⁸² Pelfrey, William V. p. 12.

⁸³ Kelly, Henry et al., p. 19.

⁸⁴ Kelly, Henry et al., p. 7.

test in a simulated event either in the field, on table tops, or in a virtual world. Training and exercises account for a significant portion of the WMD educational assistance provided to the responder community on an annual basis. To assess the cost effectiveness of current WMD education an examination is made of: 1) recent education costs, and 2) the costs of an example training program and its efficiency/productivity values. This data is used to estimate costs to expand the program to address current gaps in preparation. After conducting this analysis, it is obvious that the expansion of the current system is not a feasible cost effective solution and alternatives must be found to the expensive delivery methods, and dependency on physical facilities that lack scalability.

1. Recent Training and Exercise Allocations/Expenditures

How much has the government spent on terrorism response preparation and education? Federal expenditures on planning, training, and exercises are significant.⁸⁵ Yet in spite of the allocation of vast sums of money to prepare the nation, there remains the question of whether existing measures are adequate.

In FY 2003, DHS allocated approximately 4 billion dollars to assist first responder preparedness and response to WMD incidents (the allocations are summarized in Table 2).^{86 87} While some of these allocations are designated for equipment purchase and security measures, significant portions are intended for planning, training and exercises. For example, Part I of the State Homeland Security Grant Program designated around thirty percent (30%) or \$169M for planning, training and exercises. In other grants, specific allocation of resources is left to the discretion of the grantee.

Many exercises are large scale, physical exercises, and as they are designed today, they account for a significant portion of the educational allocations. In FY03, the federal government directly allocated \$112,000,000 for state and local exercises, including

⁸⁵ It should be noted that allocations for first responder preparations often include equipment and it is therefore difficult to exactly calculate the total amount going to planning, training, and exercises.

⁸⁶ _____, "Funding Report: Helping Our Nation's First Responders." Department of Homeland Security Press Release. Database Available on line at <http://www.dhs.gov/dhspublic/display?content=963> [Accessed 13 April 2004].

⁸⁷ _____, Office for Domestic Preparedness Support Website. Office for Domestic Preparedness Support. Washington DC. Database available on line at http://www.ojp.usdoj.gov/odp/grants_programs.htm [Accessed 7 May 2004].

\$7,000,000 for the TOPOFF II exercise.⁸⁸ Of the \$112M, the ODP exercise budget was about \$12M with the remaining \$100M going directly to the states. In FY04, the exercise division of ODP saw a budget increase to \$49.7 million dollars.⁸⁹

In addition to the hundreds of millions of dollars that have been allocated directly in FY03 to the states or distributed to support exercises, many more millions support federally sponsored training programs. New Mexico Tech's Energetic Materials Research and Testing Center (EMRTC) was awarded \$19.8 million in 2003 for explosives response training.⁹⁰ In fact, at just one of the consortium members, the CDP, the budget for FY03 was \$45 million and in FY04 was \$55 million.⁹¹ In FY03, the total the federal government allocation for the ODP training consortium was \$125,000,000.⁹²

Table 2. Recent Department of Homeland Security Grants^{93 94}

FY 2003	State Homeland Security Grant Program – Part I	Equipment 397.4M Exercises 99.4M Training 29.8M Planning 39.7M	566,295,000
10 March 2003	Firefighter assistance grants	Train, Prepare, Equip	750,000,000
FY 2003	Urban Areas Security Initiative Grant Program		96,351,000
16 April, 2003	State & local governments	Planning, training, exercising, facilities	165,000,000
FY 2003	State Homeland Security Grant Program - Part II	First Responder Preparedness 1300.0M Critical Infrastructure Protection 200.0M	1,500,000,000
FY 2003	Urban Areas Security Initiative Grant Program – Part II		500,000,000
12 June 2003	Texas	First Responder Preparedness and response	78,238,000
12 June 2003	Florida	First responder preparedness and response	62,655,000
12 June 2003	Illinois	First responder preparedness and response	50,005,000
12 June 2003	Washington	First responder preparedness and response	29,971,000

⁸⁸ _____, "Conference Report [Fiscal Year 2003 Appropriations]" p. 637.

⁸⁹ Darnell, Darrell.

⁹⁰ _____, "NMT Awarded Funding for Counter-Terrorism Training." New Mexico Institute of Mining and Technology. September 2003. Database available on line at <http://www.nmt.edu/mainpage/news/2003/17sept02.html> [Accessed 4 March 2004].

⁹¹ Darnell, Darrell.

⁹² _____, "Conference Report [Fiscal Year 2003 Appropriations]" p. 637.

⁹³ _____, "Funding Report: Helping Our Nation's First Responders." Department of Homeland Security Press Release. Database Available on line at <http://www.dhs.gov/dhspublic/display?content=963> [Accessed 13 April 2004]

⁹⁴ _____, Office for Domestic Preparedness Support Website.

12 June 2003	Wisconsin	First responder preparedness and response	27,985,000
12 June 2003	Minnesota	First responder preparedness and response	26,690,000
12 June 2003	Louisiana	First responder preparedness and response	25,037,000
12 June 2003	Arkansas	First responder preparedness and response	19,585,000
12 June 2003	New Mexico	First responder preparedness and response	16,956,000
12 June 2003	Maine	First responder preparedness and response	15,232,000
Total			\$3,930,000,000

Table 3 summarizes the funds that can be directly connected to training and exercises; however, review of the FY03 Homeland Security Grant Allocations detailed in Table 2 suggests that the total expenditure on training and exercises is likely much higher. In fact, if a conservative figure of 30 percent based on Part I of the State grant program is used to estimate the amount allocated to training and exercises for the remainder of allocations in Table 2, the total amount is greater than \$1.1 billion. Thus the amount in Table 3 should be considered a very conservative estimate.

Table 3. FY03 Training and Exercise Allocations^{95 96}

National Domestic Preparedness Consortium	\$125,000,000
Continuing and Emerging Training	25,000,000
Discretionary Training Grants	30,000,000
Virtual Medical Campus	2,000,000
Dartmouth Institute for Security and Tech. Studies	18,000,000
OCNM Inst. For the Prevention of Terrorism	18,000,000
Center on Catastrophe Preparedness and Response	7,000,000
National Counter terrorism Policy Center	3,000,000
Terrorism Prevention and Response Training Center	5,000,000
Exercises – Grants	100,000,000
TOPOFF Exercise Series	7,000,000
Evaluation and After Action Program	5,000,000
Total	\$345,000,000

2. Analysis of ODP Current Training Program Costs

How are these hundreds of millions of dollars being used? A close examination of the costs of existing programs should be helpful to understand the possibilities of

⁹⁵ Ibid., p. 635.

⁹⁶ Darnell, Darrell.

alternative training methods. This thesis examines one case: expenditures by ODP Consortium members.

Costs that are covered by the ODP programs and therefore included in the budget include:^{97 98 99 100}

- Course material & equipment
- Student Travel: Airfare and ground transport
- Meals
- Lodging
- Management and administration
- Facilities
- Course Instruction
- Some overtime and backfill for attendees

While most of these expenditures are self explanatory, some are not and are detailed below.

A significant operational expense is the cost of the facilities themselves. The ODP Consortium operates out of five separate locations in facilities worth hundreds of millions of dollars; the National Emergency Response and Rescue Training Center (NERRTC) complex alone is valued at over \$125M.¹⁰¹ In addition to the annual maintenance of these facilities, they represent an opportunity cost to the government. Each facility has tied up funds that can potentially be used for other programs, and this opportunity cost should be considered. While this thesis does not calculate the opportunity cost of the facilities or their depreciated value, it is recommended that GAO perform a thorough analysis of these costs when any decision about future training methodologies is considered.

⁹⁷ _____, "ODP Fact Sheet. New Mexico...".

⁹⁸ _____, "WMD Training" Center for Domestic Preparedness. Anniston, Alabama. 2004. Database available on line at <http://www.cdptraining.com/cdp.htm> [Accessed 4 March 2004].

⁹⁹ _____, "ODP Fact Sheet. U. S. Department of ...".

¹⁰⁰ _____, "2004 Homeland Security Grant Program." Department of Homeland Security. Washington, DC. 2003.

¹⁰¹ _____, "ODP Fact Sheet. Texas A&M ...".

While the Consortium has associations with academic institutions around the country, many instructors are hired contractors. Low instructor to student ratios are advantageous for the learning experience, but add expense to the program. Instructors who are not on the full time in-residence staff must be reimbursed for their time, travel, and other expenses. This can be a significant part of the course cost.

Another significant portion of the overall cost of in-residence training can be the cost of the students themselves. That is, the costs of staffing and backfill for attendees. While *some* staffing and backfill costs to attend training are covered and accounted for in the overall program costs, many people arrange their own time off from work to attend training or are reimbursed by their employer. These costs should also be considered. Departments reimburse their employees differently across the nation, but regardless of the pay levels, it is necessary and appropriate to include the employee's wages and backfill costs. Firefighter work schedules, for example, range from 40 to 56 hours per week. Cost of attending the program includes the wages of the employee attending the training and any overtime wages of the employee's replacement. Some labor agreements require 24 hour reimbursement when deployed on official business. If an employee earns \$35,000 annually and a one week course costs the department a week of time and a half overtime, the cost to send a student can easily exceed \$1000 ($\$35,000 / 52 \text{ weeks} \times 1.5$) for backfill wages not including benefits. If the student earned a higher wage or their contract required 24 hour reimbursement while away from home the costs can be 5 times as much.

3. Analysis of the Efficiency of Existing Training

An alternative method of estimating costs is to analyze the efficiency of existing training rather than total cost. Efficiency can be expressed as the ratio of inputs over outputs or as the average cost per student for the FY03 investments. Below are two efficiency assessments, one for the CDP and one for DHS training of first responders.

The CDP budget for FY03 was \$45M and they trained 26,958 responders; therefore the cost per student was about \$1,700.¹⁰²

¹⁰² Darnell, Darrell.

DHS indicate they trained 400,000 responders in the two years following 9-11 (see above) or about 200,000 per year. Taking the FY03 allocation for training and exercises from Figure 5 (\$345,000,000) then the cost per student can be estimated at \$1,725.

Both these figures are low because they do not include the cost of all overtime and backfill for the student to attend the training, nor do they include the opportunity costs of the facilities and equipment, but at least this gives a general figure to which we can compare alternatives.

An examination of available documents that describe WMD preparedness expenditures reveals little discussion of the marginal benefits for additional expenditures in training. In fact, most of the multi-million dollar government programs researched for this thesis did not have marginal cost and marginal benefit figures immediately available for review. It appears that significant allocations are being made without consideration to the increased benefit in outcomes resulting from the expenditure. This thesis recommends that GAO conduct an assessment of the allocations to existing programs to determine the marginal costs and benefits of further investments. It is highly likely that if such a detailed analysis were made, it would determine that the expense of some programs is not justified and they should be terminated. The impression gained from this brief assessment is that the ODP Consortium is one of the *most* productive programs for first responder training. It is likely that other federal programs for which output data are not available are of much less value to the first responder community than the training offered by the ODP Consortium.

4. Cost of Filling the Training Gaps

What would be the cost to provide training for the responders who have not yet received it? Below is an estimation of costs of scaling existing programs up to meet first responder needs. It is apparent that costs are exceedingly large, suggesting that alternatives must be found.

If we wish to provide training for the remaining 87 percent of untrained first responders to the equivalent level of those trained to date, at equivalent cost, then the total cost would be at least \$6.2 billion (87% untrained x 4,200,000 first responders x \$1,700 per student = \$6,211,800,000).

The actual cost per student would be significantly larger. First, it has been noted that the CDP only has a capacity to train around 10,000 students on site per year. Expansion of this or similar facilities to scale up to meet the need of 4.2 M responders requires huge investments. Next, as previously noted, the cost of student wages and backfill for a week at a minimum adds \$1000 per person to the cost of one week of training. Rising fuel prices affect the cost of travel to the site and inflation may increase the average cost to above \$1700 per student. Finally, much of the training that has been provided has been awareness level training; provision of operations and technician level training to first responders requires more training hours resulting in significantly higher costs. Generally, operations and technician level training are orders of magnitude higher than awareness level training. For example, the Puget Sound Marine Firefighting Commission estimated the initial per student costs of Marine Firefighting education at \$60 for Awareness Level, \$830 for Operational Level, and \$8,330 for Technician Level.¹⁰³ One should expect that First Responder WMD training should scale similarly since the hours, equipment and instruction required to achieve each level is successively greater. If all of these factors are considered, it is reasonable to suggest that the actual cost of training students to WMD operations level may be closer to double the \$6.2B figure.

Are funds available to expand programs to this level? As Pelfrey (et al) concluded: “[...] the availability of training courses and facilities often does not imply that sufficient funds are available to actually execute training. In fact, funding availability to mobilize and conduct training is an exceptional and significant problem.”¹⁰⁴

¹⁰³ Vickery, A.D., Jeff Jensen, and Dave deHaan. “Proposal for Establishment and Sustainment of a Regional Fire and Life Safety Response Capability for the Pacific Northwest and Puget Sound.” The Puget Sound Marine Firefighting Commission (PSMFC). November 2001. Seattle, Washington. p. 3.

¹⁰⁴ Pelfrey, William V. p. 3.

The existing ODP programs have value, but it is neither economically nor logistically feasible to provide the kinds of on-site hands on training they offer to the entire first responder community.

Plus, there is an additional need that has not yet been addressed: training of the civilian community. The 290,000,000¹⁰⁵ people in the U. S. can benefit from the delivery of training on how to react to a WMD incident. A survey of school officials noted that “Over 76% of the [safety] officers feel that their schools are not adequately prepared to respond to a terrorist attack upon their schools.”¹⁰⁶ The survey notes that “Over 71% of the respondents report that their schools’ teachers, administrators, in-house (civilian, non-school police) security personnel, and support staff have not received terrorism specific training.”¹⁰⁷ Just as schools are unprepared, so also are businesses and communities around the nation. Obviously, using on-site hands-on training methods to provide the civilian community with WMD education is cost prohibitive. A cost effective alternative training mechanism must be found that has the capacity to teach large numbers of responders and civilians.

Billions of dollars are being spent to prepare the nation to respond to WMD terrorism. Hundreds of millions of dollars are going directly into training and exercises to educate responders in essential skills and to practice those skills. Yet in spite of these significant expenditures, training on response to WMD terrorist incidents has simply not reached enough responders. Furthermore, of the training that has been delivered, it lacks the depth required to develop the entire response skill set to be considered adequately prepared. Civilians have echoed the concerns of first responders about lack of available training and a sense that they lack preparedness. It is not economically or logistically feasible to scale existing programs up to meet the needs of millions of responders and hundreds of millions of civilians.

¹⁰⁵ _____, “U. S. Population Clock.” U. S. Census Bureau. Database available on line at <http://www.census.gov/cgi-bin/popclock> [Accessed 10 March 2004].

¹⁰⁶ Trump, Kenneth S. “School Safety Threats Persist, Funding Decreasing: NASRO 2003 National School-Based Law Enforcement Survey.” National Association of School Resource Officers. Cleveland, OH. 19 August 2003. p. 4.

¹⁰⁷ Trump, Kenneth S. p. 4.

Alternative training methodologies must be developed and implemented to meet the demand for education. Alternatives must be more realistic than courses available today,¹⁰⁸ and they must be more economical and efficient.

¹⁰⁸ ____, "Fourth Annual Report to The President..." p. 4.

III. APPROACH AND MOTIVATION TRAINING GAMES

New information and training technologies can build a training system that will reach this audience [of emergency responders] quickly with timely information, allow tailoring training to unique local situations, and provide simulated experiences that transfer efficiently into high levels of performance in an actual emergency.¹⁰⁹ ~ Henry Kelly (et al).

A. APPROACH: MASSIVELY MULTIPLAYER ONLINE GAMING

Massively Multiplayer On-line Gaming (MMOG) offers an effective alternative to existing training programs. Gaming can provide a realistic training environment for delivery of WMD awareness skills and can be used to exercise the decision making process in real time scenarios. This thesis proposes to create an entirely new training model using MMOGs as the platform for education.

Before proceeding, it is important to understand what an MMOG is and how it applies to WMD training. The latest evolution in computer gaming is called MMOGs. MMOGs use virtual worlds to bring multiple game players (gamers) together to complete a common mission. Players log on to networked computers and play with dozens of others in the same virtual world. Their actions can be seen by other players and they can see the actions of these other players in the same environment. One advantage of a MMOG is that the players have the opportunity to develop strategies and tactics for play with a large number of teammates. MMOG elevates the sophistication of gaming because of the strategic and tactical challenges of interacting with many different individuals. Whereas single player games tend to follow a storyboard, multiplayer games have constantly changing scenarios because the behavior of each individual has so many variables.

This thesis suggests that a WMD first responder game be developed to train both first responders and civilians. This proposed MMOG WMD civilian and responder training game addresses two needs. First, it serves as a WMD awareness and operational education tool. Second, it serves as a tool for practicing responses. A RAND study

¹⁰⁹ Kelly, Henry et al., p. 3.

noted that “[...] for the training to be most effective, it must include realistic “operational” or “situational” scenarios and simulations [...]”¹¹⁰ Gaming answers this need.

The intention is to enhance student learning of core WMD recognition and decision making skills by immersing students in a realistic game environment. Through this immersion, students become engaged in the game. The FAS advises that training is more effective and leads to better understanding and retention of material if students learn in a gaming environment that challenges them with complex problems and realistic scenarios.¹¹¹ As students play the game, messages about WMD response are reinforced. For example, players operating in the MMOG world are constrained by the game rules, the proposed game would establish game rules that are based on operational factors at a WMD incident. During the game, the players constantly have lessons reinforced about such things as PPE, WMD hazards, and patient symptoms. Because players are relaxed, engaged, and having fun, the learning and retention increases. The game provides multi-sensory feedback, thus stimulating more learning processes. That is, students have audible, visual, and sensory cues, enabling learning by hearing, seeing, and doing. Because students can play scenarios multiple times, lessons are reinforced and some behaviors become habitual.

