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Getting Serious About Games - Using Video Game-based Learning to Enhance Nuclear Terrorism Preparedness

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THESIS

GETTING SERIOUS ABOUT GAMES—USING VIDEO GAME-BASED LEARNING TO ENHANCE NUCLEAR TERRORISM PREPAREDNESS

by

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March 2012

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This thesis proposes the development of a video game platform to increase the public's knowledge of required protective actions in the event of a nuclear terrorism attack. Current scientific analyses have identified elementary steps the public should take to increase the likelihood of survival in the event of a nuclear terrorism incident; however, a knowledge gap currently exists with regard to the public's understanding of these required actions. Unfortunately, today's preparedness initiatives do not have the efficacy required to impact significant improvements in this area. Video games, more specifically a sub-genre of games known as serious games, are uniquely postured to address this knowledge gap. Not only do video games provide a motivating, enriching and engaging educational medium, but also they are unique in that they address the emerging educational needs of today's games generation, which desires more interactive educational environments since they have been immersed in technology for the majority of their lives. As such, leveraging this technology can help close the current knowledge gap and increase the nation's resilience to nuclear terrorism.

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GETTING SERIOUS ABOUT GAMES—USING VIDEO GAME-BASED LEARNING TO ENHANCE NUCLEAR TERRORISM PREPAREDNESS

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This thesis proposes the development of a video game platform to increase the public's knowledge of required protective actions in the event of a nuclear terrorism attack. Current scientific analyses have identified elementary steps the public should take to increase the likelihood of survival in the event of a nuclear terrorism incident; however, a knowledge gap currently exists with regard to the public's understanding of these required actions. Unfortunately, today's preparedness initiatives do not have the efficacy required to impact significant improvements in this area. Video games, more specifically a sub-genre of games known as serious games, are uniquely postured to address this knowledge gap. Not only do video games provide a motivating, enriching and engaging educational medium, but also they are unique in that they address the emerging educational needs of today's games generation, which desires more interactive educational environments since they have been immersed in technology for the majority of their lives. As such, leveraging this technology can help close the current knowledge gap and increase the nation's resilience to nuclear terrorism.

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LIST OF ACRONYMS AND ABBREVIATIONS

CDC	Centers for Disease Control and Prevention
DFZ	Dangerous Fallout Zone
DHS	Department of Homeland Security
GAO	Government Accountability Office
E-E	Entertainment-Education
EMP	Electromagnetic Pulse
ESA	Entertainment Software Association
FEMA	Federal Emergency Management Agency
HH&S	Hollywood, Health and Society
IND	Improvised Nuclear Device
KT	Kiloton
NGO	Non-governmental Organization
PSA	Public Service Announcement
WTC	World Trade Center

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This thesis builds on the efforts and ideas of public servants, scientists, academics, video game experts, technologists, and those who constantly challenge our existing system. Their efforts have created a vast knowledge base that allowed me to explore this topic from multiple vantage points and the influences of their ideas, theories, and analyses can be seen throughout this thesis.

I would like to take a moment to share my appreciation with those who directly contributed to this project. My wife Jessica and son Xander, for their incredible patience and support as I dedicated significant portions of my life over the past 18 months to the Center for Homeland Defense and Security program; my thesis advisor Dr. Lauren Wollman, for her guidance and counsel throughout this project; my thesis reader Dr. Michael Gresalfi, for his enthusiasm and advice and for not letting me lose sight of the larger picture; Under Secretary for Science & Technology Dr. Tara O'Toole, who planted the initial seed for this thesis in my brain with her statement "I would like to explore how to leverage video games to address some of these gaps;" Brooke Buddemeier from Lawrence Livermore National Laboratory for opening his vast scientific library of nuclear weapons effects to me to assist in my research; gaming expert Robert Gehorsam and Co-President of Games for Change Asi Burak for the generous time they spent introducing me to the video game development community and their help in maturing my approach to this project; my colleagues at the Federal Emergency Management Agency, for their overwhelming support of my participation in this master's program; the faculty and staff of the Center for Homeland Defense and Security, for providing an unparalled academic environment; and everyone else I failed to mention who helped me along the way.

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I. THE LANDSCAPE

> We need to move away from the mindset that Federal and State governments are always in the lead, and build upon the strengths of our local communities and, more importantly, our citizens. We must treat individuals and communities as key assets rather than liabilities
>
> - W. Craig Fugate, FEMA Administrator

A. PREPARING THE PUBLIC FOR NUCLEAR TERRORISM, A WICKED PROBLEM

As demonstrated at the World Trade Center (WTC) on September 11, 2001, the preparedness level of private citizens can weigh heavily on the outcome of an incident, especially a no-notice event. On that day, only 5.36% of building occupants who perished in the WTC collapse worked below the impact zones (National Commission on Terrorist Attacks Upon the United States, 2004, p. 316).[1] The 9-11 Commission attributed this low mortality rate primarily to the advancements in preparedness made by the Port Authority following the 1993 bombing of the WTC. By training and educating building occupants, the Port Authority was able to reduce the evacuation time from four hours in 1993 to just under one hour on September 11, 2001. This analysis, which demonstrates the impact citizen preparedness can make during a disaster, led the 9-11 commission to conclude that citizens across the nation need to be prepared to maximize their odds of survival should disaster strike (National Commission on Terrorist Attacks Upon the United States, 2004. p. 316).

A catastrophic event, such as a nuclear detonation in a dense urban area, could be considered the ultimate test of citizen preparedness: Not only would the initial prompt

[1] According to analysis done by the National Institute of Science and Technology, the locations of 2,052 of the 2,152 building residents/visitors that perished in the collapse were identified. Of this number, 1,942 (94.63%) were supposed to be at work or a meeting above the impact zones at the times the airliners collided with the buildings (National Commission on Terrorist Attacks Upon the United States, 2004, p. 316).

blast effects of the detonation cause great devastation,[2] but this scenario also provides the added complication of nuclear fallout, which would rapidly blanket the surrounding areas downwind with radioactive particles. The rapid spread of fallout would make evacuations within the immediate and downwind areas extremely risky, as unprotected populations would be exposed to lethal amounts of radiation within a short timeframe (National Security Staff, 2010a, pp. 14–32).

Current science suggests sheltering, rather than evacuation, as the most prudent action to take following a nuclear detonation. Shelters, such as houses with basements, large multi-story structures, and subterranean parking garages, can greatly reduce fallout exposures by a factor of 10 or more (National Security Staff, 2010a, pp. 66–72). In fact, recent scientific studies funded by the Department of Homeland Security estimate that if citizens simply went inside to basements or the core of large office buildings, fatalities from exposure to lethal fallout could be reduced by over 80 percent. In a city like Los Angeles that amounts to almost 240,000 lives saved (Broad, 2010).

Due to the extreme public communication challenges resulting after a nuclear detonation, emergency managers will not be able to rely on traditional protective action messaging protocols. As such, a prepared public educated on what steps to take is essential to saving lives (National Security Staff, 2010b, pp. 116–121).

While the scientific and policy communities are largely in agreement that preparedness is the key to lifesaving on a mass scale following a terrorist nuclear attack, recent data suggest the nation's preparedness efforts are stalled. Currently, the Ready Campaign, in partnership with the Ad Council, works to raise public awareness about emergency preparedness and motivate the public to take action, but this approach alone lacks the effectiveness needed in preparation for nuclear terrorism. One of the limiting factors of current efforts is the web-based approach, which is inherently passive and puts the onus on citizens to locate the preparedness information they require and then act upon

[2] Estimates suggest a nuclear detonation in a large urban center could cause thousands of casualties from prompt effects, with hundreds to thousands more possibly becoming casualties later in the incident due to exposure to high levels of lethal radiation. Millions of people will likely self-evacuate from major urban centers, while hundreds of thousands of people in the affected area try to avoid radiation and fallout as it spreads down wind from ground zero (U.S. Department of Homeland Security, 2005, pp. 1.1–1.12).

it (McGee, Bott, Gupta, Jones, Karr, & Lark, 2009, pp. 28–30). Beyond its website, the Ready Campaign relies on donations of time slots for public service announcements (PSA), which are typically not aired during primetime viewing or listening hours—in 2008 about 25% of these PSAs occurred between 1am and 4am (Government Accountability Office, 2010, pp. 12–13). These challenges bring into question the efficacy of the nation's current approach to enhance the public's knowledge of the threat they face and what actions they will be expected to take in a crisis.

According to a recent study conducted by the Homeland Security Institute, simply initiating dialogue about a nuclear attack is met with skepticism and concern about fear-mongering or hidden threat information. This reaction is primarily driven by distant memories of the U.S. Government's attempts to educate the public on the subject of nuclear war and the effects of nuclear weapons. The public's negative reaction to nuclear-specific public communications resulted from significant inconsistencies in Cold War messages. During this period, communications from senior political leaders, the scientific community, and civil defense organizations often contradicted each other. These contradictions left the public skeptical and led many to view these messages as government propaganda. As a result, the public began to view a nuclear scenario as either a catastrophic incident in which few would ever survive or so unlikely that preparations were not required. The sense of apathy and fatalism that resulted from these early communication efforts blocked any significant progress toward a prepared public (Hampton, Altmire, Brunjes, Jennings, Mallory, Maloney, & Tuohy, 2009, pp. 20–26).

If traditional approaches to message delivery are inadequate for the threat of nuclear disasters, new strategies must be developed. Video games are a promising, potentially very suitable, way of achieving preparedness on this topic. The immersive aspects of modern videogames support theories concerning their potential as learning tools. Additionally, virtual reality environments in many videogames mimic training environments previously only available within complex training simulators used by the military community (Arnseth, 2006, pp. 1–4).

B. RESEARCHING THE APPLICABILITY OF VIDEO GAMES WITHIN PREPAREDNESS

1. Primary Research Question

How can video games be leveraged to enhance preparedness by teaching the public essential actions to take to survive a nuclear detonation?

2. Secondary Research Questions

- What actions should individuals take to increase their ability to survive a nuclear attack?
- How are today's preparedness programs performing with regard to improving the public's resilience?
- How do video games enhance players' learning experience?
- What models exist to implement gaming technology as a preparedness tool?

C. IMPROVING DHS/FEMA'S APPROACH TO NUCLEAR TERRORISM PREPAREDNESS

This thesis proposes an alternative approach to preparing the public for a nuclear terrorism incident, a significant homeland security issue well defined by existing literature. The proposed policy recommendations in this thesis assist the U.S. Department of Homeland Security and the Federal Emergency Management Agency in preparing the public to save their own lives during a catastrophic nuclear terrorism attack. Beyond the direct scope of this thesis, the concepts proposed may be useful to increase national resilience to a range of potential threats.