Gaming provides a safe environment to ask questions and make mistakes. Students obtain answers via training modules, virtual resources or through experimentation. Students operate in simulated high risk environments without fear of physical harm or death. Learning is enhanced through the scoring and evaluation of game play. Students review which tasks they accomplished, which tasks they failed and have instantaneous positive feed back. At the end of each game student scores and mission accomplishments are posted. This immediate feedback reinforces learning objectives. The ability to post student score and high score motivates learners to replay the game in an attempt to obtain higher scores by accomplishing more learning objectives. Because the game is completely relevant to WMD preparations and challenges the players, learning again is enhanced.

¹¹⁰ LaTourrette, Tom, p. 111.

¹¹¹ Kelly, Henry et al., p. 22.

Just as military leaders have allowed their troops to play certain games with educational benefits while on duty,¹¹² it is also envisioned that first responder agencies would encourage their staff to complete education and game modules while at work, during times when not occupied by other duties.

B. MOTIVATION FOR GAMING SOLUTIONS

Why should the federal government invest in gaming technology for WMD training? Gaming can be a catalyst for the development of alternative solutions to WMD response problems and can lead to innovation and enhanced performance. Games have been endorsed by a variety of professionals and organizations. Gaming has the capability to meet the demands of the Government Performance and Results Act (GPRA). In fact, gaming can address the shortcomings of existing training that were outlined above. “America’s Army” is an example of gaming possibilities: it demonstrated that gaming does not merely need to be an entertainment media but can implement other objectives and effectively change outcomes.¹¹³

1. Transitioning from Hierarchical to Networked Control

This thesis proposes use of gaming as a radical change element to existing training and incident management practices. The primary benefit of inter-netted GBT is the significantly greater ability to efficiently disseminate training knowledge and information. The efficiency benefit of modern information technologies is the focus of the remaining chapters. But there is an additional aspect worthy of discussion: using information technologies, specifically computer gaming, to enhance incident management capacity. Gaming itself is a networked innovation of the type recommended to counter technology developments by terrorist organizations. Gaming can not only serve as an effective training tool, it can also help reduce responder dependence on hierarchical organizations by inspiring development and testing of new networked response practices.

¹¹² Computer Science and Telecommunications Board. “Modeling and Simulation. Linking Entertainment and Defense.” National Research Council, National Academy Press. Washington, DC. 1997. p. 26.

¹¹³ _____, “America’s Army PC Game Vision and Realization.” United States Army and the MOVES Institute. San Francisco. January, 2004. pp. 7, 9.

Terrorists are using modern technologies to their advantage. Thomas Friedman observed in *The Lexus and the Olive Tree* that just as the road system with which Caesar created his empire, was used by the Vandals and Visigoths to attack Rome, so also are modern terrorists like Bin Laden using computers and the internet to organize and communicate against the United States.¹¹⁴ Just as terrorists are studying and learning from the preparations of governments they oppose, the governments should study and learn from the preparations of terrorists. Louis Beam advocated use of computer technology to support bulletin boards for terrorist communication, phantom cell networks¹¹⁵ and “leaderless resistance”¹¹⁶ to organize loosely affiliated people against the state. In fact, these organizations have already developed recruitment and training games such as “Special Force – Hezbollah”¹¹⁷, “Under Ash”¹¹⁸, and “Ethnic Cleansing”¹¹⁹.



Figure 3. Screen Shots From Pro-Terror Organization Gaming Websites¹²⁰

State governments should consider applying similar tactics to organize their first responders. In other words, gaming may provide an avenue for first responders to

¹¹⁴ Friedman, Thomas L. “The Lexus and the Olive Tree.” Anchor Books. New York. 2000. pp. 398, 401, 402.

¹¹⁵ Hoffman, Bruce. “Inside Terrorism.” Columbia University Press. New York. 1998. pp. 117, 118.

¹¹⁶ Hewitt, Christopher. “Understanding Terrorism in America. From the Klan to al Qaeda.” Routledge. New York. 2003. p. 58.

¹¹⁷ _____, Special Force Website. Database available on line at <http://www.specialforce.net/english/indexeng.htm> [Accessed 23 May 2004].

¹¹⁸ _____, Under Ash Website. Database available on line at <http://www.underash.net> [Accessed 23 May 2004].

¹¹⁹ _____, Resistance Website. Database available on line at <http://www.resistance.com/ethniccleansing> [Accessed 23 May 2004].

¹²⁰ Screen shots from left to right downloaded from websites for “Special Force”, “Under Ash” and “Ethnic Cleansing”: <http://www.specialforce.net/english/indexeng.htm>, [Accessed 23 May 2004], http://www.underash.net/images/resize%20of%20us_11_7.jpg, [Accessed 23 May 2004], <http://www.resistance.com/ethniccleansing/promos.htm> [Accessed 23 May 2004].

develop optimal solutions and create response playbooks. Call it “leaderless cooperation.” The principle proposed by Buns and Stalker is that knowledge of a task itself becomes the “[...] ad hoc center of control authority [...]”¹²¹ This principle has application for first responders.

Just as “[...] mutual consultation and consensus building, can enable [terrorists] to be “all of one mind,” even though they are dispersed and devoted to different tasks [...]”¹²² so also these technologies can be developed to foster similar cohesiveness in the first responder community. “Cook and Yanow (1993) point out that the knowledge to undertake a highly skilled operation in an organization ‘resides not in any one individual, but in the organization as a whole. The organization was not “born” with that knowledge; it had to learn it’.”¹²³

Traditional training models have put emphasis on Incident Command Systems (ICS), the latest evolution being the National Incident Management System (NIMS). While effective command and control are an essential part of an organized response and critical to a WMD response, this thesis suggests gaming can reduce the dependence on NIMS and free responders to take action without being micromanaged. Arquilla (et al) have a simple recommendation: “[...] learning to draw on the same design principles of network forms [that our adversaries use] in the information age. These principles depend... mainly on a willingness to innovate organizationally and doctrinally, and by building new mechanisms for interagency and multi-jurisdictional cooperation.”¹²⁴ One positive example of the use of IT in this manner was when “[...] Jody Williams won the Nobel Peace Prize in 1997 for her contribution to the international ban on landmines [...] organizing 1,000 different human rights and arms control groups on six continents [...]using e-mail].”¹²⁵

¹²¹ Howard, Russell D. and Reid L. Sawyer. “Terrorism and Counter-terrorism.” Guilford, CT. McGraw-Hill/Dushkin. 2002. p. 102.

¹²²Arquilla (et al) quoted in Howard, Russell D. and Reid L. Sawyer. “Terrorism and Counter-terrorism.” Guilford, CT. McGraw-Hill/Dushkin. 2002. p. 104.

¹²³ Quoted from Sims, David. “Organizational Learning as the Development of Stories: Canons, Apocrypha and Pious Myths.” In “Organizational Learning and the Learning Organization. Developments in Theory and Practice.” Edited by Mark Easterby-Smith et al. Sage Publications. Thousand Oaks. 1999. p. 46.

¹²⁴ Arquilla et al quoted in Howard, Russell D. p. 106.

¹²⁵ Friedman, Thomas L. “The Lexus and the Olive Tree.” Anchor Books. New York. 2000. p. 14.

It has been observed that “Most special interest extremist movements capitalize on the technical and computer skills of their adherents and use the nearly limitless communication opportunities of the Internet to spread their messages, recruit new members, raise funds, and plan activities.”¹²⁶ U. S. First responders should similarly take advantage of the efficiency of IT in training efforts.

While the MMOG does not propose to eliminate the ICS hierarchy, it does offer the opportunity to reduce dependence on it so that first responders also will “[...] know what they have to do.”¹²⁷ Nationally, we continue to push to create an incident management system capable of directing and controlling first responders, yet the very nature of a WMD incident suggests that the most efficient means of taking action is achieved when everyone is familiar with the organizational missions and goals and can act somewhat independently. The point is further emphasized by the expectation that communication systems fail in large scale emergencies, either from damage or overwhelming use.

The suggestion to emulate the ‘leaderless resistance’ model of terror organizations may be criticized because of the expectation that governmental organizations take care of their people and look out for their welfare, while terrorists may not. After all, experience has shown that incident command systems, like the recently federally advocated NIMS, increase efficiency and effectiveness of managing large scale incidents, and incident management systems are said to enhance accountability and safety. It is true that there are different expectations between government organizations and terror cells, but this does not mean that we cannot take advantage of modern technologies. The existing incident management systems were developed using rudimentary management tools and have never been fully re-engineered to capitalize on the benefits of modern technologies. While we may never fully negate the need for an incident management system, gaming can test IT tools that maximize efficiency of such a system. That is, games can prove the effectiveness of various IT tools as a force multiplier that reduce the need for small span

¹²⁶ _____, “Terrorism in the United States. 1999.” U. S. Department of Justice, Federal Bureau of Investigation. Washington, DC. 1999. p. 33.

¹²⁷ Arquilla et al quoted in Howard, Russell D. Ibid. p. 104.

of control, and reduce need for incident management staff by increasing their effectiveness. The net result can be more first responders working to mitigate the incident instead of managing it.

Using gaming as a tool to discover force multipliers to improve management efficiency is in line with business process reengineering trends. It is recognized that large numbers of modern employees, like first responders, are educated and have the expectation of affecting how businesses (or incidents) are run.¹²⁸ Just as traditional manufacturing businesses must re-examine the way they use technology to enhance work productivity, so also must first responders.¹²⁹ Similar to modern manufacturing lines, the current incident management system is based on the expectation that the managers are more informed and make better decisions than the entry level employees, but this is no longer a valid assumption. As Michael Hammer observed: “Conventional process structures [...] are breeding grounds for tunnel vision [...]”¹³⁰ One view of first responders is to consider them a sensor that collects data and forwards it up the chain of command for processing. This view of responders should be expanded; they should instead be considered intelligent sensors that are capable of decisions and initiating independent action.

Incident commanders may cringe at the thought of losing control to the operational responders, but in fact this is exactly the recommendation of reengineering proponents: that “[...] an organization that produces information also process[es] it [...]”¹³¹ In fact, there is a loss of accountability and increase in error when information or work is passed up the chain of command and back down again.¹³² Application of new methods and technologies such as those proposed above can be tested in a WMD first responder game and validated. Managers should not view the importance of personnel to be a matter of rank, but instead the people performing the work should be viewed as more important than those supervising the work.¹³³ Thus, the impact of ego may be minimized

¹²⁸ Hammer, Michael. “Reengineering Work: Don’t Automate, Obliterate” July-August 1990. Harvard Business Review. Boston. p. 107.

¹²⁹ Ibid., p. 107.

¹³⁰ Ibid., p. 108.

¹³¹ Ibid., p. 110.

¹³² Ibid., p. 108.

¹³³ Ibid., p. 112.

in the management of an incident and the focus put where it belongs - on the mission of saving lives. Just as businesses seek to eliminate unproductive layers of middle management, so also should the evolution of modern incident command systems. Gaming and simulation can serve as the inspiration and proving ground for the implementation of these new ideas.

While some might consider the transition from hierarchical to networked organization to be a trendy new departure for emergency management¹³⁴, in fact it can be said that this is simply the “old school” and time proven method for structural firefighting operations where firefighters with special expertise have pre-designated assignments which they adapt to differing conditions and solve their local problems. This problem solving mechanism avoids the dilemma of micromanagement. Incident management systems were largely created to inhibit this swarm approach and exert more control on employee actions. While current systems enable better tracking of personnel and are credited with more efficient deployment of resources, they do not always result in the most expedient or best incident outcome. It is interesting to observe that the mantra of many fire service educators is that it is the initial actions of the first in company that set the stage for successful incident outcomes. While this observation is often used to point to the need for an incident management system, it can equally be used to note the validity of networked decision making, since the first arriving unit is usually a front line company officer and not a high level manager.

In a time critical WMD incident, if too many resources are allocated to establishing the incident management system, patients may become victims while they wait. In fact, a criticism of first responder performance in TOPOFF II included the extensive delays in accessing and extracting the patients; responders may well have been hamstrung by management direction issues.¹³⁵ The fact is that the front line firefighters of today can be highly educated professionals with broad experience bases.¹³⁶ Gaming can test the validity of the premise of using situational rather than hierarchical leaders in

¹³⁴ Turban, Efraim, R. Kelly Rainer, Jr., Richard E. Potter. “Introduction to Information Technology. Second Edition.” John Wiley & Sons. 2003. Hoboken, New Jersey. p. 447.

¹³⁵ Hepburn, Bill and Tom Gudmestad. “Simulated Dirty Bomb Attack Tests Seattle’s Resources.” fireEMS. Fair Lawn, New Jersey. September/October 2003. p. 18.

¹³⁶ In Seattle Fire Department for example, firefighters have been educated in such varied fields as business, medicine, and engineering.

WMD response decision making. Of course, no one can make quality decisions without knowledge; thus the game should be a place where institutional knowledge is developed and shared to instill core skills in all the participants. Turban (et al) observed that such empowerment of first responders requires training to develop the needed skills.¹³⁷ Gaming can offer this training.

2. Compliance with Government Performance and Results Act

In an effort to reduce government waste and reassure citizens that tax funds are being efficiently and effectively used, the 1993 Government Performance and Results Act (GPRA) requires that all government agencies submit strategic plans for program activities. These plans must include 1) measurable performance goals, 2) description of processes and resources needed to meet the goal, 3) performance indicators to measure outputs and outcomes, 4) methods of comparing program goals and results, and 5) validation of measurement tools.¹³⁸ Gaming tools are feasible mechanisms for delivering training while providing optimal compliance with the GPRA.

Per the GPRA, a gaming training tool ensures DHS funds are used effectively in accordance with the “National Strategy for Homeland Security.” The National Strategy includes a requirement for a national training and evaluation system.¹³⁹ Networked gaming can provide standardized national training and evaluation tools. The National Strategy plans a national exercise program with the capacity for all individuals and agencies to complete an exercise annually.¹⁴⁰ Gaming can scale to meet the need of national exercises for individuals and agencies at even greater frequencies than once a year. The National Strategy requires performance measures to evaluate progress¹⁴¹ and these measures can easily be included in the game design. America’s Army (AA) demonstrates MMOG ability to present specific, measurable performance measures that are more informative and easily understood than the performance measures in existing documents such as FEMA’s Annual Performance Plan. For example, AA compiles

¹³⁷ Turban, Efraim. p. 449.

¹³⁸ _____, “Government Performance and Results Act of 1993.” 103rd Congress of the United States of America at the First Session. Washington DC. 1993. Database available on line at <http://govinfo.library.unt.edu/npr/library/misc/s20.html> [Accessed 9 May 2004].

¹³⁹ _____, “National Strategy for Homeland Security.” Office of Homeland Security. Washington DC. July 2002. p. 45.

¹⁴⁰ Ibid., p. 45.

¹⁴¹ Ibid., p. 4.

statistics on total numbers of players registered and total training sessions completed.¹⁴² The National Strategy requires systems for sharing information¹⁴³ and this is another element that is integral to MMOGs through player chat rooms, bulletin boards, etc.

Similarly, a GBT tool can ensure that ODP funds are effectively used for its mission to “[...] develop and implement a national program to enhance the capacity of state and local agencies to respond to incidents of domestic terrorism, particularly those involving weapons of mass destruction (WMD), through coordinated training, equipment acquisition, technical assistance, and support for Federal, state, and local exercises.”¹⁴⁴

MMOGs have the ability not only to meet the letter of the GPRA law, but its intent as well, by making performance measures user friendly and easy to understand.

3. Safety

Use of gaming to deliver WMD training offers the opportunity for significant risk reduction. Virtual training exercises minimize possibility for risk of injury, damage to equipment, and damage to the environment. Injuries and deaths have occurred in first responder hands-on training exercises. For examples, back strains, heat exhaustion and other injuries occurred in the TOPOFF II exercise, necessitating the transport of some responders to the hospital.¹⁴⁵ In the worst case scenarios, responders have been critically injured and killed in training exercises. Users of a MMOG are at little risk of injury or death. Simulation offers the ability to reduce risk by providing a safe environment where responders do not suffer from falls, heat exhaustion, etc. In addition, operating in a virtual world eliminates risk of damage to equipment from normal use, wear, or mistakes, and eliminates risk of environmental damage in hands-on exercises that involve chemicals, fire, smoke, vehicle travel, emissions, and use of chlorinated water. MMOGs offer another kind of safety; they offer a safe learning environment where participants and officials do not fear public embarrassment or humiliation from failure to perform adequately in front of evaluators, the public, and the media.

¹⁴² _____, “FY 2002 Annual Performance Plan.” The Federal Emergency Management Agency. Washington DC. 2003. Database available on line at http://www.fema.gov/pdf/library/fy2002_new_all.pdf [Accessed 9 May 2004].

¹⁴³ _____, “National Strategy for Homeland Security.” p. 69.

¹⁴⁴ _____, “Office for Domestic Preparedness Website.” Washington DC. Database available on line at <http://www.ojp.usdoj.gov/odp/about/mission.htm> [Accessed 9 May 2004].

¹⁴⁵ Hepburn, Bill. p. 19.

4. Legitimacy/Support for Gaming

Gaming applied as a training solution has interest and support from government, academia, and private industry.

Simulations and gaming have a proven track record with the Department of Defense (DoD). The military has successfully used gaming for training for years.¹⁴⁶ The DoD currently uses simulation games as "...a cost-effective means of conducting joint training; developing new doctrine, tactics, and operational plans..."¹⁴⁷ In the 2001 Quadrennial Defense Review (QDR) Report, the DoD described virtual exercises, games and simulations as a critical way of finding new ways of responding to changing threats.¹⁴⁸ The DoD has indicated that simulations are one of the top five critical information technologies and have used them to move away from full scale field exercises.¹⁴⁹

DHS officials have also highlighted computer simulation or gaming exercises as a necessary tool to test response capabilities and determine needs.¹⁵⁰ ODP support for simulations includes a 1997 grant of \$7.7M to the Texas Engineering Extension Service to develop a virtual reality simulation facility in order to help response agencies practice coordination of WMD incidents. But the problem with this facility is that it still requires responders to travel to Texas to use it.¹⁵¹ ODP also provided grants to Dartmouth University to develop a "Virtual Terrorism Response Academy" to use gaming and personal computers to train first responders in WMD response procedures.¹⁵² ODP is

¹⁴⁶ _____, "Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response." National Research Council. National Academy Press. Washington DC. 1999. p. 148.

¹⁴⁷ Computer Science and Telecommunications Board. "Modeling and Simulation. Linking Entertainment and Defense." National Research Council, National Academy Press. Washington, DC. 1997. p. vii.

¹⁴⁸ _____, "Quadrennial Defense Review Report." Department of Defense. September 2001. pp. 35-36.

¹⁴⁹ Attributed to 1997 Defense Technology Area Plan in Computer Science and Telecommunications Board. "Modeling and Simulation. Linking Entertainment and Defense." National Research Council, National Academy Press. Washington, DC. 1997. p. 16.

¹⁵⁰ Kimery, Anthony. p. 24.

¹⁵¹ _____, "\$7.7 Million Expansion for TEEX Training Complex." Texas Engineering Extension Service. 26 October, 1999. Texas. Database available on line at <http://teexweb.tamu.edu/teex.cfm?pageid=NERRTCprog&area=NERRTC&templateid=927> [Accessed 4 March 2004].

¹⁵² Noel, Mark. Interview by Author. 7 January 2004. Lebanon, NH Database available on line at <http://iml.dartmouth.edu/education/pcpt/VTRA/index.html> [Accessed 23 May 2004].

also recognized the need to explore the use of models, simulations and games in their training and exercise programs.¹⁵³ The vast bulk of students taught at institutions such as FEMA's Emergency Management Institute (EMI) already receive their training through distance learning mechanisms. For example, in FY 2002, FEMA planned to deliver training to only 6,800 students on-site at EMI but planned for 75,000 or more than 90 percent of the students to be taught using distance learning methods.¹⁵⁴

First responders have previously used gaming simulations successfully. For example, fire simulators are used for ICS training; fire fighters enjoy using the simulators and their use has resulted in improved performance of incident command tasks.¹⁵⁵ Beering (et al) in a paper for the John F. Kennedy School of Government offered advice on how to conduct training to meet the national need: "We recommend that [... t]raining be conducted using train-the-trainer, Internet, Intranet, and other systems that permit distance and home learning."¹⁵⁶

Games enable learners to develop stories around their experiences, similar to the stories of responses to real events. This process is advocated by David Sims as one necessary to retain memory surrounding complex tasks.¹⁵⁷

¹⁵³ E.g. Contract GS-35F-0132K/OJP-2002-BF-016. Agrait, Rebecca, David Evans, Lisa Grossman et al "Review of Models, Simulations and Games for Domestic Preparedness Training and Exercising Volume 1." ThoughtLink. Vienna, Virginia. Database available on line at http://www.ojp.usdoj.gov/odp/docs/trngexercise_vol1.pdf [Accessed 27 April 2004].

¹⁵⁴ _____, "FY 2002 Annual Performance Plan." The Federal Emergency Management Agency. Washington DC. 2003. Database available on line at http://www.fema.gov/pdf/library/fy2002_new_all.pdf [Accessed 9 May 2004]. p. 9.

¹⁵⁵ _____, "VectorCommand." Australasian Fire Authorities Council Website, Database available on line at: <http://www.afac.com.au/products/vectorcommand.html> [Accessed 27 November 2003].

¹⁵⁶ Beering, Peter S. et al. "Winning Plays: Essential Guidance from the Terrorism Line of Scrimmage." BCSIA Discussion Paper 2002-6, ESDP Discussion Paper ESDP-2002-02, John F. Kennedy School of Government, Harvard University, February 2002. p. 4.

¹⁵⁷ Sims, David. p. 56.

IV. ANALYSIS OF A WMD GAMING SOLUTION

This chapter introduces the mechanism for MMOG WMD training and examines the predicted scope, effectiveness, and cost efficiency of MMOGs applied to first responder and civilian training. It looks at a successful example of gaming and compares that experience with applications for WMD training. It is clear that computer gaming applied to WMD training and exercises is a more appropriate mechanism for delivering training because it is scaleable, effective, and cost efficient.

A. MECHANISM FOR MMOG TRAINING

The MMOG for WMD training uses a personal computer (PC) based platform networked to host servers to run games with multiple players. This delivery mechanism has been proven in the past in the game “America’s Army”. The advantages of using a PC versus a game console include: 1) the hard disk has large storage capability, 2) there are diverse user interface options (via keyboard, mouse or joystick), 3) original games, new levels and repairs can be downloaded over the internet, 4) PC games can easily be updated, and 5) it is possible to purchase a game engine for use on a PC whereas game console manufacturers would not allow their platform to be used to host a game title that is available for free.^{158 159} The game America’s Army (AA) was developed for the DoD “[...] to expose, inform, educate, and entertain citizens about military service.”¹⁶⁰ “Part of the Army plan is to have people understand what basic training is, hence the training modules [...]”¹⁶¹ that educate civilians about what it is like to be in the army. AA has excellent applicability to the first responder training situation. The military uses modular training to qualify soldiers to fight and military work is thought of in terms of missions.

¹⁵⁸ Adams, Ernest. “Break into the Game Industry: How to Get A job Making Video Games.” McGraw-Hill/Osborne. San Francisco. 2003. pp. 12-13.

¹⁵⁹ For example, the X-box game console is sold at a loss and Microsoft must sell more than ten game titles on average to be profitable. The business plan is incompatible with the idea of giving away game titles for use on this console. Clark, Andrew. Microsoft Corporation. Interview with author. February 27, 2004. Redmond, WA

¹⁶⁰ _____, “America’s Army PC Game Vision and Realization.” United States Army and the MOVES Institute. San Francisco. January 2004. p. 30.

¹⁶¹ Zyda, Mike Interview by Author by phone & e-mail correspondence on 2 March 2004.

This is similar to the fire department which has initial qualification training and continuing education modules as well as response missions. Experience from AA is used in this chapter to analyze the potential of MMOGs as a training tool.

B. SCOPE OF GAME BASED TRAINING

The first chapter provided an extensive analysis of the shortcomings of existing training. This section reexamines these issues and suggests possible solutions. Specific examination is made of 1) first responder training needs, 2) civilian training needs, 3) continuing education, and 4) exercises. It is evident that GBT has the ability to address many of the tasks that previously have not been accommodated.¹⁶²

1. First Responder Training Needs

Existing training for first responders lacks depth of content. It has been mentioned that first responders need operational and technician level training. What role would an MMOG play in this training? A first responder MMOG can deliver awareness training and other courses in a virtual classroom replicating live course material available today. This technique was used in AA to teach first aid courses, vehicle identification, tactics, etc. A MMOG can also provide a realistic environment with simulated patients and prepare students for hands-on training, reducing the time dedicated to skill performance in the field. The first responder game could accommodate all of the awareness level skills and most of the operational level skills, with the exception of performance of hands-on tasks.

Performance of hands-on tasks could be prompted by modules in the first responder MMOG that require individuals to establish decontamination corridors, don and doff PPE, use detection tools, search rooms, triage, rescue, decontaminate and treat patients. Initial hands-on skill sessions could be condensed into one four hour module facilitated by a single instructor teaching 10 students. The instructor would be certified from “train the trainer” sessions and would bring reusable equipment and evaluation

¹⁶² This thesis outlines suggested requirements and design for a MMOG. If this project were funded, a full task analysis would compare current minimum tasks specified by the ODP with the capacity of gaming technology at the time. This analysis would be intended to ensure inclusion of all critical tasks at the right level of game fidelity.

check sheets for the hands-on session. Then the MMOG could meet or exceed skills provided by existing training by educating responders primarily on the computer and then supplementing games with hands-on task training at the responder's workplace.

In addition, responders need to participate in annual continuing education and exercises. While the bulk of this continuing education could occur in a simulated environment, some hands on refresher training would be desirable. This thesis recommends that responders spend at least two hours annually completing skill refresher stations similar to the initial hands on training. These annual skill stations could be standardized and self taught using layouts and evaluation criteria published in the MMOG.

2. Civilian Training Needs

The first responder WMD training game should be made available to civilians to enhance WMD preparedness and reduce anxiety about terrorism.¹⁶³ Civilians could have two options, either to play the game as a first responder or as a civilian in the midst of a WMD event. The game should prove to be successful at attracting civilian participation for several reasons. First, it offers civilians the opportunity to do something they rarely if ever have a chance to do: respond to a WMD incident and rescue its patients. The game is exciting, and the situation alone creates tension that should draw the player in. While there is a graphic aspect to the game (it depicts the victims of violence), the overall message is positive: rescue the injured and minimize losses while staying alive yourself. Theoretically, parents should welcome an alternative to first person shooter games where players are trying to kill; instead, these players save lives. Parents may even encourage children to play the game, instilling WMD awareness and core skills on the next generation. Civilians who are given the opportunity to practice proper first responder actions to a WMD event learn more about the WMD hazards, self protective actions, and responder expectations. Viewing the problem from different aspects is a proven technique to enhance learning.¹⁶⁴ By including citizens in the training, the game

¹⁶³ Butler, Adrienne, Allison Ponzer, Lewis Goldfrank, Editors. "Preparing for the Psychological Consequences of Terrorism. A Public Health Strategy" Committee on Responding to the Psychological Consequences of Terrorism. National Academies Press. Washington DC. 2003. pp. 107-109.

¹⁶⁴ Kelly, Henry et al., p. 24.

acknowledges that the public tends to lend assistance during emergencies.¹⁶⁵ An added advantage is that first responders can learn more about civilian behavior in a crisis. As mentioned previously, it is imperative to address the psychological aspect of a WMD incident since the largest numbers of casualties are minor or the “worried well” as seen in the Tokyo sarin attacks. Glass (et al) suggest that dissemination of information is as important as providing medicine.¹⁶⁶ By availing the first responder game and WMD information to citizens before a crisis, fear can be decreased. Glass (et al) agree that a strategy of education and information can serve to reduce public panic: “[...] in the midst of a collective crisis, a positive and active role for community groups and individual citizens provides a potential antidote to panic and other adverse psychological effects. In times of crisis, having a constructive role to play engages people in a common mission and provides a sense of control in periods of grave uncertainty.”¹⁶⁷ Per Butler’s recommendation, the game would be designed to teach specific actions for citizens to take in response to a WMD incident.¹⁶⁸ The intention would be to teach these shelter-in-place or escape type procedures to a broader audience than is currently reached on the [ready.gov](http://www.ready.gov) website.¹⁶⁹

3. Continuing Education

A MMOG does not have limitations on the number of times a player can enter the environment, therefore the original game can serve as a medium for continuing education and skill review. In addition, training modules installed in the game can be upgraded and enhanced to provide more in depth material during refresher training. Players can be encouraged to view the continuing education sessions by notifying them when policies, practices or technologies change and crediting them with successful completion of training modules.

4. Exercises

The National Research Council suggested in 1999 that computer tools like simulations can reduce the need for physical exercises which “...can be disruptive,

¹⁶⁵ Glass, Thomas A. p. 219.

¹⁶⁶ Ibid., pp. 220.

¹⁶⁷ Ibid., pp. 218-220.

¹⁶⁸ Butler, Ibid., p. 109.

¹⁶⁹ The Department of Homeland Security website <http://www.ready.gov> lists prioritized protective actions for civilians to take when caught in the middle of a WMD incident.

logistically complicated, expensive and unproductive.”¹⁷⁰ A MMOG used for virtual exercises accomplishes the task of delivering training by the preferred method¹⁷¹ while avoiding the costs of physical exercises. Games offer the advantage of simulating large scale responses without committing vast numbers of resources. An effective emergency response to a WMD incident depends on practice and experience; gaming offers an alternative way of practicing, since it is highly improbable that first responders will gain experience responding to real terrorist incidents.¹⁷²

Actual responses to WMD incidents involve the coordination of a significant number of resources. For example, 131 ambulances and 1,364 EMTs responded to the sarin attack on the Tokyo subway.¹⁷³ It is extremely difficult to muster equivalent resources for large scale physical exercises, but MMOGs will eventually have the potential to scale up to involve thousands of responders in a simulation. Holli Ploog of Unisys notes that while hands-on crisis response exercises have a hard time simulating the environmental chaos in an emergency, computer simulations now are capable of modeling these situations.¹⁷⁴ Furthermore, scene and character animation that uses artificial intelligence technologies addresses issues that arose in the live exercises such as excessive scripting, notional elements and lack of realism.¹⁷⁵

C. EFFECTIVENESS OF GAME BASED TRAINING

Effective training improves the responder’s task performance efficiency. Are gaming simulations more effective than the delivery mechanisms offered by ODP today? According to the Federation of American Scientists they are: “During the past few years the DoD and industrial organizations with major training requirements have found that large, distributed, multi-user simulations proved highly effective in training large groups of people to work together in performing complex tasks.”¹⁷⁶ They note training times

¹⁷⁰ _____, “Chemical and Biological Terrorism...” p. 143.

¹⁷¹ Pelfrey, William V. p. 12.

¹⁷² Kelly, Henry et al., p. 6.

¹⁷³ Smithson, Amy. “Ataxia: The Chemical and Biological Terrorism Threat and the U. S. Response.” Henry L. Stimson Center. Washington DC. 2000. p. 191.

¹⁷⁴ Ploog, Holli. “Mission: Possible. The Role of Partnership with Business.” Presented 13 September 2003, at Conference on Crisis Management and Information Technology. Helsinki, Finland. Database available on line at http://www.itcm.org/ppt2/Speech_Ploog.ppt [Accessed 7 February 2004]

¹⁷⁵ Hepburn, Bill. pp. 14-15.

¹⁷⁶ Kelly, Henry et al., p. 23.

can be reduced by as much as 80 percent.¹⁷⁷ One study on the effectiveness of flight simulator training quantified the effectiveness using the Transfer Effectiveness Ratio (TER) value suggesting that time required to learn a task on a simulator is less than one half (TER of 48%) the time required to learn in the air.¹⁷⁸ It is reasonable to expect that the TER for simulations of complex WMD exercises will be equal or better. The FAS noted that training simulations increased confidence and capability in communication and collaboration, and reduced casualties in real life high risk combat situations.¹⁷⁹

AA had a goal to inform and educate about the army. How effective were they at accomplishing this task? According to one survey, “[...] the game engendered positive awareness of soldiering among twenty-nine percent of young Americans age 16 to 24.”¹⁸⁰ Amazingly, this was accomplished with “[...] an expenditure of about one-third of one percent of the Army’s total marketing budget.”¹⁸¹

Will an MMOG ensure effective training? A reexamination of the issues of 1) accommodation, 2) capacity, 3) standards, and 4) evaluation suggests that MMOG WMD training would be more effective than existing hands-on mechanisms.

1. Accommodation of Training Needs

Will new MMOG training programs accommodate core WMD response tasks better than existing programs? The advantage a new program has is the ability to condense information from many resources into one place. Today, the ODP training consortium has spread training out to five specialized centers, each providing different instruction on their specialized area. A MMOG has the capacity to condense this dispersed expertise to one location. Levels of play could be developed to allow players to practice with each type of WMD. So theoretically, a MMOG would eventually have the

¹⁷⁷ Ibid., p. 24.

¹⁷⁸ Ibid., p. 26.

¹⁷⁹ Ibid., p. 5.

¹⁸⁰ _____, “America’s Army PC Game Vision and Realization.” p. 7.

¹⁸¹ Ibid., p. 7.

capacity to provide training for all core tasks.¹⁸² A fully developed MMOG has potential to provide greater task accommodation than exists today, so any game development should strive to include all WMDs as soon as feasible.

Levels of game play would offer accommodation of knowledge and decision tasks but not of hands-on tasks like donning and operating in protective equipment. Motion capture (MOCAP) simulation of these hands-on tasks offers players the visual representation of procedures, enabling them to envision the process. And since MOCAP covers each of the discrete steps, some learning of these tasks occurs with repeated viewing. However, the MMOG is not a proxy for hands-on drilling of these tasks, so the aforementioned annual skill stations should be included in the overall training plan.

2. Training Capacity

Does a MMOG have the capacity to provide training to millions of responders? AA offers insight to the possibilities. Since the initial release of AA in July of 2002, more than 3.3M people have voluntarily registered for the game.¹⁸³ Of these, 2.0M or about 60 percent have completed the basic training modules.¹⁸⁴ The AA game also includes first aid training modules on airway management, bleeding, and shock. Each first aid module has a test where the gamer must demonstrate satisfactory knowledge of the material presented. To date, more than 419,000¹⁸⁵ or 12 percent of the gamers have satisfactorily completed three of the first aid training modules.¹⁸⁶ In a randomly selected 24 hour period, over 6,700 players registered for AA, more than 3,500 completed the basic training module, and more than 1,500 completed first aid training.¹⁸⁷ AA has accomplished its mission very well.

¹⁸² However, initial development would be limited to one type of WMD, like chemical agents, potentially leaving significant gaps in overall accommodation.