D. METHODOLOGY

This thesis employs policy analysis to assess the viability of applying video gaming principles to nuclear preparedness and proposes a path for implementation. Drawing upon existing literature on the hazards of nuclear terrorism, nuclear weapons

effects, the didactic use of video games, and the introduction of disruptive technologies within a marketplace, this thesis demonstrates the viability of a policy to use video games with a socially conscious message, known as serious games, to enhance nuclear preparedness.

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II. LITERATURE REVIEW

A. SCIENTIFIC PERSPECTIVE ON NUCLEAR WEAPONS EFFECTS

The scientific literature on nuclear weapons effects is an expansive body of knowledge dating back to World War II and the Manhattan Project. Due in large part to the continuing efforts of the Department of Energy's national laboratories, this nation is awash with data and analysis on the effects of state-held weapons and what would result from a nuclear detonation. Following the end of the Cold War and the subsequent shift in political focus from global nuclear war to nuclear terrorism, a sub-set of this literature has developed to address the scientific uniqueness of nuclear terrorism. Brooke Buddemeier and Michael Dillon, from Lawrence Livermore National Laboratory, represent the current advancements in this expanding body of knowledge. According to them, a detonation of a nuclear weapon in a modern U.S. city, while catastrophic, also presents great opportunity for lifesaving if the proper protective actions are taken (Buddemeier & Dillon, 2009; Buddemeier, 2010).

Richard Garwin, a Fellow Emeritus at the IBM Thomas J. Watson Research Center, provides a useful comparison between the bombing of Hiroshima and a terrorist employing a low-yield nuclear device in a dense urban area. Garwin, an accomplished physicist, has contributed to the design of nuclear weapons and published several reports on nuclear weapons effects (Garwin, 2004; Garwin, 2007; Garwin, 2008). His analysis of the Hiroshima attack is particularly important because it was one of only two nuclear detonations in a densely populated area, and is thus, useful in the analysis of terrorist scenarios, while reinforcing the conclusions of Buddemeier and Dillon (Garwin, 2010).

One point of contention within the literature is the extent of damage that an electromagnetic pulse (EMP) would generate following detonation. EMP is an "electromagnetic field generated from the detonation of a nuclear device that produces a high-voltage surge… EMP effects could result in extensive electronics disruptions complicating the function of communications, computers, and other essential electronic equipment" (National Security Staff, 2010a, p. 36). While disagreement exists on the

extent of damage associated with an EMP, there is agreement, however, that EMP would cause at least minimal disruptions (National Security Staff, 2010a, p. 36). While this debate continues, consensus exists within this community on the topics of primary and secondary effects, points of deviation from the effects of state-held nuclear weapons, and recommended protective actions. This scientific consensus provides the foundation for this thesis.

B. STRATEGIC COMMUNICATIONS REGARDING NUCLEAR TERRORISM AND PREPAREDNESS

A review of the literature on strategic communications with regard to nuclear terrorism shows two relevant tracks, the first addresses broader preparedness strategies, while the second focuses specifically on the hazards of the nuclear threat.

The nation's preparedness strategies of all kinds have received considerable attention over the past decade. *The 9/11 Commission Report: The Final Report of the National Commission on Terrorist Attacks Upon the United States* serves as a foundational document. Drawing lessons from the events of September 11, 2001, recommendations on personal preparedness found in this report have laid the foundation for critical reviews of the nation's efforts to enhance public preparedness (National Commission on Terrorist Attacks Upon the United States, 2004, p. 316).

Two such notable reviews are the report on *The Federal Response to Hurricane Katrina: Lessons Learned* (The White House, 2006) and the 2010 Report to Congress from Local, State, Tribal, and Federal Preparedness Task Force. Drawing from the recommendations of the *9/11 Commission Report*, these reports provide critical reviews of the nation's state of personal preparedness, but lack details needed to develop policy solutions. Indeed, the literature lacks in-depth analysis as to why current preparedness programs are ineffective. The only body of knowledge, albeit limited, that does address this gap comes from the U.S. Government Accountability Office (GAO). In its report *Emergency Preparedness: FEMA Faces Challenges Integrating Community Preparedness Programs into Its Strategic Approach*, the GAO analyzes the limitations and challenges of today's personal preparedness initiatives. This report, unique in the

literature, provides essential insights that can be used to inform enhanced public preparedness efforts specific to nuclear terrorism. The underlying theme of this report is that the dissemination of information alone is not sufficient to drive public action towards preparedness activities. The report highlights that the message delivery vehicle can be just as important as the message itself, and in some cases, the lack of quality in the delivery mechanism can significantly detract from its impact within the target audience (Government Accountability Office, 2010, pp. 9–16).

Beyond assessments of current preparedness infrastructures, the recently published The National Preparedness Goal represents the beginnings of a cultural shift toward an all-hazards, capability-based approach to preparedness that emphasizes the engagement and participation of all members of society to increase the nation's resilience to those hazards that pose the greatest risk. This document transforms the national dialogue regarding preparedness by defining response-centric core capabilities and associated capability targets. The National Preparedness Goal establishes this capability-based framework on the belief that individual and community preparedness is the foundation for success and only through the provision of knowledge and skills to all members of society will the nation achieve true resilience (Department of Homeland Security, 2011, pp. 1–15).