¹⁸³ _____, America's Army Website. Database available on line at <http://www.americasarmy.com/> [Accessed 6 March 2004].

¹⁸⁴ Ibid.

¹⁸⁵ Approximately the same number who received WMD training from FEMA & ODP in the two years following 9-11.

¹⁸⁶ _____, America's Army Website.

¹⁸⁷ Data recorded from 1952 hours on March 6 thru 1952 hours on 7 March 2004. _____, America's Army Website.

A MMOG allows training to occur at any time of the day and with as much frequency as the learner desires. In fact, players can repeat iterations of various exercises ad infinitum in order to find optimal solutions. Since games do not require attendance at a scheduled class, they can be played anywhere, at work, home or when traveling. The FAS has noted the need to take advantage of the capacity of gaming to coordinate and disseminate WMD training:¹⁸⁸ “Internet-based tools for delivering the training will almost certainly be necessary to ensure that large numbers of people throughout the U. S. get involved.”¹⁸⁹ Clearly, a first responder MMOG for WMD training would have much greater capacity than conventional classroom training.

3. Training Standards

A critical aspect of a first responder training game is its ability to standardize training quality, content and performance measures by becoming the focal point that responders come to in order to gain knowledge. As opposed to the 170 odd WMD training programs offered by government agencies today, this WMD training MMOG could be the standard program that all responders would use. It is envisioned that such a game would replace many of the existing awareness programs and provide the bulk of training for operations certification.

4. Evaluation of Training

Current training programs have sparse data on outputs and even less on outcomes, but MMOGs offer numerous mechanisms to evaluate both the training outputs and outcomes. A WMD training MMOG can record output data such as numbers of players completing training and level of training completed, as well as outcome data such as overall performance on WMD simulations. MMOGs like AA have shown the viability of administering multiple choice exams following virtual training sessions. Games can record attendance at classes (instruction delivered), test scores, and generate individual and compiled group transcripts. Similarly, tracking of performance on exercise simulations can be automated by recording each task the player satisfactorily completes and benchmarks achieved. As players continue to use the MMOG, overall average scores

¹⁸⁸ Kelly, Henry et al., p. 4.

¹⁸⁹ Kelly, Henry. “Testimony of Dr. Henry Kelly, President Federation of American Scientists before the Senate Committee on Foreign Relations.” Federation of American Scientists. 6 March 2002. Database available on line at http://www.fas.org/ssp/docs/kelly_testimony_030602.pdf [Accessed 7 March 2004] pp. 8-9.

can be compared with earlier average scores to determine if player performance is improving. Captured performance results can be stored for analysis and documentation. Players have immediate feedback following the completion of each class and each game level, a proven tactic to reinforce learning objectives. Individual evaluations do not need to be made public, but overall data can be shared, thus avoiding embarrassment for individuals or jurisdictions. MMOGs can also restrict access to higher levels of training by locking out those levels until players demonstrate they can satisfactorily accomplish the basic tasks. In addition to course work and exercise evaluations, the MMOG can establish chat rooms and forums for players to meet and discuss tactics, procedures and plans. Player communities of practice can capture lessons learned from past virtual responses and record enhancements to virtual playbooks. Best practices and top scoring games could be stored for others to replay and view. Players can also replay their own scenarios and review their actions from a third person perspective. Gaming simulations improve proficiency while allowing assessment of skills and analysis of training effectiveness.¹⁹⁰

5. First Responder Computer Use and Access

First responders have excellent access to computers, and are likely to use a computer based game. 78.3 percent of first responders and 85 percent of firefighters have home computers compared with 66.7 percent of the general public.¹⁹¹ First responder home computers are relatively modern with more than 47 percent purchased in the last 4 years and 52 percent having Intel Pentium processors.¹⁹² First responders led the public in nearly 70 percent of categories of internet use.¹⁹³ A survey by the Interactive Digital Software Association (IDSA) indicated that 145 million people or 60 percent of the U. S. population over 6 years old already play computer and video games.¹⁹⁴ An even greater number of first responders (67%) play games on their home computer, and still more

¹⁹⁰ _____, "Why Use Simulation? – Return-on-investment" National Training Systems Association. 2004. Database available on line at <http://www.trainingsystems.org/publications/simulation/roi.cfm> [Accessed 7 March 2004].

¹⁹¹ _____, "Demographic Data and Draw Feature Report." p. 14.

¹⁹² Ibid., p. 15.

¹⁹³ _____, "First Responders Matrix Analysis Website Draws." p. 8.

¹⁹⁴ Saltzman, Marc et al. "Game Creation and Careers: Insider Secrets from Industry Experts." New Riders Publishing. San Francisco. 2004. p. xxix.

firefighters game on-line (75%).¹⁹⁵ Gaming does not appear to be age or gender biased: the average age of game players is 28 years old and 43 percent of the gamers are women.¹⁹⁶ If the majority of first responders and Americans are already voluntarily playing these games, it should not be difficult to entice them to play a game as a part of training, education or exercises.

However, several areas of IT capacity are concerning and warrant discussion. First, survey results indicate that bandwidth constraints and poor staff/help desk support are cited as among the biggest problems for federal entities, and while reports on first responder internet connection speed vary, responders are likely to encounter similar problems.¹⁹⁷ ¹⁹⁸ High speed internet access is generally advisable for MMOGs; games like AA can accommodate connection speeds of 56k or less but players may not be satisfied with the performance. Second, software used by first responders at home tends to be older, with 58 percent using Windows 95 or 98; this older software may have compatibility problems with newer games.¹⁹⁹ Third, PCs tend to lack standardization, that is, PCs tend to have different hard disks, memory, processors, video drivers, and software.²⁰⁰ Patches and fixes do not guarantee a game runs on all computers, for example, some games do not run if the graphics card on the particular machine is not compatible.²⁰¹ A first responder MMOG may experience similar problems. Fourth, many first responders do not connect to the internet at work (43%), in fact, *none* of the firefighters who responded to the Plexus survey used on-line training at work.²⁰² This does not mean that computers are not available to first responders at work, only that the

¹⁹⁵ _____, "Demographic Data and Draw Feature Report." pp. 22, 24, 25.

¹⁹⁶ Saltzman, Marc et al., p. xxix.

¹⁹⁷ _____, "Demographic Data and Draw Feature Report." p. 27.

¹⁹⁸ Kelly, Henry et al., p. 29.

¹⁹⁹ _____, "Demographic Data and Draw Feature Report." p. 16.

²⁰⁰ Adams, Ernest. "Break into the Game Industry: How to Get A job Making Video Games." McGraw-Hill/Osborne. San Francisco. 2003. p. 13.

²⁰¹ Zyda, Mike. 13 April 2004.

²⁰² _____, "Demographic Data and Draw Feature Report." pp. 18, 23.

respondents to the survey did not use on line training.²⁰³ Fifth, on the game development side, bugs can appear if the game engine is purchased rather than developed internally. Game developers who purchase the game engine commercially tend to elect to allocate resources to developing new and interesting levels of game play rather than focus on the game engine.²⁰⁴ As the developers of the game engine implement changes, problems that impede operation and smooth functioning of the game can develop if the game level developers fail to implement fixes to the engine. The fact there were frequent changes to the AA game engine coupled with the lack of programmers to keep up with the engine fixes was one of the main reasons for problems experienced with the game.²⁰⁵ Finally, game designers develop game software based on the computing capacity of high end machines around the time the project begins, as these machines tend to be the average two years later when the project is completed.²⁰⁶ While first responders have good computers today, their resources are not the high end machines and a new first responder MMOG may exceed their computer capacity. It is important that new developments in gaming technology parallel enhancements to computer resources that are available to first responders. Computer memory requirements, operating systems, and connection speeds must meet or exceed capabilities required by the training game. Any new training game must be compatible with these computing resources or these resources must be upgraded to be compatible with the game.

First responders still have greater accessibility to computers than they do to the ODP consortium training sites, and MMOGs should be a good mechanism to deliver training, but responders may need assistance in upgrading computer systems and connectivity to ensure compatibility with the MMOGs.

²⁰³ In the City of Seattle the experience is quite different. Every fire station has at least one computer and all firefighter/EMTs use the computer for on-line competency based training (CBT). A certain percentage of first responders do not use, and may resist using computerized training tools for a variety of reasons. However, these issues can be overcome. For example, Seattle Firefighters are rewarded for completing CBT modules on line with a small specialty pay premium. Seattle fire fighters who lack computer skills or interest in using computers are often aided by more computer savvy co-workers in the completion of this training.

_____, 2002-04 Contract. Seattle Fire Fighters Union, Local 27. Seattle. 2002. p. 55.

²⁰⁴ Zyda, Mike.

²⁰⁵ Ibid.

²⁰⁶ Ibid. 2 March 2004.

D. COST EFFICIENCY OF GAMING BASED TRAINING

Using MMOGs as a WMD training tool is a much more cost efficient solution than expanding existing training programs to meet the need. The cost model for this approach is vastly different from the traditional model. Costs include system development, delivery, maintenance, and updates. The majority of these costs are non-recurring engineering costs making this training scalable to include the entire target population. This thesis suggest that one game level be developed to prove the concept, and further levels be developed later at lower cost (due to non-recurring costs of such items as MOCAP system and equipment) to ensure training addresses all the core tasks that can be learned in a virtual environment. GBT has the potential to educate millions of users at a fraction of the expense of traditional methods. The following sections detail costs for 1) game development, 2) game distribution, 3) game hosting, 4) first responder computer use and access, and 5) supplemental operational skill training. These costs are used to make a comparison of the cost efficiency of existing instruction methods to a first responder WMD training MMOG.

1. Game Development Costs

How much would it cost to develop a WMD training MMOG for first responders? A team of 25 people at the MOVES²⁰⁷ Institute costs about \$2.5M per year and staff there estimate that one game level could be developed in about one year.^{208 209} Purchase of rights to a game engine such as the “Epic Unreal Engine” is approximately \$300,000 and computer laboratory PC’s and software cost approximately \$600,000.²¹⁰ A MOCAP system²¹¹ costs about \$200,000.²¹² MOCAP work can be conducted in conjunction with first responder exercises.²¹³ A budget of \$500k covers smaller scale exercises involving a few responders in multiple locations to enable MOCAP for activities surrounding one

²⁰⁷ MOdeling, Virtual Environments and Simulation (MOVES)

²⁰⁸ _____, “America’s Army PC Game Vision and Realization.” p. 20.

²⁰⁹ Zyda, Mike. 2 March 2004.

²¹⁰ Ibid.

²¹¹ Motion capture is the process of creating realistic animations by filming people as they perform common maneuvers unique to their discipline while wearing a special suit that tracks position of key body parts.

²¹² Zyda, Mike. 2 March 2004.

²¹³ This offers a double benefit for the response community: an exercise today that leads to a game tomorrow.

type of agent.²¹⁴ Table 4 shows that the estimated cost of developing *the first level* of a WMD training game for chemical agents is \$4.1M or 3.3 percent of the annual ODP Training Consortium's budget.²¹⁵

Table 4. WMD Responder MMOG Development Cost Estimate for One Game Level

MOVES Institute Wages for 1 ½ years [ops]	\$2,500,000
Game engine rights [capital]	300,000
Computer laboratory computers, MOCAP system and software [capital]	800,000
Operational costs - exercises and drills with first responder skill MOCAP	500,000
Total	\$ 4,100,000

The cost of developing the first level of a WMD responder MMOG is only about 1 percent of total FY03 federal training and exercise budget allocations.²¹⁶

Development of additional levels would require programming by the MOVES staff, and additional skill MOCAP, technical review, testing, and validation with first responders. Using an estimate of one year development cost for each additional WMD,²¹⁷ an annual cost of institute staff of \$2.5M, and cost for first responder participation of \$0.5M, then the additional cost to create a complete game would only be \$12M.²¹⁸

Clearly, cost savings from using simulations has great potential.

2. Distribution Costs

Once the game is developed, it must be distributed. If the game were made into a Compact Disk (CD) then costs of manufacture, packaging and shipment could become significant. However, games like AA have demonstrated that distribution can be accomplished by free downloads from a host web site. Thus the manufacturing, packaging and distribution costs are bypassed by advertising about how to access a

²¹⁴ WMD exercises involving all of the first responder agencies can be expensive - as mentioned previously - the TOPOFF II exercise was allocated \$7M. However, it is possible to hold smaller scale exercises and complete motion capture work for much less.

²¹⁵ ODP Training Consortium Budget was \$125M in FY03.

_____, "Conference Report [Fiscal Year 2003 Appropriations]"p. 635.

²¹⁶ \$4.1M / \$345M = 1.2% (from Tables 4 and 3).

²¹⁷ Remaining WMDs include radiological/nuclear, explosives, incendiary and biological.

²¹⁸ (2.5M MOVES wages & costs + 0.5M cost for motion capture, exercises, research, technical support and validation) x 4 years (or levels) = \$12M.

download site and provision of the site (details below). A significant advantage of delivering the game via the internet is that information and curriculum updates are much easier – developers simply release the latest version and have users update their program. As WMD response technologies develop, the game can become a platform for dissemination of new information for responders.

3. Game Hosting Costs

While game design is a significant area of investment, a MMOG must be supported by dedicated high speed game servers. Servers provide interface between the client computers (player computer) and the game's character and world databases.²¹⁹

In order to determine the required server hosting capacities, it is necessary to determine the total player base. The player base can be determined by a variety of methods, including counting: 1) the number of registered players, 2) the number of daily players, 3) the number of player hours, or 4) the number of simultaneous players.²²⁰ For the purpose of determining server capacity, the best measure probably is the total number of simultaneous players that must be supported during peak load times.

AA has more than 3.3M registered players and 8,187 servers with player capacities of around 32 players, or capacity to host of approximately 8 percent of total players at any given time.²²¹ Since there are 4.2M first responders, if server capacity were designed for maximum number of simultaneous players at 10 percent then approximately 420,000 player slots are needed.²²² Commercial prices for dedicated high

²¹⁹ Bartle, Richard A. "Designing Virtual Worlds." New Riders Publishing. San Francisco. 2004. pp. 94-96.

²²⁰ Ibid., pp. 50-52.

²²¹ While only a small portion of these servers are registered (468), this thesis will consider all the servers as having necessarily arisen to support demand and therefore a good indicator of the true need for support. _____, America's Army Website.

²²² $4,200,000 \times 10\% = 420,000$ player slots (or $13,125$ servers with 32 player capacity would be required to support the entire first responder population $420,000/32$ slots per server = 13,125 servers).

speed public game servers are \$105-140 per month for a 20 player slot public server.²²³ If server access was purchased for 420,000 slots the annual commercial cost for hosting a MMOG would be \$25.2M.²²⁴ It is possible that the price of server hardware and high speed access when bulk purchased for ownership would be considerably less than player slot public access to servers purchased individually on the commercial market.

4. Responder Computer Enhancement Costs

Prior sections noted potential problems with first responder computers primarily concerning speed of internet connectivity and lack of standardization and compatibility. While responders generally have adequate access to quality computers these issues could be resolved by providing new gaming computers and internet access for first responders. How much would this cost? Many responders use shared facilities such as fire stations, police stations, and hospitals and would be able to share computer access (they don't each need a computer).²²⁵ If one gaming computer work station was provided for every 25 employees, there would be approximately two full weeks access to the computer per year for each employee.²²⁶ If these computers were provided, they could serve a dual function for intelligence and information sharing between local, state, and federal

²²³ \$140 for 20 slot public server for America's Army. Gamevault web site. Database available on line at http://gamevault.com/game_prices.php?game_name=America%27s+Army; \$109 for 20 slot public server for America's Army. Multiplay web site. Database available on line at http://hosting.multiplay.co.uk/buy_clanserver.php; \$105 for 20 slot server for America's Army. UrbanServers web site. Database available on line at <http://urbanservers.com/>; \$120 for 20 slot server. Cyberseals.net website. Database available on line at <http://www.cyberseals.net/portal/modules.php?name=Content&pa=showpage&pid=107>; \$110 for 20 slot public server for Tribes2 game. Recongamer Web Site. Database available on line at <http://www.recongamer.com/gameservers/t2/public.aspx>; \$140 for 20 America's Army Players _____ Game Vault Web Site. Database available on-line at http://gamevault.com/signup_form_game_servers.php _____, Cyberseals.net Website for Gamer Server Hosting. Database Available on line at <http://www.cyberseals.net/portal/modules.php?name=Content&pa=showpage&pid=27> [Accessed 20 May 2004]. [Accessed 21 May 2004].

²²⁴ It is believed that a large bulk purchase of 420,000 slots would receive a discount of at least \$5 from normal prices of \$105 for a 20 person server. $420,000 / 20 \text{ slots per server} \times \$100 \text{ per server} \times 12 \text{ mo/yr} = \$25,200,000 / \text{year}$.

²²⁵ In Seattle, for example, there are 1003 uniformed members and 34 fire stations or approximately 30 employees per station spread among 4 shifts – so a single computer installed in a station would only have demand from seven or eight employees on any given day. _____, Seattle Fire Department Web Site. City of Seattle. Database available on line at http://www.cityofseattle.net/fire/departmentsInfo/dept_profile.htm [Accessed 20 May 2004] The Seattle Police Department has 1,262 officers and five precincts or about 250 per station. _____, Seattle Police Department Website. City of Seattle. Database available on line at <http://www.cityofseattle.net/police/jobs/sworn/FAQs.htm> [Accessed 20 May 2004].