The literature suggests that strategic communications regarding nuclear weapons have waned considerably since the devolution of the Civil Defense Program in the 1960s, which aimed to educate the public on what steps to take should a nuclear attack occur (Hampton et al., 2009, pp. 20–26). While a noticeable gap can be identified, recent policy emphasis on the threat of nuclear terrorism has spurred action. In this respect, the beginnings of growth in literature on this topical area can be seen, mostly focused on applying what is known about nuclear weapons and their effects (Buddemeier & Dillon, 2009; Buddemeier, 2010; Garwin, 2010; National Security Staff, 2010a).

The Planning Guidance for Response to a Nuclear Detonation: Second Edition (here forward referred to as *The Planning Guidance*), published by the National Security Staff: Interagency Policy Coordination Subcommittee for Preparedness and Response to Radiological and Nuclear Threats, sets the foundation for nuclear terrorism response

policy. *The Planning Guidance* and its companion document *Nuclear Detonation Preparedness: Communicating in the Immediate Aftermath* were developed under the auspices of the White House National Security Staff and the Office of Science and Technology Policy. These documents blend expertise from the scientific, academic, and policy communities to provide guidance for emergency management officials when planning for and responding to nuclear terrorism incidents. Leveraging enhanced scientific experience and knowledge, this update addresses issues, such as response zones, worker health and safety, shelter guidance, and preparedness and public communications relevant to the first 72 hours following a nuclear detonation (National Security Staff, 2010a; National Security Staff, 2010b). The guidance provided by these documents serves as basis for public preparedness messaging as it outlines the specific steps the public can take to maximize the probability of their survival.

With regard to strategic communications, both tracks of literature support the conclusion that improvements must be made to increase the nation's preparedness level, and provide data sufficient to inform alternative approaches.

C. GAME BASED LEARNING

With the increased affordability of the personal computer and expansion in the use of personal gaming systems, the idea of leveraging video game technology to enhance learning has received considerable attention (Arnseth, 2006, p. 1). This expansion is noted in the Entertainment Software Association's (ESA) report entitled, *2010 Sales, Demographic and Usage Data: Essential Facts about the Video Game Industry*. This report, a yearly ESA publication, provides a quantitative analysis of the video game industry and identifies interesting trends that break such popular misconceptions as gamers' gender, age and social interactions. The analysis provided by ESA demonstrates how widely video games have diffused throughout the American population and serves as a foundation for this thesis and the use of video games as a viable preparedness vehicle (Entertainment Software Association, 2010).

Along with the growth of this industry, gaming theory has exploded into a broad scholarship area and is supported by a vast amount of literature, much of which is not relevant to this thesis. The modality of gaming and its impact on learning is directly relevant, however, and is reviewed below.

In his book, *Digital Game Based Learning*, founder, CEO and Chief Creative Officer of Corporate Gameware LLC Mark Prensky provides a useful approach to the discussion of using gaming technology to enhance learning. Prensky addresses how people learn, technology's effect on cognition, society's current approach to teaching, what gaming has to offer in a learning environment, and current uses of gaming as teaching tools. While his focus is mostly the younger gaming population within an academic environment, the principles of game-based learning that he outlines are applicable well beyond the confines of the traditional classroom (Prensky, 2001).

Prensky's Digital Game-Based Learning theory, while centered on traditional education, holds enormous potential for application in enhancing nuclear preparedness. At a macro level, the challenges faced in the education and preparedness communities are very similar. Both teach material not intrinsically motivating and have traditionally employed mediums that do not synch with the way today's learners experience their world (Government Accountability Office, 2010; Federal Emergency Management Agency, 2009; Prensky, 2001, pp. 9–65).

According to Hans Christian Arnseth, Associate Professor at the University of Oslo's Institute for Education Research, two distinct approaches exist to applying games to learning, "playing to learn" and "learning to play" (Arnseth, 2006, p. 4). The playing to learn approach emphasizes the skill that should result from gameplay, which can be seen in the majority of educational games available today. On the other hand, the learning to play approach presumes that the act of learning is integral to mastering a game, but to be successful, players must find the gaming medium interesting and motivating (Arnseth, 2006, pp. 4–7). This dichotomy highlights the key issue in the acceptance of games as a viable educational medium and provides a framework to approach applying games to learning.

While Arnseth provides a logical argument that players' learning is a byproduct of the gaming experience, his conclusion lacks a deep theoretical explanation beyond immersive engagement (Arnseth, 2006). Gee's book, *Good Video Games Good Learning*, seems to continue this dialogue where Arnseth leaves off. In this collection of essays on using video games to enhance learning, Gee argues that video games should be viewed as a literacy similar to the written word. In this theoretical model, the player is directly involved in developing the story line within the game. As each player action is met with feedback within the game, the narrative is allowed to continue and is shaped by the manner in which the player interprets and reacts to the gaming environment (Gee, 2008, pp. 135–137). Through this lens, it is possible to identify learning within video games as an activity that requires players to be a direct participant, vice a bystander or casual observer.

Further support for this conclusion can be seen in Aaron Dignan's book, *Game Frame: Using Games as a Strategy for Success*. In this book, Dignan weaves current gaming literature together with psychological and social theories to argue that higher levels of human achievement, learning and engagement lie in making this world more game like (Dignan, 2011). Central to his thesis, Dignan draws from the work of psychologist Mihaly Csikszentmihalyi and his theory that optimal experiences are a result of an altered state of consciousness known as flow (Dignan, 2011, pp. 6–8; Csikszentmihalyi, 1990). In his book, *Flow: The Psychology of Optimal Experience*, Csikszentmihalyi (1990) blends theory with practical examples to show how the human mind seeks out experiences to enhance flow, which can result in higher achievement, learning, and a temporary separation from the restrains associated with time and reality. This principle is highly compatible with gaming theory and the principles of digital game-based learning described by Prensky.

Seeds of these theoretical approaches to video games can be observed in the recent debate surrounding serious games, which utilize engaging video game platforms to educate the public on socially important issues. According to a recent presentation by Dr. Geoffrey Martin Rockwell, Professor of Philosophy and Humanities Computing at the

University of Alberta, Canada, and Dr. Kevin Lee, Canada Research Chair of Humanities Computing, these serious games hold enormous potential to expand public understanding of the challenges facing today's world (Rockwell & Kee, 2011).

As an emerging area of video game studies, the origins of serious games can be traced to gaming experts such as Ben Sawyer, co-founder of a leading commercial gaming company, who published a paper in 2002 entitled *Serious Games: Improving Public Policy through Game-based Learning and Simulation*. Sawyer's paper, a rallying cry for greater cross pollination between game developers and institutions such as government, academia, and non-governmental organizations (NGOs), recognizes the inherent potential video games have to positively influence the world when applied outside a purely entertainment focused mindset (Sawyer, 2002). Sawyer's argument, made a decade ago, is in some ways more relevant today than when originally published. The birth of organizations such as Games for Change with the specific mandate to further develop this emerging genre of games (Games for Change, 2011) combined with the growing list of serious games developed to improve society (Chatfield, 2010, pp. 182–187; Snider, 2011, p. 3B) is evidence to this end.

D. DISRUPTIVE TECHNOLOGIES

The existing literature on video games demonstrates that fun, learning, motivation, and games can be valuable catalysts to explore very complex problems, which highlights the potential for video games, and more specifically, serious games, to affect positive progress in the area of nuclear terrorism preparedness. However, specific to serious games, the current literature base focuses almost primarily on the issue of why games are valuable tools and falls short with regard to leveraging this innovation within an existing system. Given this shortfall, it is important to review other disciplines, such as the business sector that is familiar with managing innovations within an existing system to identify informative parallels.

Clayton Christensen, a professor at the Harvard Business School, offers a unique perspective on innovation in his book, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. In this book, Christensen (1997) analyzes

innovations in various business markets throughout the past century and describes a phenomenon known as disruptive technologies, which are game changing innovations within a particular market space that require specific management techniques. What is interesting is that several parallels exist between the examples and lessons outlined by Christensen and the emergence of serious games that suggest the latter in a preparedness context is a disruptive technology—a concept explained in further detail in Chapter IV (Christensen, locations 191–786; Federal Emergency Management Agency, 2009; Games for Change, 2011). These parallels form the foundation for key findings to inform recommendations for the implementation of serious games within the nuclear terrorism preparedness problem space.

III. THE NUCLEAR TERRORISM PROBLEM SPACE

A. INTRODUCTION

> In a strange turn of history, the threat of global nuclear war has gone down, but the risk of a nuclear attack has gone up... The technology to build a bomb has spread. Terrorists are determined to buy, build or steal one. Our efforts to contain these dangers are centered on a global non-proliferation regime, but as more people and nations break the rules, we could reach the point where the center cannot hold.
>
> - President Barack Obama, 44th President of the United States

The nature of the nuclear threat today has changed. Following the end of the Cold War, U.S. focus has shifted from world super powers employing state-held nuclear weapons to terrorists attacking this country with an improvised nuclear device (IND)[3] (Dugan, Brownstein, Chaudhary, Mallory, Reichow, Smith, Maloney, & Tuohy, 2010, p. 1).

According to a 2007 U.S. Intelligence Community assessment, the al-Qa'ida terrorist organization is the primary terrorist threat to the U.S. homeland and continues to enhance its capability to deliver a massive blow within U.S. borders. Intelligence analysts assess that "al-Qa'ida will continue to try to acquire and employ chemical, biological, radiological, or nuclear materials in attacks and would not hesitate to use them if it develops what it deems is sufficient capability" (Office of the Director of National Intelligence: National Intelligence Council, 2007, p. 6). Although analysts agree that al-Qa'ida does not have an organic nuclear capability, the group's commitment to acquiring this capability is demonstrated by a September 2006 audio statement by al-Qa'ida in Iraq that called on nuclear scientists to join the jihad. In that address, Abu Hamza al-Muhajir, also known as Abu Ayyub al-Masri, stated, "experts in the fields of chemistry, physics, electronics, media and all other sciences—especially nuclear scientists and explosive

[3] According to the U.S. Department of Energy, an IND is defined as "a device, incorporating fissile materials, designed or constructed outside of an official Government agency and which has, or appears to have, or is claimed to have the capacity to produce a nuclear explosion" (U.S. Department of Energy, 2006, attachment 3, p. 1).

experts" (as quoted by Al Qaeda in Iraq Beckons Nuclear Scientists, 2006) should join him (Office of the Director of National Intelligence, n.d., p. 7; Al Qaeda in Iraq Beckons Nuclear Scientists, 2006).