²²⁶ $1 \text{ computer} \times 52 \text{ weeks} / 25 \text{ employees} = 2.08 \text{ weeks access per employee}$.

agencies. A cutting edge gaming computer can cost from \$1,100 to \$3,000 or more.²²⁷ The cost to provide one \$1,500 gaming computer for every 25 first responders would be \$252,000,000.²²⁸ DSL services cost approximately \$35 per month per line.²²⁹ The cost of 1 year DSL access for each of these computers would be \$70,560,000.²³⁰ This still adds only about \$77 per student to the cost of implementation or about 5% average per student cost of existing programs.²³¹ These numbers are provided for reference only; computer and access costs are not included in subsequent estimates because of the adequacy of existing responder computers.

5. Supplemental Operational Skill Training Costs

It was previously noted that the MMOG would not fulfill all training requirements. Some skills must be performed hands on under the guidance of a trained instructor who sets up and monitors rotating skill stations.

These instructors would be certified using “train the trainer” courses which could be delivered via the MMOG. The MMOG is an appropriate mechanism because the skill stations are simple to set up and standardized. Instructors would be provided student evaluation criteria and instructions on how to establish skill stations. By making train the trainer certification a part of the MMOG, students are encouraged to explore game material more deeply and learning is enhanced.

The supplemental operational skill instruction sessions should occur at the responder’s workplace to minimize their impact on agency operations. The instructor would run the students through a series of mini-drills or skill stations during a four hour period where they demonstrate basic competency using PPE, detection equipment,

²²⁷ Modern Gateway gaming computers range in price from \$1,100-3,300 ____, Gateway Website. Database available on line at http://www.gateway.com/home/products/gaming.shtml?cm_ven=Google&cm_cat=Consumer&cm_pla=search&cm_ite=gaming_computer [Accessed 20 May, 2004], Modern Dell gaming computers range from \$1750-2400. ____, Dell Computer Website. Database available on line at \$1750-2400 http://www1.us.dell.com/content/topics/segtopic.aspx/jmp_gmr?c=us&cs=19&l=en&s=dhs [Accessed 20 May 2004].

²²⁸ 4,200,000 responders x 1 computer / 25 responders = 168,000 computers. 168,000 x \$1500 = \$252,000,000.

²²⁹ ____, Verizon Internet Site. Database available on line at http://www22.verizon.com/forhomedsl/channels/dsl/forhomedsl.asp?promotion_code=VZBNR/W28&variant= [Accessed 20 May 2004].

²³⁰ 168,000 computers x \$35 / month for DSL x 12 months = \$70,560,000.

²³¹ \$77 / \$ 1700 = 4.5%.

decontamination, etc. Instructors should be readily available at \$50 per hour or \$300 for 4 hour session (including 2 hours travel and set up time) resulting in a cost of \$30 per student.

Skill stations completed after the first year would be guided by the MMOG but self taught by the students. There would not be an additional instruction cost for annual refresher skill stations.

6. Analysis of Training Efficiency – Per Student Cost

The FAS suggest that use of games and simulations can “...reduce training times by as much as 80 percent.”²³² A Finnish logging company found that “[...] with the help of a visual simulation program, training can now be carried out for only 1 percent of the cost of the traditional method.”²³³ Is it possible that similar savings could be realized by using games to train first responders? Comparing the predicted training efficiency of existing ODP programs against a MMOG shows the potential for cost savings.

First responders must receive both initial WMD operational level education and a minimum of one day continuing education and exercise annually.²³⁴ This section examines cost per student of providing this initial operations level hands-on training, and the cost of one day of continuing education and exercises per responder, for a span of five years using two different methods: 1) the existing ODP program or 2) a MMOG.

What is the cost of scaling existing training to complete this five year program? While the bulk of existing ODP training is awareness level, this section will presume that this training could be expanded into a full operational level course lasting one week for the same per student cost of \$1700. It also presumes system capacity is capable of scaling to meet this need. As previously noted, the cost of providing this training to first responders who have not yet received it is \$6.2B.²³⁵ Using average student costs from ODP consortium sites like the CDP of approximately \$1700, the daily cost is estimated at

²³² Kelly, Henry et al., p. 24.

²³³ Turban, Efraim. p. 376.

²³⁴ _____, “National Strategy for Homeland Security.” p. 45.

²³⁵ 87% of 4.2M.

1/5 this or \$340. The cost of providing one day of WMD continuing education/exercises per year for five years for all responders is \$7.1B. Table 5 shows the total 5 year cost to train first responders is approximately \$13.4B.

What is the cost of using a MMOG to complete the 5 year program? Expenses include cost of: 1) developing an MMOG for all five WMDs, 2) cost of web hosting, and 3) cost of supplemental operational skill training. It should be noted that in both cases above the labor costs for student attendance and backfill are omitted because they require roughly the same time commitment. The main difference is that the MMOG enables the student to complete the training at work, while the current programs involve travel to Consortium sites. Table 5 summarizes the estimated costs.

Table 5. Training Efficiency Cost Comparison

Cost of Training Using Existing Programs	
Initial Operational Training ²³⁶	6,211,800,000
Continuing Education & Exercises ²³⁷	7,140,000,000
Total Using Hands-On Training	13,351,800,000
Cost of Training Using MMOG	
Proof of Concept First Level Development	4,100,000
Development of 4 Additional Levels	12,000,000
Web Hosting for 5 years ²³⁸	126,000,000
Supplemental Skill Station Instruction ²³⁹	126,000,000
Total Using MMOG	268,100,000

The total cost of a five year training program using an MMOG would be just 2 percent the cost of conventional techniques (or a savings of \$13.1B).²⁴⁰ The total per student cost is \$64 using a MMOG compared with \$3179 using conventional methods.
²⁴¹ ²⁴² Plus, in addition to providing training to the first responder community, the game

²³⁶ 4,200,000 responders x 87% untrained x \$1700 per week = 6,211,800,000.

²³⁷ 4,200,000 responders x \$340 per day x 5 years = \$7,140,000,000.

²³⁸ 25,200,000 server cost per year x 5 years = 126,000,000.

²³⁹ \$30 per student x 4,200,000 = 126,000,000.

²⁴⁰ \$268,100,000 / \$13,351,800,000 = 2.0%. 13,351,800,000 – 268,100,000 = 13,083,700,000.

²⁴¹ Including 4 hours of initial hands on operational skill training with an instructor.

²⁴² For a five year training program with a continuing education component the respective values are: MMOG training: \$268,100,000 / 4,200,000 responders = \$63.83 / responder. Existing training model: 13,351,800,000 / 4,200,000 = \$3179/responder.

can also provide training and information to the nation's 290M civilians, something the hands on programs could not do even at the estimated expansion cost of \$13.4B. The game development cost is a very small part of the training expenditure and with the opportunity to save literally billions of dollars, MMOG development for first responder WMD training should begin immediately.

One critique of these cost statements may be that they presume training of *all* first responders and it was previously noted that 43% of first responders do not connect to the internet at work. Even if a computer was provided for every 25 responders and DSL access was provided for 5 years, the total 5 year cost would still be only \$208 per student or 6.5 % the cost of providing conventional instruction.²⁴³ But it is not likely that computers will have to be provided in this fashion, after all, many first responders are volunteers and have excellent access to home computers. If the game is well designed and fun, it is likely that first responders would engage in on-line gaming and instruction from their home computers.

An additional advantage of simulations is that they enable responders to train at work, and interrupt an exercise at any moment to respond to an emergency. Thus, responders have higher "mission availability" because they are not deployed to off site locations for training. GBT can occur during low intensity work periods. This is a particular advantage to law enforcement agencies that RAND found "[...] find it very difficult to train large groups of personnel and sustain competency across an entire force over time."²⁴⁴

²⁴³ \$252,000,000 for computers + (\$70,560,000 DSL x 5 years) + 268,100,000 (cost of MMOG training) = 872,900,000 total cost. $\$872,900,000 / 4,200,000$ responders = \$207.83 / responder.

²⁴⁴ LaTourrette, Tom. p. 111.

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V. CONCLUSIONS & FUTURE WORK

A. CONCLUSIONS

The first responder community is made up of 4.2M workers in the fire, EMS, law enforcement, public health, public works, and emergency management professions. This community of responders is in dire need of WMD operational level training and current programs cannot scale to address the need because of financial and logistical impediments. In addition, there is a need to provide WMD training to other responders from the skilled trades, the military and the general public. Gaming technologies offer a solution to meet this training need.

Existing WMD training programs are inadequate in scope, effectiveness and cost efficiency. The bulk of training provided has been one time awareness level and not the operations level training that first responders need, and programs have not begun to address training civilians. Today's WMD education efforts are ineffective because they lack the delivery capacity to handle millions of responders, do not hold responders to minimum performance standards, and lack capacity to measure outcomes or impact on response effectiveness. These programs are not standardized and educational material that is presented lacks consistency. The most significant problem of today's WMD training programs is their huge expense and lack of scalability. These programs currently account for hundreds of millions of dollars of annual spending yet have trained only a fraction of the first responder population. The exercises that have been conducted have been extremely expensive and of marginal benefit. The practice of having students travel to training campuses to receive instruction makes poor use of modern technology and increases program expenses resulting in poor cost efficiency. Use of these inefficient programs to provide instruction to all responders would cost billions of dollars. But the existing programs are not even capable of scaling to meet the needs of millions of responders.

Massively Multiplayer On-line Gaming (MMOG) offers a cost efficient answer capable of addressing the bulk of WMD training needs. Educational material is delivered in a fresh and exciting manner. Computer games can scale to meet the vast need of

responders and can be a tool to spur innovation. Reliance on hierarchical organizational structures is reduced by ingraining knowledge of appropriate actions in both responders and civilians alike. MMOGs meet the requirements and intent of the 1993 Government Performance and Results Act both strategically and tactically. They offer a safe environment to practice WMD response, and their use is encouraged by scientists, government officials, responders and academics. Since games operate on a networked PC platform, the first responder community would generally have good access to training. Awareness training is easily delivered plus opportunities are given to practice of strategic decision making. Operational level training requirements can be accommodated by providing supplemental skill stations taught at the responder's workplace. MMOGs can meet national strategic objectives of annual training and exercises for first responders while fulfilling responder needs of continuing education and skill maintenance. Gaming also can be made available for civilian education offering the potential to enhance survival and reduce psychological impacts. These technologies have demonstrated ability to reduce training times. Scalability is far superior to conventional education methods. MMOGs can offer a nationally standardized training program and eliminate the need for many existing courses. Evaluation and measurement of training outcomes can be accomplished using a variety of tools including record of training delivered, test scores, and automated performance tracking or scoring in the simulated responses. Repeated play of WMD games can enable responders to discover and record optimal response practices. But the main advantage of GBT is the significant cost savings. Cost of developing a game would be nominal in comparison with federal training expenditures. The cost of developing *and hosting* a game, and delivering training of hands on skills to train first responders to the operational level is only two percent the cost of scaling existing programs to deliver comparable training. The savings from use of gaming technologies could exceed \$13B.

The federal government must reassess the existing mechanism for delivering training. When MMOGs are compared to delivery of conventional hands on training they surpass current methods in scope, effectiveness, and cost efficiency. The model for training proposed here is suitable for other DHS training and instruction requirements and should be considered a template for the next evolution in education. The choice is clear,

the next step in the evolution of WMD training is the implementation of a comprehensive on line multiplayer gaming system. The technology to accomplish the task exists today. We only need to begin.

B. FUTURE WORK

In order to implement a WMD training MMOG for first responders and civilians, some additional research is required. This research pertains more to the content and design of the game than to whether gaming is an appropriate solution.

The training game must be carefully designed to meet ODP task delivery requirements and it must be empirically validated to demonstrate that it has achieved these objectives. It was previously mentioned that there are more than 170 WMD training courses currently taught by federal agencies. These courses lack standardization and skills taught are not all the same. The WMD MMOG must capture the skills and information taught in this plethora of courses and condense them into one program. It is important that the task list is inclusive; therefore, further research is required to create a validated and complete skill / task list for the game designers.

The MMOG will use artificial intelligence to simulate the behavior of civilians in WMD emergencies. Human behavior cannot simply be modeled as a race to the nearest exit; in fact, actual actions are much more complicated. Some people focus on self preservation, some bypass responders and seek medical assistance at health care facilities, others investigate the hazard or render aid to patients. Human behavior in emergencies and disasters has previously been modeled. Data from these studies should be included in design of artificial intelligence for modeled civilians in the training game. Additional research may be needed to accurately model evacuation during emergencies in above ground and below grade structures.

Percentages of uninjured people who seek help have varied widely depending on incident type, WMD agent and cultural factors. More research is needed to predict the behavior of help seeking by uninjured parties during a WMD incident to guide the game rules.

While the hazards of WMD agents are generally known, and attempts have been made by Universities such as Dartmouth to simulate these hazards in a virtual world, we

do not know how accurate these virtual models need to be in order to deliver the correct impression on first responders. Super accurate models are memory intensive and slow down the game engine, they are also unnecessary since it is difficult to perceive actual distances in a virtual world. In addition, the exact movement of WMD gases is variable, and probably does not need to be modeled to a high degree of accuracy. However, some basic set of standards should be developed for modeling the behavior of WMD solids, liquids and gases accurately enough to give a reasonably close impression to the first responder of their hazards.

The game scoring matrix and task priorities must be established, reviewed and validated by subject matter experts from the first responder community.

There must be some consideration of the possibility that a terrorist may attempt to gain intelligence from the game to study first responder plans and vulnerabilities. Security issues must be resolved in order to ensure full participation of the first responder community. Research is needed on adequacy of Operational Security (OPSEC) procedures like password protection and player screening to prevent major security breaches. Research is also required that weighs the potential benefits of civilian participation in the MMOG against possible security risks to national response plans.

Some procedures when implemented in the field put first responders at risk. These procedures are controversial and have a liability aspect because they infer potential harm to first responders. While responders are often willing to “risk a lot to save a lot”, and accept some dangers, the implementation of policies that presume a level of harm to responders is another matter. Research is needed regarding the liability of teaching procedures that accept harm to the responder. Some response policies (e.g. response to radiological and chemical agents while wearing standard firefighting PPE) have not been adequately solidified nationally because of these kinds of concerns. It is important that a MMOG consider these difficult decisions and the liability of presenting certain course material. Research should be conducted on the extent of liability for injury of the training program if responders incur injury while following recommended procedures.

In order to implement a MMOG training solution for WMD education, research is needed to find the best organization, company or agency to complete the program

development. While large private corporations have the technical capacity to develop such tools, the need to be profitable presents hurdles when creating software designed for free distribution. A preferred organization would be modeled after academic research institutions such as the MOVES Institute. Research organizations offer the advantage of focusing on leading edge technologies rather than finding ways to adapt or profit off existing tools. The experience of the MOVES Institute in creating “America’s Army”, a complex MMOG, would prove invaluable in the development of a first responder training game. Any agency contracted to create this game should have a proven track record in developing complex reality based educational or training MMOGs. The optimal project development plan would partner a first responder agency that holds WMD response subject matter expertise with a research institute experienced in MMOG development work.

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APPENDIX GAME DESIGN DOCUMENT²⁴⁵

A. INTRODUCTION/OVERVIEW

That first hour will be crucial to containing the attack and reducing casualties. The ability of first responders to correctly identify an incident as a terrorist WMD attack – and respond accordingly – will mean the difference between life and death in the outcome and will prevent first responders from becoming victims. – H. Allen Holmes.²⁴⁶

B. FOCUS

The Weapons of Mass Destruction 1st Responder (WMD1R) game is a tactical Massively Multiplayer On-line Game for first responders that teaches WMD awareness and response operations skills and allows players to practice these skills. Game objectives include proper scene approach, recognition of WMD indicators, selection of appropriate PPE, use of proper communication and command procedures, scene isolation, evacuation, and rescue, decontamination, triage and treatment of patients.

The game is expandable from a single player game to a Massively Multiplayer On-line Game involving dozens of players simultaneously engaged in on line play. It is envisioned that technology will eventually allow the game to be scaled to involve hundreds to thousands of players. Future versions will also be designed to include tools and vehicles for other first responders like law enforcement officers, EMS workers, public works and public health workers.

Initially, ten game missions would be developed for chemical WMD agents. Later versions will expand the levels of play to include all potential types of WMDs. WMD agents simulated in the game will have realistic properties that can injure or kill the game characters if they approach the agent without proper protection.

The game has three main environments the players move through: the fire station, the city, and the emergency scene. Players work in a virtual fire station where they can

²⁴⁵ Outline taken from Rouse, Richard. “Game Design: Theory & Practice.” Wordware Publishing. Plano. 2001.

²⁴⁶ _____, “Combating Terrorism. Opportunities to Improve Domestic Preparedness Program Focus and Efficiency.” United States General Accounting Office. GAO/NSIAD-99-3. Washington DC. November, 1998, p. 38. [Appendix VI. Comments from the Department of Defense. [2 October 1998 Letter from H. Allen Holmes to Mr. Richard Davis, Director, National Security Analysis, U. S. GAO].

take training courses in WMD, firefighting, and first aid. When players receive an “alarm” or notification of an emergency, they need to quickly board the fire apparatus and respond through the city to the scene.²⁴⁷ Once on the emergency scene, players get off the apparatus, select equipment, and engage in solving the problems presented. Players must select the proper PPE, interact with simulated patients, and take measures to mitigate the problem. When the ‘emergency’ is complete, or time runs out, the player returns to the station and prepares for the next alarm.

The game is set in a growing city whose jurisdiction has both urban and rural areas. The mock city has a full time fire department with hazardous materials response capability. Players have the choice to assume the role of firefighter or fire fighter/hazardous materials technician. Players will staff apparatus in teams of four. Initial multiplayer options will enable up to thirty two players or eight teams of four to play. The eight apparatus will respond from different stations²⁴⁸ located throughout the city.