Given this threat, it is prudent to train and educate the public on how to survive such an attack (National Council on Radiation Protection & Measurements, 2010, pp. 61–62; Dugan et al., 2010, pp. 5–7; National Security Staff, 2010b, pp. 120–121). While obvious and simple in principle, a direct conversation with the public regarding this specific technical hazard presents many challenges due to many factors. These factors include limited public understanding of radiation and associated fear, the recollection of the nuclear effects observed during World War II in Japan, such as horrifying injuries and destruction, and the association of nuclear terrorism with Armageddon-like global nuclear war scenarios. These reactionary themes create a wide spread sense of futility and can lead many to abandon preparedness activities as they perceive the probability of their survival in a nuclear incident is near zero. Since a direct conversation with the public on the topic of nuclear detonations may prove too challenging given the current environment, the preparedness community should consider alternative methodologies to deliver the message (Hampton et al., 2009, pp. 20–38; National Security Staff, 2010b, pp. 120–121).

B. NUCLEAR WEAPON EFFECTS OVERVIEW

A catastrophic nuclear detonation in a large metropolitan area would be the ultimate test of citizen preparedness. The scientific community is largely in agreement that a low-yield nuclear detonation in a densely populated city would create two types of hazards—prompt hazards of radiation, heat, and blast overpressures in the immediate area, and secondary fallout[4] hazards that would expose areas several miles downwind to deadly levels of radiation. See Figure 1. Prompt radiation, thermal effects, and blast overpressures occur in the first few seconds following detonation and, in the case of a 10-

[4] Fallout is produced when the radioactive products from the nuclear detonation, combined with debris and materials near ground zero, are propelled into the atmosphere by the explosion and fall back to the ground over time. Once on the ground, these fallout particles produce deadly levels of ionizing radiation for a period of time following the detonation (Buddemeier & Dillon, 2009, pp. 2–4).

kiloton (KT) detonation, make the immediate area within approximately three and a half miles of ground zero extremely hazardous (Buddemeier & Dillon, 2009, pp. 2–4). These prompt effects were observed in Hiroshima in 1945, when the United States detonated a nuclear bomb with a 13-KT yield over the city (Garwin, 2010, pp. 20–21).

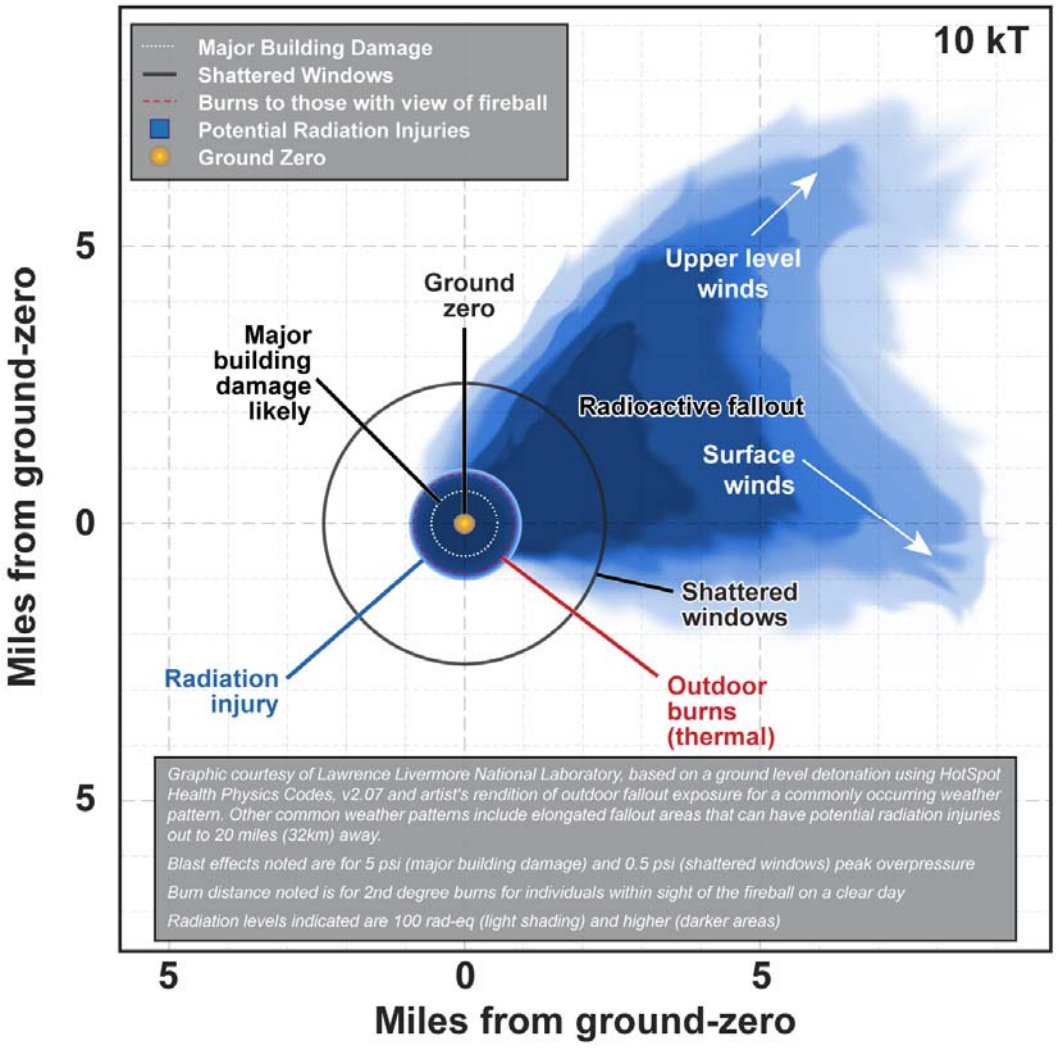

Figure 1. Nuclear Weapon Effects (From: Buddemeier, 2010, p. 32)

While the bomb used at Hiroshima produced a yield similar to the 10-KT detonation used in today's planning scenarios (Garwin, 2010, pp. 20–21; U.S. Department of Homeland Security, 2005), the altitude of the detonation, approximately 1,900 feet, led to drastically different outcomes. Garwin emphasizes that the Hiroshima

attack lacked significant radioactive fallout that typically accompanies ground-based nuclear detonations. Had the nuclear device been delivered via a terrestrial means, the outcome would have been far different because nuclear fallout presents a significant threat to life following a terrorist nuclear strike in a dense urban city, since it has the potential to rapidly expose populations in over 12 square miles to radiation levels that could cause 50 percent mortality (Garwin, 2010, pp. 20–21). See Figure 2.

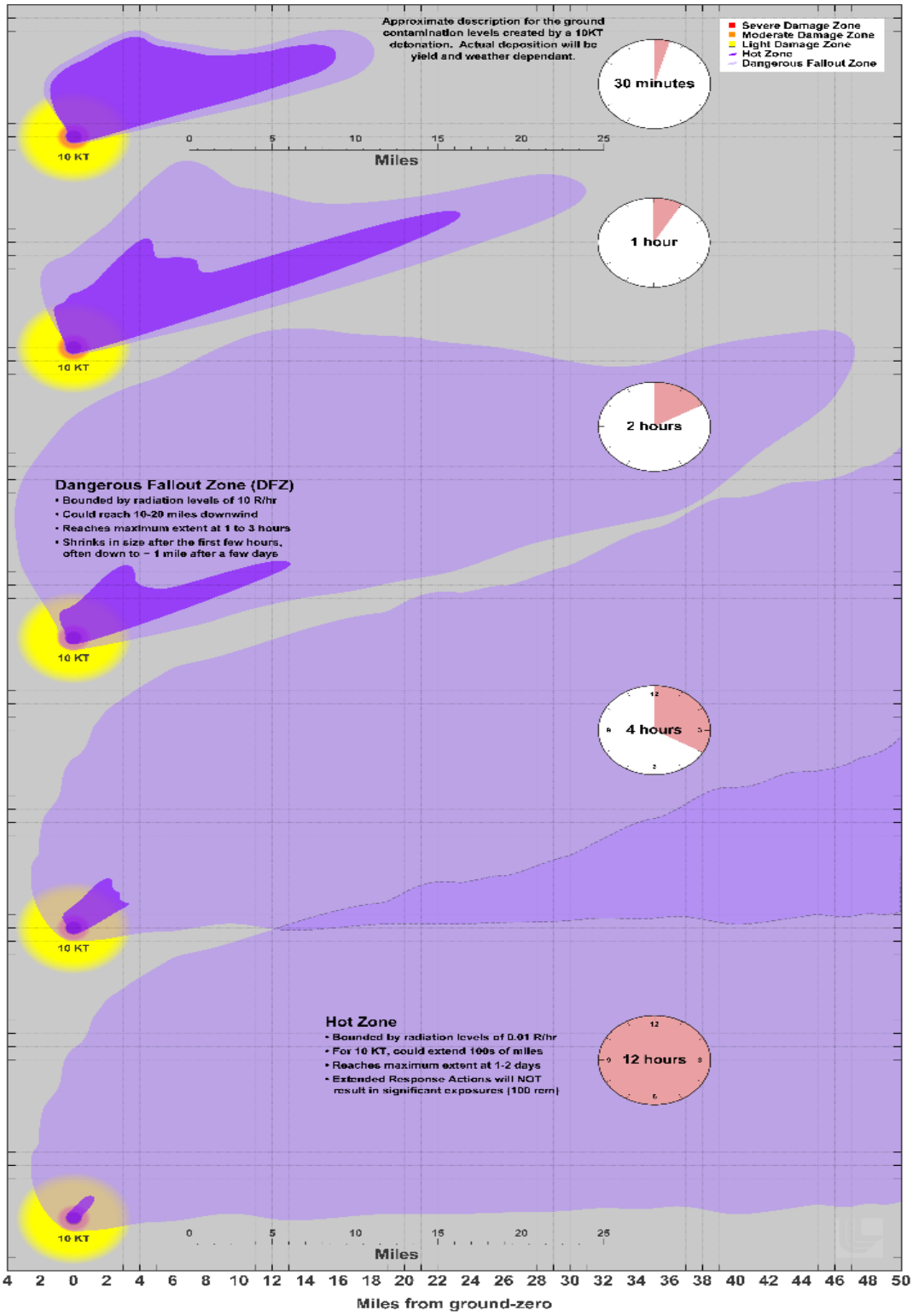

Figure 2. Time Phased Fallout Trajectory (From: National Security Staff: Interagency Policy Coordination Subcommittee for Preparedness & Response to Radiological and Nuclear Threats, 2010, p. 32)

Communicating in the immediate aftermath of a nuclear detonation would be fraught with challenges. Disruptions to communications infrastructure and devices will likely be caused by the physical blast, as well as the EMP associated with the nuclear detonation, which makes the dissemination of accurate protection action guidance within the immediate impacted area nearly impossible. Given these post-incident communication challenges, pre-incident public awareness is essential to saving lives. Without concise, accurate pre-incident knowledge, potential survivors are more likely to follow their initial survival instincts, and in so doing, expose themselves to potentially fatal doses of radiation (National Security Staff, 2010b, pp. 116–121).