The game provides a platform for players to practice WMD response skills and develop methods for efficiently and effectively handling complex WMD problems. Accomplishment of mission tasks within a timely manner credits the player with positive points toward an overall score. Failures may result in the injury or death of the player and reintroduction into the game as an alternate responder. WMD1R is designed to be played on a personal computer (PC) with consideration for video game platform compatibility. The game reduces cost of initial and recurrent training for WMD first responders while creating a fun and realistic environment that encourages practice and experimentation.

C. AUDIENCE

The game is initially designed for fire fighters and hazardous materials technicians to practice response actions at a simulated WMD incident. The game is also

²⁴⁷ The response to the emergency scene is both entertaining and teaches the players about a cautious and proper approach.

²⁴⁸ Between four and eight stations.

intended to teach WMD response skills and survival behavior to other first responders, military personnel²⁴⁹ and the civilian community. This game focuses on the first few hours of the incident when the greatest potential for lifesaving exists.

While traumatic injuries would be depicted in the game, the player themselves do not engage in violent behavior, but instead focus on saving lives. It is envisioned that the game would be made available to the civilian community as an educational tool, and it is expected that it would be a popular alternative to violent ‘first person shooter’ games that proliferate the market today. The positive nature of the game should appeal to parents.

Simulation of federal response agencies initially is minimized due to the focus on the moments immediately after the WMD incident occurs, since many federal response agencies will not arrive until hours or days later.²⁵⁰ Later evolutions of the game capable of hosting hundreds of players would include federal responders in the simulations.

D. GAME PROGRESSION

Players who enter the game may immediately report for duty and begin practicing their WMD response skills by responding to simulated emergencies, or they may participate in training before making themselves available for responses.

Players will be encouraged to complete the training modules; training will be documented and included in their game record of accomplishments, plus it allows players to operate more effectively and efficiently in the virtual environment. Completion of the training modules will be required for certification in different response capabilities.

Players learn about the virtual world through training missions that familiarize them with the game controls and environment. Training missions include driving the apparatus, donning PPE, and using specialized equipment.

²⁴⁹ The gaming solution has applications beyond first responder training. For example, the Army has also experienced problems training their personnel in WMD Medicine and other WMD task skills and a first responder game can help address these needs. _____, “Chemical and Biological Defense. DoD Needs to Clarify Expectations for Medical Readiness.” U. S. GAO. Washington, DC. October 2001. pp. 28, 30-31.

²⁵⁰ Federal response agencies like the National Medical Response Teams (NMRT), (who have a mission of field decontamination and medical care for mass casualties of a WMD incident) typically do not arrive early (unless they are pre-deployed) since they must call back personnel from regularly assigned duties, ready their equipment, obtain transportation, travel to the site, then unload and set up. Once on scene, federal responders’ capacity to help is limited by staffing (e.g. NMRTs only bring 28 in a standard deployed force and at best have a capacity to decontaminate 30-60 patients per hour). _____, “Briefing Sheet. United States Public Health Service Central U. S. National Medical Response Team Weapons of Mass Destruction.” Colorado DMAT. Denver. July 1998.

Players learn about WMD hazards and response skills through on-line learning courses taught in the virtual fire station by guest instructors, computer e-learning tools, manuals in the company libraries, and through such media as virtual television programming. Once the player is confident in their skills, they can “report for duty” after which they respond on emergencies and take mitigating actions.

E. GAME ENVIRONMENTS AND LEVELS

Initially, WMD1R has three primary environments and ten levels of play. Players choose between staffing and responding on a fire apparatus or hazardous materials units.

1. Environment 1: Fire Station

The fire stations would be the initial player gathering place and the primary location where training sessions occur. The four to eight fire stations located throughout the city will have one or two apparatus. These stations will have similar floor plans and contents. Station layout (for player gathering and learning) includes an apparatus bay (where the fire apparatus is parked), training room, offices, dining area, kitchen, recreation room, restrooms and sleeping areas. Supplemental training information and materials would be located throughout the station for the player to read, watch or use.²⁵¹ WMD and terrorism information would be posted on walls and bulletin boards. Offices have reading materials in a company library. Computer work stations offer internet resource access, PowerPoint style presentations, and other material. Televisions play training videos and courses. Fire apparatus carry maps and pre-incident drawings of key buildings. Plus, virtual officers and guest instructors teach some training sessions. Players will complete virtual instruction sessions at the stations by performing tasks or completing multiple choice exams that quantify performance and validate instructional techniques.

2. Environment 2: The City

The fire stations would be dispersed throughout a city that has urban, suburban, and rural areas. The city consists of streets, emergency scene buildings, other buildings, and world objects. The players can board the fire apparatus at any time and drive around

²⁵¹ This learning system design is suggested both by existing structure in fire stations across the world and by development work underway at Dartmouth University under grant by the ODP on the “Virtual Terrorism Response Academy”. Noel, Mark. Interview by Author. 7 January 2004. Lebanon, New Hampshire. Database available on line at <http://iml.dartmouth.edu/education/pcpt/VTRA/index.html> [Accessed 23 May 2004].

the city. Fire apparatus will be constrained to driving only on roads or in parking areas.²⁵² The city and roads would be populated by artificial intelligence (AI) characters and vehicles whose behaviors are described below.

3. Environment 3: Emergency Scene

The structures at the emergency scene would be the only city buildings other than the fire stations whose interiors are modeled. There would be ten total emergency scene locations including a 1) subway/train station, 2) public venue (theater, stadium or arena), 3) office building, 4) school, 5) hospital, 6) retail shopping complex, 7) industrial/manufacturing facility, 8) multi-residential, 9) container or port facility, and 10) street level area. These locations provide the background environment for the players to interact with patients and the WMD.

4. Game Levels

Comprehensive WMD training *should* cover all weapon categories including Biological, Nuclear, Radiological, Incendiary, Chemical, and Explosive; however, this thesis proposes a prototype game to demonstrate feasibility of the concept by using one weapon type: chemical.²⁵³ It should be recognized that any WMD game that only includes one type of hazard is of limited usefulness and the MMOG should be expanded to include all WMDs as soon as feasibility is verified.

²⁵² Sidewalks and other features will be created so they are too narrow to fit a fire apparatus down without running into the building or other objects such as light or telephone poles.

²⁵³ Which WMD agents should be modeled first? WMD agents are not all equally time critical. First responders have considerable experience responding to incendiary incidents or fires; therefore these types of incidents are less of a priority. On the other hand, the rarity of Nuclear WMDs and the fact they produce catastrophic results that are difficult to mitigate suggests that these also may also be a lower priority. Biological agents often have incubation periods of days to weeks and patients do not typically experience acute symptoms. But chemical, radiological, and explosive incidents confront the rescue teams with a time critical extraction and treatment scenario. It has been noted [_____, "The Washington Statewide Homeland Security Strategic Plan." Team Washington. A Statewide collaborative partnership. 2003. p. 26] that at least 70 percent of terrorist attacks use conventional explosives, and this certainly is an argument for training on high speed evolutions to effect maximum life saving in super time critical explosive events. However, a Chemical and Biological Arms Control Institute (CBACI) publication suggests that "There will be more opportunity to save lives in the aftermath of a chemical or biological terrorist attack than in the aftermath of a conventional attack. Whereas most of the fatalities in a conventional bombing occur immediately or shortly after the incident, this is not the case with chemical or biological terrorism..." [Roberts, Brad (Editor) "Hype or Reality: The 'New Terrorism' and Mass Casualty Attacks." The Chemical and Biological Arms Control Institute. Alexandria. 2000. p. 80] Chemical and radiological incidents also have a decontamination component. Falkenrath (et al) agree that chemical and biological weapons afford first responders the greatest life saving opportunities. [Falkenrath, Richard A., pp. 148, 159] This thesis proposes the first game level to be a chemical scenario, in part because of the CBACI publication and partially because it has every day application. This assertion is certainly open to debate, in particular with regard to the effects of efficient triage, treatment and transportation of those injured in a conventional attack.

WMD1R has ten response levels plus training modules available at the fire station.²⁵⁴ The ten levels of game play would be based on the ten emergency scenes listed above. Game levels have varying degrees of difficulty that is determined by a number of variables including: 1) type and quantity of WMD,²⁵⁵ 2) location of WMD, 3) number of patients, and 4) presence of secondary devices. Level difficulty is greater if the agent has higher lethality, greater quantity, rapid effect, or problematic location (e.g. in an exit path). Level difficulty also increases with number of patients and with presence of a secondary device proximal to the responder operational area. Game levels and degree of difficulty would normally be randomly picked. If players need to practice use of a specific procedure, skill, tool or plan they may select specific game levels and difficulty factors.

Players will be simultaneously dispatched to a WMD response. They will need to board their fire engine and respond to the scene using proper approach. Once on scene players must communicate key points about nature of incident, additional resources required, wind direction and recommended approach, possible secondary devices, and location of base. Players will then select appropriate PPE, detection equipment and tools, and begin managing the incident. Players must work cooperatively to identify the agent, determine the hot zone boundaries, and establish decontamination. They also must rescue, decontaminate, triage, and treat patients.

The game levels will be fast paced, high intensity, and high risk. Communication will be critical and players will have the option to communicate to all involved or just to specified team members. Players face dangers of contamination from the WMD, contamination from patients, and possible secondary devices. They will also be limited by their air supply, endurance, and heat stress. Players will need to go through a rehab station after using one or two bottles if working hard. Games will be complete when all the patients are rescued and all players have finished decontamination and final rehab.

²⁵⁴ Some levels of play will start with simple alarms where players apply skills developed for large scale responses (e.g. aid call for man with breathing difficulties or a HAZMAT spill at industrial facility) but escalate by being dispatched to larger incidents.

²⁵⁵ In the prototype game this refers to the type of chemical: nerve, blood, blister, choking, or incapacitating agent.

F. PLAYER OBJECTIVES

The two types of players – fire fighters and HAZMAT responders – have a shared common objective: save lives while avoiding danger. Below are specific objectives for each of the player types.

1. Fire Fighter Objectives:

Major missions for the fire fighters include:

- Recognize the Danger of a Potential WMD Incident
 - Rapid response, but...
 - Don't Rush In
 - Proper approach (upwind, uphill)
 - Position apparatus 300 feet or more from incident (upwind, uphill)
 - Avoid possible secondary devices (suspicious vehicles or packages)
 - Communicate danger to other responders
 - Protector yourself - wear PPE: bunker gear, SCBA, butyl or nitrile rubber gloves
 - Avoid hazards
- Implement NIMS
 - Establish command
 - Locate command post (upwind, uphill)
 - Direct incoming units
- Control the Scene
 - Identify and mark exclusion zone (with fire tape)
 - Deny access 360 degrees around incident (Isolate)
 - Evacuate the hot zone (communicate with patients via PA, megaphone to move away from hazard area)
 - Direct ambulatory to safe holding area
 - Separate symptomatic from non-symptomatic – decontaminate symptomatic
 - Isolate contamination and the contaminated
- Call for additional help
- Notify of WMD Incident
 - Other responders

- Hospitals
- City Leaders – to initiate federal notifications and requests for assistance via State
- Locate triage, treatment, and transportation areas (near the decontamination corridor)
- Rescue and decontaminate the patients
 - Locate and set up a gross decontamination corridor
 - Use hose line, side by side engines, or ladder pipe shower
 - Locate and stage red bags for clothing, pens, blankets
 - Direct ambulatory to decontaminate
 - Instruct ambulatory to blot (or wet for biological & radiological), strip, flush, and cover
 - Rescue non ambulatory using backboard, stretcher, drag and bring them to decontamination and treatment
- Triage patients
- Provide first aid to injured²⁵⁶

The ultimate goal of first responders is to remove the victims from the hazard area, decontaminate them, and provide treatment in a safe, fast, and efficient manner. Life safety and life saving is the highest priority of first responders, and the focus of this game is finding ways to perform these tasks optimally, so that the greatest possible number of lives can be saved.

2. HAZMAT Objectives

Major missions for the HAZMAT responders include those of firefighters, plus:

- Use Level A PPE initially in hot zone
- Use detection equipment to identify WMD
- Communicate with incident commander WMD identification

²⁵⁶ Ideally, first responders would identify the details of the WMD exposure, in particular the probable dose the patient received since this can reduce the need for transport to hospitals by up to 70 percent. [Burgess, Jeffrey L., pp. 761, 764] However, it is unrealistic to expect that this data is available rapidly in a mass casualty WMD incident, and treatment initially will be based on patient signs and symptoms. [_____, “Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response.” National Research Council. National Academy Press. Washington DC. 1999. p. 4] Therefore, a higher priority for responders is evaluating patient symptoms and providing treatment accordingly. It should be noted that “[...] concern over the exposure alone can have resulted in symptoms, such as has been described in episodes of mass sociogenic illness. Therefore, the presence of symptoms does not always indicate that significant exposure has occurred.” [Burgess, Jeffrey L., pp. 762-3]

- Establish and mark hot zone boundaries based on WMD agent properties (using unique firefighter exclusion scene tape)
- Mitigate hazards where possible (neutralize, cover, etc.)
- Determine exclusion/evacuation areas
- Determine appropriate PPE for WMD hazard
- Assist in hot zone triage and medical treatment of patients
- Assist in rescue and decontamination of patients
- Monitor hazard area
- Monitor outside hazard area for possible secondary contamination

An early goal for hazardous materials teams should be shrinking the hot zone and determining the minimum level of PPE in which first responders can safely operate. WMD agents were developed in part to cause adversaries to wear chemical protective clothing, thus reducing their effectiveness as a fighting force and making simple tasks like communication more complex.²⁵⁷ The effects of a WMD agent used for terrorist purposes are the same. HAZMAT teams should recognize the negative effects of WMD on overall operations and strive to rapidly shrink the hot zone and the associated requirements for higher levels of PPE.

G. GAME MECHANICS

WMD1R would initially be developed for up to 32 simultaneous players with design consideration for expansion to host hundreds of players when advancements technology permits.²⁵⁸ There would be two methods of playing WMD1R: in single or multiplayer mode.

Individuals may enter into the game environment and attend training sessions at the fire station or they can respond on incidents with AI characters in the role of the other firefighters.

In the multiplayer game, users initially define the size of the response they wish to simulate. AI characters would play in the open slots not occupied by humans. One

²⁵⁷ Croddey, Eric. "Chemical and Biological Warfare." Copernicus Books. New York. 2002. p. 7.

²⁵⁸ Large scale WMD incidents such as the bombing of the Murrah Federal Building in Oklahoma City, the NYC 9-11 attacks on the World Trade Center, and the Tokyo subway sarin attacks have required hundreds to thousands of responders. The DoD has demonstrated the feasibility of linking thousands of participants and it should be the goal of WMD1R to support thousands of game players. [Computer Science and Telecommunications Board. "Modeling and Simulation. Linking Entertainment and Defense." National Research Council, National Academy Press. Washington, DC. 1997. p. 5].

consideration in a MMOG is how to react to players leaving the game or becoming inactive. Since first responders would be encouraged to play the training game at work, it is probable that they may log out or leave the game for emergency responses. If a player is inactive for more than 1 minute, the game should query the player if they wish to continue, and if no response is received the game should insert an AI character to continue for that player.

1. Movement

Players move through their environment in two ways: 1) on foot, or 2) in a vehicle.

a. Moving on Foot

When on foot, the players default position is standing. Players can walk forward, backward, or to the side in a standing or crouching position. In addition, they can crawl forward or backward and sit. Players can only run in the forward direction. Characters can climb stairs, ladders and mild inclines (4:12 or less). Inclines steeper than 4:12 will result in the player slipping down the slope unless the incline is a stairway or ladder. Inclines greater than 14:12 will be treated like a wall and the player will bump into them and stop forward progression.

b. Moving in a Vehicle

There would be three types of apparatus: a fire engine, a ladder truck, and a hazardous materials unit. The apparatus would be used to transport the players and their tools/equipment to the emergency scene.

Players interact with the fire apparatus in several ways. When players face compartment doors, they can press an action key to open the door and view the compartment contents. Another action key can be pressed to pickup items in the compartment. Players standing near a crew door can press an “action” key to board the apparatus in that position. There would be four doors and seats on the apparatus each corresponding to different positions and responsibilities; these positions are numbered counterclockwise from the right front seat. Only one person can occupy any given seat/position. Position 1 is for the officer, riders in this position have access to a radio,

maps,²⁵⁹ pre-incident drawings, and the siren and horn controls. Position 2 is the driver, riders in this position have access to emergency lights (on/off) steering, acceleration and braking. The Position 3 firefighter automatically dons his Self Contained Breathing Apparatus (SCBA) and carries a pressurized water extinguisher whenever he boards the apparatus while wearing his bunker gear (fire fighter's protective clothing). Position 4 firefighter automatically dons his SCBA and carries irons (Halligan and flat head axe) whenever he boards the apparatus while wearing his bunker gear. The different apparatus (engine, ladder, HAZMAT) have different types of equipment in the compartments and slightly different appearances. The players may board the vehicles at any time and drive around the city; however they may not board or exit the apparatus while it is moving.

2. Visuals

a. Camera

The primary "camera" view, or player's screen view is first person when the player is moving on foot – that is through the eyes of the surrogate character. When the player has donned PPE, a frame representing the face piece of the breathing equipment would slightly reduce peripheral vision.

The default view when driving or riding in a vehicle is third person - looking from above and behind the vehicle.

Players may select objects to read or view. For example, the officer may look at a map when responding to an alarm or players may read a posting on a bulletin board in the fire station. When the player selects objects to read or view, the player's view changes to enlarge the material presented to fill the screen.

b. Looking

When players change the direction they are looking, their body adjusts to face that direction when standing, crouching, or crawling. They also may look up or down, but this does not change their body orientation.

²⁵⁹ It is important to keep game play flowing and avoid artificial barriers [Ragnar Tornquist in Saltzman, Marc et al., p. 122], therefore WMD1R includes maps that show the players where the call is located in the virtual city. It does not include arrows showing the best route of travel, however, because one of the first responder tasks is to consider the effects of wind and terrain on response routes and apparatus positioning. Electronic maps on a computer display show the location of the apparatus relative to the fire station and the current emergency response to the officer. Maps are only show to the officer in order to stimulate conversation between the players about best route of travel.

c. Graphical User Interface

Information that would be intuitively known to the player, like the status of their health and the objects they are carrying are depicted using a Graphical User Interface (GUI). In addition, the player may call some objects up for view on the GUI if these objects would be visible to the player by looking for them in their near vicinity.

The GUI automatically shows body temperature, tools carried, recent radio messages, and general health/strength/endurance. Users may also call up GUI display of bottle air pressure, instrument readings and current score. The GUI depicts body temperature as a range of possible values and tools as simple icons with the currently selected tool highlighted. Recent audible radio messages or spoken messages from other characters are printed in text in the GUI to give the player the opportunity to receive the message regardless of game volume settings.

d. Text Messages

A variety of text will be displayed throughout the game in the GUI, fire station, fire apparatus and city environment, as needed the player may zoom in on text to read it.

As mentioned above, the GUI will display text of recent audible dialogue and radio transmissions. Fire stations will use text as a part of posted materials, training sessions, run sheets and examinations. Run sheets will have dispatch information that includes units assigned, reported nature of the emergency, and location of the emergency. Maps will have text for street names and emergency location. In addition, there would be clues to possible terrorist operations. These clues would be available both before and during the emergency. Players may encounter restricted precursor chemicals or equipment, or observe abnormal behavior around a target facility. These clues would offer the opportunity to notify appropriate authorities and possibly prevent a terrorist attack.

Text will also be used to provide brief game instructions. Subdued messages would be visible when the player has the opportunity to pickup, manipulate or

use a tool or object in the game environment. These messages consist of a simple instructional reminder such as “Press Action Button to Pick up Tool” or “Press Action Button to Use Tool”.

e. Environmental

WMD1R would include simulation of all weather and daylight conditions. Lighting will vary with time of day. Wind direction will be variable. For each level of play, a weather report that reflects the outside temperature, precipitation and wind speed and direction would be available. Flags and plumes should shift with changes in wind direction to visually cue responders.

3. Objects

WMD1R would have three primary categories of objects: 1) world objects, 2) tools, and 3) hazards (including WMDs). The characters themselves are discussed in a later section. Heavy objects such as people may only be carried as long as the player holds the ‘action’ key down. When players let go of this key, they automatically set the object or person down. For smaller objects, the player must press the “drop” key to set it down.

a. World Objects

World objects are provided as needed to create a sense of realism. These objects are primarily fixed or inanimate and consist of buildings, trees, and miscellaneous urban items (light poles, news stands, signs, etc.). Some of the world objects can be manipulated or damaged. These items include such things as vehicles²⁶⁰, doors, windows, and building heating, ventilation, and air conditioning systems (HVAC).

The city includes a full spectrum of occupancies including single and multi-family residential, industrial, commercial, assembly, public health, government and transportation structures. Some buildings will be unique in height and design to serve as landmarks for players as they navigate. Streets will have signs at intersections that correspond to player maps. The buildings in the city are not accessible but are merely an exterior facade (with the exception of the buildings where emergencies occur).

²⁶⁰ Vehicles will be discussed separately as AI objects.

b. Tools

There would be a substantial number of tools available to players. These tools fall into several categories: 1) PPE, 2) forcible entry and rescue, 3) hazardous materials (WMD) detection, sampling and mitigation, 4) decontamination, and 5) medical.

Tools are carried on the apparatus in the various compartments. Players access the tools by opening the compartment on the apparatus and selecting tools to carry by using an “action” key. Players may carry multiple tools at one time, but not an infinite number. They are limited by what they can carry in their hands or over their shoulders. Players can pick up, set down, and use tools in their environment. The player may toggle or cycle through the icons shown on the GUI to select any of the tools they are carrying for use, or they may select none of the tools if they are going to use their hands.

Several types of PPE will be available to players in the game including Level A, B, C and D plus firefighter bunker gear and SCBA. Level A, B, and C clothing will only be carried on the HAZMAT apparatus. Level A clothing is fully encapsulated vapor resistant suits plus SCBA with 1 hour bottles. Level B clothing provides splash protection and SCBA with 1 hour bottle. Level C clothing also provides splash protection plus Powered Air Purifying respirators (PAPR). Level D is not really considered PPE – it is the station uniform and the default player clothing. Firefighter bunker gear and SCBA are carried on all apparatus. Players will choose to don and doff PPE in the same way they chose to pick up or set down tools but it will be a two stage process. When players choose the PPE they wish to wear they will use an “action” key and a quick MOCAP segment will play showing all the steps of donning the PPE except for going on air and final zip up. Once the player is in the location they wish to begin using air, they will use the “action” key again to put the respiratory face piece in place, go “on air”, do final zip up and tape the suit (if level A, B, or C is worn).

Players may choose to carry forcible entry equipment such as irons. As they move through the game environment, they will encounter objects on which they may use the tools. If objects such as doors can be manipulated, a pop up message appears suggesting the player use the action key to manipulate the object. For example, when

encountering a door, the message “Press Action Key to Open” would appear. If the player has no tools currently selected, then the player would open the door using his hands. If a tool is selected, when the player presses the ‘action’ button a MOCAP segment would play showing the player using the tool on the object. Continuing with the door example, some doors may be unlocked and operable by hand, some may be locked and tools must be used to force entry, while other doors may not be forced (e.g. doors on façade buildings). If the player uses a tool on an inanimate object, the result will be visible damage.

Players will have access to a variety of detection equipment on both the fire apparatus and HAZMAT unit. This detection equipment will be picked up the same way other tools are picked up – with an “action” key. Players are not required to be familiar with all subtle details of the detection equipment. When detection equipment is picked up, a MOCAP segment will automatically display the process to turn the equipment on. When the equipment is set down, a MOCAP segment will display the process of turning this equipment off. If the equipment is not set down by returning it to the apparatus compartments then it will be left on. To look at the display of detection equipment, the player must be carrying the tool and have it selected (highlighted on the GUI). When the player presses the “action” key, the view will zoom to show display and readings of the detection equipment. If there are multiple readings of the detection equipment, the player must press the action key to scroll through those screens. Adjustments to sensitivity of the detection equipment will be prompted when the equipment exceeds the range of its current setting; players press the action key after the prompt and will see a MOCAP segment of this adjustment. If the equipment is for sampling, and the player is near HAZMATs that can be sampled, pressing the action key with sampling equipment highlighted will display a MOCAP segment of the sampling procedure. Similarly, if the equipment can be used to mitigate the problem (e.g. plug a leak), pressing the action key when the equipment is highlighted will display a short MOCAP segment of the mitigation activity.

Players may set up gross decontamination shower system using a hose line, engine discharge port and nozzle, or ladder pipe system. Players will be able to select a pre-connected hose, a discharge port or a ladder pipe and MOCAP segments will

display when the action key is pressed. More elaborate decontamination systems will be simulated using AI responders. A player must designate a location for the “Decontamination Unit” to set up, and once this is done, the game would show the elements of this system gradually going in place over a period of several minutes after the request is made.

Medical tools available in WMD1R include nerve agent antidote kits, bag valve masks (BVM), bandages, splints, backboards and extrication collars. If the player is carrying any of these tools and encounters a patient, they would be able to apply the tool to the patient by using the “action” key and a MOCAP segment would display the application of the tool. Some actions, such as cardio pulmonary resuscitation (CPR) either in the compression position or the BVM position would require the player to hold the action button down. When the player stops holding the action button MOCAP simulation ends.

c. Hazards

Hazard objects include WMD, vehicles, sharp objects, and secondary devices.

Exposure to WMD agents negatively impacts the health of unprotected players and AI characters.²⁶¹ WMD solids and liquids will act much like the tools that were discussed above, except that there is no need to press an action key to pick them up – they will be picked up automatically when players pass through areas containing solid and liquid WMD. Players who “carry” solid or liquid WMDs will act as a point source of these hazards and physical contact with a contaminated player or character will result in contamination of the individual who made contact. Exposure to a contaminated player or character without use of PPE will result in the same effects as exposure to that hazard area. Hazards are divided into two categories which correspond to the criteria in the

²⁶¹ The most common mechanism of exposure to a HAZMAT is respiratory exposure with dermal exposures secondary. [Burgess, Jeffrey L., George P. Pappas, and William O. Robertson. “Hazardous Materials Incidents: The Washington Poison Center Experience and Approach to Exposure Assessment.” *Journal of Occupational and Environmental Medicine* Vol. 39, Number 8. August 1997. p. 763].

“SBCCOM 3/30 options.”²⁶² These hazard areas are 1) a very high hazard (VHH), and 2) a high hazard (HH). VHH areas [3 minute areas] are the places containing the WMD agents in such concentrations that they constitute an immediate hazard to life and health, do not contain known live victims, and will seriously injure or kill civilians or players not wearing proper chemical PPE (some will die even with medical treatment).²⁶³ Bunker gear and SCBA do not constitute adequate PPE in VHH areas, and firefighters in this PPE can only operate for 3 minutes without incurring serious injury. Players who enter a VHH area for less than 3 minutes can immediately go to decontamination to prevent adverse affects. Similarly, if firefighters encounter oily puddles or droplets of oily liquid or receive victim reports of garlic odors, it would be considered a VHH area and they should immediately exit with the victims and go through decontamination. HH areas [30 minute areas] are the places containing WMD agents in such concentrations that they constitute a hazard to life and health, do contain live victims, and will seriously injure civilians or players not wearing proper PPE if they do not receive medical treatment. Bunker gear and SCBA *do constitute* adequate protection in HH areas. Firefighters wearing bunker gear and SCBA can operate in HH areas for up to 30 minutes and only incur minor health effects such as sweating and muscle soreness. Firefighters entering the HH area for less than 30 minutes can undergo decontamination to prevent serious adverse health effects.

The environment includes moving responder and AI vehicles; if a player contacts one of these moving vehicles they will incur significant injury or death. Players must implement traffic control or avoid moving vehicles.

²⁶² Use of firefighter bunker gear and SCBA PPE in VHH and HH areas is known as the 3/30 option. The 3/30 option presumes that the time it takes for firefighters to be dispatched, arrive, don PPE, and enter results in entry after vapor concentrations are at their highest (ten or more minutes after the initial release). Injury that may result is estimated that 50% of firefighters may experience sweating and muscle weakness up to 18 hours after exposure. _____, “Risk Assessment of Using Firefighter Protective Ensemble with Self-Contained Breathing Apparatus for Rescue Operations During a Terrorist Chemical Agent Incident” U.S. Army Soldier and Biological Chemical Command Homeland Defense Business Unit Improved Response Program. June 2003. Database available on line at http://hld.sbccom.army.mil/cwirp/ffpe_scba_rescue_ops_download.htm Accessed 28 May 2004.

²⁶³ For some VHH areas, particularly some radiation hazards, there is *no* PPE that will protect the player.

Sharp objects located in various places in the game (broken windows, material from explosion, etc.) also pose a hazard. If the player runs into these sharp objects they would incur a minor injury with minimal impact on health. However, if the player is wearing PPE and then contacts a sharp object, their garment would be torn and the dermal protection of the clothing defeated. If the player is in a VHH area, or is contaminated from physical contact with a contaminated character, they would incur injury if they do not exit the area within 3 minutes and undergo decontamination.

WMD1R will have secondary devices located randomly in the game levels. Close proximity to these devices when they activate may result in injury or death of the player or AI characters nearby. Players need to not only look for secondary devices to protect themselves, but also to protect the AI characters and their fellow players from injury or death.

4. Motion Capture

Motion capture is the process of capturing data for the creation of realistic animations by filming people as they perform common maneuvers unique to their discipline while they wear a special suit that tracks position of key body parts. MOCAP would be used primarily to display frequent actions by the players, and in some cases, it would be used for data to create displays of background activity such as establishing decontamination corridors.

MOCAP segments would not play real time. MOCAP would show the essential steps necessary to complete tasks (such as donning PPE or using the irons to open a door), but the segments would be artificially shortened to maintain game continuity and flow.

Some operations, such as picking up a patient, require two or more players to execute. In the case of multi-player tasks, both players must be in vicinity of the object they are going to manipulate and both must press the action key. When this occurs, a short MOCAP segment plays, after which the players are connected to that object for as long as they hold down the action key.

MOCAP will be used as an instructional tool. Repetition of segments that display the necessary tasks will reinforce the processes and promote learning. For example,

when a player enters one of the three decontamination corridors, a speeded up MOCAP sequence would play, showing the tool drop, decontamination steps, and doffing procedures including bottle change. This would ingrain these procedures so that they become rote when players perform them for drills or actual events.

a. *Cut Scenes*

A few cut scenes will be injected into WMD1R. These scenes are not MOCAP animation of player actions or background activity but would actually play across the players entire screen and with no interaction from the player. Cut scenes will be developed for the opening and concluding sequences of each game level to inspire the spirit of play. In addition, some scenes will interrupt play.

Cut scenes that are envisioned include:

- Roll call briefing at beginning of shift / game level.
- Instruction sessions on TV or in station
- Television story segments about terrorism
- Weather reports on television
- Positive and negative comments from chief officers about performance during and after levels of play.
- Funeral scene at graveyard with uniformed crowd in attendance, a mourning spouse and children looking over a casket while bagpipes play. This short scene would be used for when the player dies. A single comment from a co-worker may also be inserted (e.g. “I told him to wear his PPE!”).

5. *Sound*

George Lucas said “Sound is half the movie going experience”²⁶⁴ and game designers suggest it is equally important in games.²⁶⁵

a. *Voice Acting*

Per the recommendation of numerous designers and gaming professionals, WMD1R will use professional directors, writers, and actors for voice work and sound bites.²⁶⁶ & ²⁶⁷ Professional actors offer the advantage of enhancing immersion by creating a more believable environment and evoking greater emotion from the players.²⁶⁸

²⁶⁴ Quoted by Saltzman, Marc et al. p. 453.

²⁶⁵ Meigs, Tom. “Ultimate Game Design: Building Game Worlds.” McGraw-Hill/Osborne. San Francisco. 2003. p. 12.

²⁶⁶ From Marty O’Donnell’s recommendations in Saltzman, Marc et al. pp. 428-431.

b. Real-Time Voice

WMD1R should support real time voice communication capability for players. Voice communication over the internet should be selectable, that is, players should be able to select the talk group to whom they wish to send a message. As the number of participants grows, the players will need to subdivide the talk groups to have manageable forms of communication.

c. Musical Scores & Sound Effects

In addition to voice acting, sound engineers will need to acquire, compile, edit, and record a variety of sound effects and music. Music can add drama to game sequences. Music would be developed, recorded or acquired for game and level introductions and conclusions and for some key sequences such as player death.

6. Replaying and Saving

While “Game Save” is a popular option in modern games, WMD1R would not have *player* game save or pause features. Game pausing and saving is avoided to encourage immersion in the game and suspension of disbelief. Real incidents present players with the challenge of limited time, and it is a critical aspect of responding to injured and dying patients from a WMD incident. Therefore, players must be similarly challenged by a “ticking clock” from the moment of dispatch to the incident, and they may not go back to saved points in time to replay the game a different way. If players leave a game, an AI character will fill their role.

WMD1R *will* have a game replay feature that will also enable the saving only of completed high score games. Players, supervisors, and evaluators may wish to review player performance in the game and discuss decisions made. A game replay capability will facilitate these reviews. Since the game is captured for replay, it can also be saved for posterity or as a best practices example. WMD1R would save the high scoring games for others to review and critique.

7. Artificial Intelligence

Artificial Intelligence (AI) animated characters and objects would be used extensively in WMD1R. The characters and objects will behave according to a set of

²⁶⁷ Rollings, Andrew & Dave Morris. “Game Architecture and Design.” New Riders Publishing. San Francisco. 2003. p. 216.

²⁶⁸ Bill Roper in Saltzman, Marc et al. p. 71.

rules that simulates real world interactions. AI characters will also be able to swap in for players when they leave the game. WMD1R will have a variety of AI characters both in the first responder and civilian roles. Each of the AI characters will have strong and unique personalities.

a. AI First Responders

The first responder AI characters will be similar to the ‘seven dwarfs’ of Snow White in that one can practically define them by their qualities. Suggested characters include a wizened chief and a street smart officer both of whom may offer stern guidance to a firefighter (e.g. “Don’t go in there without a mask!”), a friendly driver who gives helpful hints (e.g. “You might want to take your mask with you.”), an experienced and strong mentor firefighter (“Dude, where’s your mask), a studious and learned tailboard firefighter, a prankster firefighter, an athletic firefighter, an unhappy firefighter, etc. AI characters will have nicknames that are reflective of their character.

As George Broussard advises, there will be an effort to create a ‘catchphrase’²⁶⁹ for each character that is both reflective of their personality and of the lessons emphasized in WMD training, for example, the seasoned officer might have a catchphrase “Slow down, lets not rush in to this thing,” that can apply to fire station banter as well as emergency scene approach. If the catchphrases are well designed and tied to WMD training, players may anticipate the phrase, repeat it, bemoan it, or even find humor with it. Regardless, the lesson will be reinforced and ingrained in the player psyche.

AI first responders are generally focused on their job and the issues that define their own character traits. AI first responders will react to alarms both by path seeking to the apparatus and with verbal comments. AI first responders interact with the player by offering a simple greeting when they are in visual range. If AI first responders face a player they will initiate conversation focused on self centered issues (e.g. the likes and dislikes of the character such as favorite physical fitness activities or problems with finances or vehicles) or general humorous observations about life. AI responders are well trained and will offer advice in circumstances where the decisions by the player are in error. The advice will be followed by sarcastic remarks if it is not followed and problems

²⁶⁹ Saltzman, Marc et al. p. 182.

result. Advice might include suggested approaches to WMD incidents (upwind, uphill), suggested selection of PPE (don't you think we should put our face pieces on now?), etc. While AI first responders may be partnered with the player, they do not dictate behavior but instead follow and provide advice at key decision points. AI first responders will follow the players lead: when he dons his SCBA, the AI first responder will also do the same. AI first responders will reinforce good decisions by the player with positive comments immediately following the communication of these decisions (e.g. when player puts on his mask).

b. AI Civilians

AI civilians will populate the model city. They will exhibit one set of behaviors to model everyday life in a city, and another set to model reaction to a WMD event.

AI civilians will generally go about their everyday life oblivious of the players. They will walk down the street, enter buildings, perform work, and get into cars. AI civilians will occasionally react to the presence of the fire apparatus by looking up; AI children will occasionally point at the apparatus and wave.

AI civilians would perform certain actions following a WMD event and the interaction of AI civilians with first responders may modify these actions. After a WMD event, varying percentages of AI civilians will investigate, render aid to others, or flee the hazard. AI civilians exposed to WMD agents will follow the rules of exposure and cross contamination established in the hazard section. Exposed AI civilians will exhibit signs and symptoms of the exposure. Uninjured AI civilians in close proximity to a WMD event will exhibit psychological symptoms mimicking symptoms exposure at a rate of up to ten times the number of actually injured victims. Of the ambulatory AI Civilians who are injured, whether from actual exposure or psychological reaction, approximately 70 percent will engage path finding behavior to seek out hospitals or health care facilities.

A percentage (to be determined) of AI Civilians that encounter first responders will seek assistance from them. Of these, a percentage (but not all) will follow the first responder instructions. AI will recognize key words such as direction to a

specific location for treatment, decontamination, etc. Of AI Civilians who seek first responders for assistance, their path seeking behavior will occur when they are within visual or audible range of first responders.

c. *AI Media*

Another central AI component is modeling of the media. Following a WMD event, AI media elements will path find to the incident scene and begin requesting information from players, AI first responders, and AI civilians. A majority of the AI media (but not all) will follow instructions if issued by players to go to a specific information center location.

AI media helicopters will be simulated over the incident scene. These helicopters will respond to direction to the clear air space.

d. *AI Vehicles*

AI vehicles are an extension of AI Civilians but follow different rules. AI vehicles travel throughout the city, with some vehicles parked and some moving in traffic. Vehicle traffic is more congested on main thoroughfares, but room to maneuver is less on side streets. Traffic volume is also less during late at night incidents. AI vehicles do not react to the presence of a fire apparatus driving through the city without lights or siren other than standard avoidance. A majority of AI vehicles will pull to the right when confronted by fire apparatus responding with lights and siren. A smaller percentage do not react or pull to the left.

Players may have collisions with AI vehicles. Minor collisions will not stop play, but major collisions will result in the end of participation and the run of a brief cut scene about vehicle accidents and reporting procedures.

e. *AI Player Health, Fitness, and Injury*

Game designers Cliff Bleszinski recommends: “Never force the player to learn by dying.”²⁷⁰ WMD1R will allow players to make mistakes, which will lead to their death; however, there will be clues along the way advising against decisions that will result in fatal errors. Clues will be provided by messages from AI first responders as well as from training sessions. For example, if a player is about to enter the hot zone without

²⁷⁰ Saltzman, Marc et al., p. 248.

PPE, an AI character may comment about the need to don the PPE. For the purposes of this game, death is not permanent, that is, when an AI character or player dies, they can re-enter play in a different player position.

Since one of the game's primary purposes is to educate first responders in safe procedures, some game rules will be skewed toward safe practices. For example, approximately 10 percent of Tokyo firefighters who aided contaminated patients of the sarin attack on the subway suffered from some symptoms of nerve agent exposure; and in St. Luke's Emergency department 16.7 percent of hospital staff suffered secondary exposure symptoms.²⁷¹ Rather than create a formula where only a certain percentage of players suffer from secondary exposure to contaminated patients, the game will fix the rules so that patients contaminated with liquid or solid product who come into close proximity to an unprotected player will *always* cause the player to experience symptoms of exposure.²⁷²

Players who are working hard (wearing PPE, using tools, carrying patients, running, etc.) will experience falling health index, climbing body core temperature, and increasing air consumption. If health falls to critical levels, core temperature exceeds a maximum or the player runs out of air, they will experience a medical emergency and be removed from play (followed by a MOCAP segment showing transport to a hospital).

Before players consume an entire air bottle they must enter a decontamination corridor. After decontamination players can choose to complete a bottle change or follow signs and enter rehabilitation (rehab). Players who complete a bottle change without going through rehabilitation will not be returned to full health, but will continue to experience elevated core temperature and reduced health index and risk reaching critical levels. Players who enter rehab after decontamination will view a brief MOCAP segment showing medical monitoring, water, food, ventilation and rest. The screen would then fade through white and end with a paramedic telling the player they

²⁷¹ Smithson, Amy. pp. 98-99.

²⁷² While contaminated patients do not universally harm responders in the real world (see Tokyo responder statistics), it is a good rule to emphasize to players the importance of avoiding contact with contaminated patients. However, not all patients will be contaminated, making overall game play more interesting while remaining consistent in the rules.

are ready to get back out. The player returns in nearly full health, but the number of AI civilians available for rescue would be proportionately decreased for the time the player was in rehab. The player would benefit from rehab and could perform more work because of a higher health index; but there would not be as many points available to score. This reflects the time critical challenges confronting a firefighter who must decide between self care and rescue of viable patients.

8. Scoring and Statistics

WMD1R will use game scoring as a way of positively reinforcing performance of first responder skills. The goals of the game will be inherently obvious. For each emergency, there will be notification via radio, pager, computer screen and printer. The players overall goals are dictated by the mission posted in their station. “Minimize the loss of life and property.” WMD1R will focus on developing first responder WMD skills while giving credit for the initial incident command functions that occur early in arrival and set the stage for successful operations.

WMD1R will have a running score corresponding to the various mission tasks accomplished, with an itemized list that the player can review to see what they are doing right and what they are doing wrong. WMD1R will focus on positive reinforcement of behavior by keeping a point tally for the completion of the core tasks that first responders are expected to complete during a WMD incident. The faster tasks are completed, the higher the score. Points will only be deducted when the player violates the “Do no harm” policy such as when firefighters become injured or killed in the game. Thus, failure to use PPE will not automatically result in negative score; however, if the player fails to use PPE and is subsequently injured by exposure to WMD agents, there will be a penalty. Similarly, during responses to the incident, players will not have points deducted for slow responses instead, quick responses will be rewarded; while players who have collisions en route to the incident will have points deducted. This method of rewarding the player and tracking their performance will reinforce the subtasks expected by the game and meets the recommendation of game designers to reward completion of simple, incremental tasks to encourage progress in the game.²⁷³

²⁷³ Rouse, Richard. p. 12.

In addition to the scoring component, player performance will be evaluated for completion of recommended WMD tasks. This differs from the score because it is a pass fail evaluation. Players can have relatively high scores but still fail in the evaluation if they fail to perform certain actions or address certain hazards. Safety violations would be the primary reason for failing an evaluation. If players die or are seriously injured as a result of failure to recognize secondary devices or failure to use proper PPE, the overall evaluation would be a fail. Thus a team may have a high score, but individuals may fail evaluations. If the player violates the general principle of “Do no harm” by taking actions that worsen a patient’s condition, this also would result in a failing evaluation.

The WMD1R web site will show cumulative statistics for training modules completed as well as high scores for individuals and teams. The game will accumulate data on the correct and incorrect performance of minimum tasks (achievement of game benchmarks) and their sequence. Evaluations will be documented, compiled and reported to the ODP to allow analysis of the game’s effectiveness.

A significant advantage of using this scoring and evaluation system is the fact that the order of task completion by the players is not dictated. Players are not required to follow a particular pre-scripted plan of action, instead they are scored based on outcomes that result from decisions they make interacting with the game rules. Players have nearly infinite options on how they solve the game problems and address the goals of the game. Designers Greenberg (et al) recommend this kind of “[...]multiple good options approach[...]”²⁷⁴ & ²⁷⁵ Allowing multiple choices for game play is both fun for players and encourages experimentation to find optimal solutions. By capturing the high scores and evaluating and recording task completion, lessons learned can suggest best practices that may contribute to the development of playbooks for responder use in real emergencies.

In addition to scores and evaluations, WMD1R should track overall game statistics. Two types of statistics would be tracked: 1) player statistics would be kept in a personal training and performance folder, and 2) cumulative game statistics would be kept on the web site. Personnel files for players would track completed WMD training

²⁷⁴ Saltzman, Marc et al. p. 205.

²⁷⁵ Rollings, Andrew and Dave Morris. p. 52.

modules, high scoring missions, and miscellaneous data. A game statistics page would show total number of registered players, high scores by game level, total training delivered, and hours of on line usage.

9. Miscellaneous Issues and Game Elements

a. Education

Some of the main goals of WMD1R are to educate the player both in WMD basics and to encourage the development of standardized response procedures. It might be suggested that game designers know all the solutions to the problems presented in the game.²⁷⁶ In the case of WMD1R, this is not true. The game design establishes rules for operating in the virtual world, but it does not predefine the optimal solutions. The rules that bound the play are based on recognized industry standards for use and effectiveness of PPE as well as experience by designers from operating in HAZMAT and firefighting environments. The lessons taught in on-line training sessions will thus be reinforced during game play. Since there are infinite variables and complex operating rules, it will be up to the first responders to find the optimal solutions. Rather than knowing all the solutions, it is the specific objective of WMD1R to provide a realistic simulation of the WMD environment where players can repeatedly try different solutions in order to find the optimal method for handling the situations. WMD1R would enhance player WMD education with the use of IT to form chat rooms, multiplayer teams, and best practices/lessons learned pages.²⁷⁷

Incorporated into the game design will be the opportunity for After Action Review (AAR). The first tool for the AAR is review of the player score. The score will include an itemized list of all the positive, and negative, mission tasks completed by the player.

In addition to the AAR, there will be other opportunities to reinforce the lessons learned. The WMD1R game will host a variety of chat rooms to encourage player to player interaction and discussion about better methods of addressing the

²⁷⁶ Phil Saunders in Saltzman, Marc et al. p. 120.

²⁷⁷ Gordon Walton appropriately notes the importance of social interaction in MMOGs: "Massively multiplayer online games are, at their core, about community... You have to build in support for your community members, like easy ways to chat, ways to remember and track their friends, ways to group with other people, and to find groups of people among others." [Saltzman, Marc et al. p. 164].

challenges of a WMD incident. The chat room feature could be used by WMD experts as a forum for discussion and interaction with first responders. Chat rooms would be topically based, focusing on current issues, specific WMD agents, and response policies and issues.

A best practices page would parallel the chat room feature. This page would link to down loads of top scoring games for players to replay and review techniques used. Documents created or acquired from chat rooms could be posted in the best practices site to encourage standardized response behaviors and policies. Approved lessons learned from WMD1R, training sessions, drills, and actual events could also be posted.

b. Technical Support

WMD1R needs adequate technical support to ensure success. While it is a common practice to provide technical support web pages that give advice on installation and fixing problems or bugs, a web page alone is inadequate for WMD1R. The intent of WMD1R is to make the game a standard for first responders and there must be a greater level of technical support to facilitate usage by persons who are not computer savvy. If WMD1R is implemented, it should establish a 1-800 phone line accessible in all U. S. time zones to lend assistance in solving installation and operational problems. This kind of technical support would encourage users to continue on and play the game when they might otherwise quit when encountering problems that will require some research to solve.

c. Security

Game security will address three major concerns. First, there will be anti-cheat software installed to prevent players from bypassing the game rules. Second, there should be basic software security to prevent hacking into and disrupting the game website. Finally, there should be consideration given to the possibility that domestic or foreign terrorists would access the game with the intention of discovering the weaknesses in U. S. plans in order to use response plans against us in a terrorist attack. A plan to address security concerns is a part of the further research required for WMD1R.

*d. **Publicity***

A complete public relations and publicity campaign should be conducted if WMD1R is implemented as a training solution. The campaign will emphasize the fun nature of learning through the gaming environment while emphasizing the quality of standardization that the game will bring to first responder training.

WMD1R would be advertised as an innovative and fun training solution. Government web sites operated by ODP and its partners would be asked to run press releases. In addition, outreach will be encouraged by the game designers into the gaming community.

Media specializing in gaming would be contacted periodically with press releases regarding the game.²⁷⁸ As artwork is developed, it would be posted on a web site advertising the game and forwarded to the media to encourage interest.

*e. **Challenges***

A good game challenges players, remains consistent provides a social experience, stimulates emotions, clear goals, and teaches lessons that have real world applications.²⁷⁹ A good game encourages the player by rewarding them as they progress and accomplish tasks in the game. Players will have no shortage of challenges in WMD1R. The players will be introduced to the game controls and priorities by being given the opportunity to attend training sessions and review information while at work, but the bulk of their time will be spent responding to and mitigating emergencies.

Not all of the emergencies in WMD1R will be caused by a terrorist act, but all will build skills that will be used when terrorist events occur. Players will have the opportunity to experience small scale success early in the game by being dispatched to minor medical emergencies and “every-day” hazardous materials incidents. This early success will encourage them to continue play and attempt to improve scores on more challenging problems.²⁸⁰

²⁷⁸ Focus will be on New York, Chicago, Minneapolis-St. Paul, Los Angeles, and San Francisco per recommendations by Chris Olmstead in Saltzman, Marc et al.

²⁷⁹ Rouse, Richard.

²⁸⁰ Ibid., p. 14.

While it theoretically will be possible to achieve a high score the first time in the game, this is highly unlikely. In fact, failure is an option. If a player rushes in to the hot zone without donning proper PPE, and becomes contaminated with the agent, they will likely die. Also, not all hazards will be visible. Liquid spills and oily residue may be apparent to the player, but vapors from WMD agent will only be discovered by use of detection equipment or observing clues from the surrounding environment.

In order to keep player interest high, WMD1R will have constantly changing game challenges. WMD agent location, type, size and number of patients affected will change even within a game level.

f. Escalating Tension

Evoking emotion is an important aspect of game play and can enhance learning.²⁸¹ One technique of increasing emotional involvement of the player is to find ways to increase tension. Time pressure is a good way of increasing tension. Even the simplest of games such as “Pong” or “Breakout” evoked emotional involvement from players by increasing time pressure and tension.

Each of the WMD1R emergencies will have time sensitive components that affect the overall score, driving a sense of urgency and putting pressure on the player to make effective and efficient decisions. One time critical element is the civilians who have been exposed to the WMD. The time pressure elements of this game will include the degrading patient conditions in a WMD environment and the degrading player health. Each of the patients who have been exposed to WMD agents will have time critical issues that must be addressed. If the patient has been overcome and remains exposed to lethal WMD agents, they must be removed from the hazard, decontaminated and treated in a rapid fashion or they will die. If the patient has been exposed but has been removed from the WMD, they must be decontaminated and treated or their health will continue to degrade. Patients suffering only from psychological symptoms will burden the system and prevent truly sick patients from accessing care, but they will not die if left untreated.

²⁸¹ The MOVES Institute performed research that showed that by engaging players emotionally learning and task performance is enhanced. _____, “America’s Army PC Game Vision and Realization.” p. 12.

An additional tension building mechanism will be foreshadowing. For example, radio or television announcements may foreshadow pending terror attacks or lack of activity at a normally busy subway entrance may ominously foreshadow the scene below.

g. Game Practices to Avoid

This section will examine the current joint effort by the ODP and Dartmouth University to create a “Virtual Terrorism Response Academy” [VTRA] that attempts to create a first responder game for WMD training.²⁸² This effort should be acknowledged for its contributions to developing first responder gaming. A critical examination of this tool in development provides insight to some game practices that should be avoided in WMD1R.

Game players want to be challenged, and they want the challenges to change,²⁸³ in fact it is essential for a quality game. Educational materials, then should avoid creating situations where the player merely walks through the scenario and manipulates objects in the same fashion each time.

One problem with VTRA is that some of the most important aspects of operating inside a WMD environment are neglected in favor of some of the least important ones to be modeled by a game. For example, VTRA goes to great lengths to model the precise behavior of a radioactive source, the detection equipment and the shielding. The problem is that it is extremely difficult to estimate distances and perspectives in a gaming environment – they are at best an approximation. So VTRA has invested a considerable amount of time precisely modeling something that cannot be precisely perceived using a computer screen. Meanwhile, VTRA neglected to include modeling of air consumption, player strength or health, and player body core temperature; all of which are of significant importance to a person operating “on-air” in PPE in a WMD environment.

Another problem with VTRA is having the WMD source the same size, in the same place, every time. Once a player has completed a level, he or she has little

²⁸² Noel, Mark. Interview by Author. 7 January 2004. Lebanon, NH Database available on line at <http://iml.dartmouth.edu/education/pcpt/VTRA/index.html> [Accessed 23 May 2004].

²⁸³ Rouse, Richard. p. 14.

incentive to return to the level and play again. A better method will be to randomly inject WMD agents of different types and sizes into different environments with different numbers of people present.

To its credit, VTRA focuses on first responder skills. Some games and tools tend to focus on higher level functions, that is, command level functions like resource allocation, while neglecting the basics of operating in a WMD environment. Yet there will only be one incident commander at a terrorist attack but hundreds if not thousands of responders. WMD1R developers should study the VTRA effort to capture the best elements of this educational tool.

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