C. WHAT THE PUBLIC SHOULD KNOW

While the fallout hazard presents a significant hazard following a nuclear detonation, it also provides the greatest opportunity for lifesaving and hazard mitigation. Unlike prompt nuclear effects, which in a no-notice attack occur too rapidly to avoid, the radiation produced by fallout particles can be avoided by those further downwind by either leaving the area before fallout arrives or by taking shelter from it. Unfortunately, evacuation is not a useful fallout avoidance strategy as lethal levels of fallout are likely to reach nearby populations within minutes of the detonation, leaving no time for large-scale evacuations. Successful post-detonation evacuation requires evacuees to know where the highest radiation levels are located to achieve the lowest radiation exposure possible (Buddemeier, 2010, pp. 31–35). While the U.S. Government maintains the capability to model the aerial distribution of radiological material following an nuclear detonation (U.S. Department of Homeland Security, 2010, pp. 1–2) due to the rapid movement of the fallout cloud, the time required to produce these predictions, and communications difficulties that would follow the initial detonation, the general population would likely not have the information necessary to make an informed evacuation route decision (Buddemeier, 2010, pp. 34–37; National Security Staff, 2010b, pp. 116–120).

Thus, following a nuclear explosion, the population in and around the impacted area of the detonation should seek immediate shelter to avoid the negative health effects

of fallout exposure (Buddemeier, 2010, pp. 31–32). In fact, the U.S. Government recently stated, in its *Planning Guidance for Response to a Nuclear Detonation: Second Edition*, that "sheltering in the most accessible and sufficiently protective building or structure is the best initial action immediately following a nuclear explosion" (National Security Staff, 2010a, p. 69). As seen in Figure 3, the protection offered by varying building types differs and is quantified by protection factors—higher protection factors identify greater protection from radiation exposure. Additionally, according to research conducted by the National Laboratories, even moderate shelters, such as a residential basement, with only a protection factor of 10 can prevent upwards of 200,000 people from significant radiation exposure (Buddemeier, 2010, pp. 32–33).

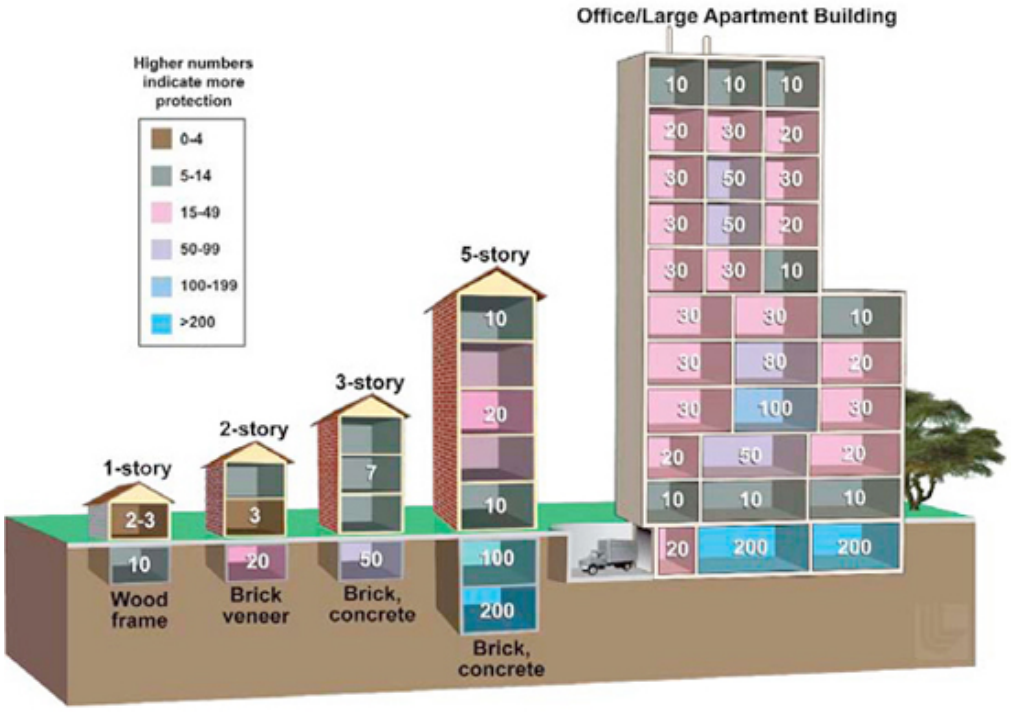

Figure 3. Radiation Protection Factors by Building Type (From: FEMA, 2011a)

Leveraging this scientific analysis, it is possible to identify steps the public should take to avoid the fallout hazard. The primary action the public should take following a nuclear detonation is to seek shelter. To minimize radiation exposure, individuals should

attempt to put as much distance and dense material as possible between themselves and locations where fallout is likely to accumulate. Ideal locations include basements, subterranean parking structures, or the center of the middle floors of multi-story buildings. Once sheltered, people can further protect themselves by removing any fallout particles that may be on their person, which involves removing and discarding any contaminated clothing and washing or showering if possible (National Security Staff, 2010a, pp. 9–29).

While this guidance is consistent with early Cold War messaging efforts that emphasized the use of fallout shelters to avoid radiation exposure, these earlier communications efforts were riddled with inconsistencies from the policy, scientific, and civil defense communities and often caused fear in audiences. These inconsistencies in messaging not only reduced the efficacy of these efforts, but also led to the branding of these messages as propaganda. These factors, along with the end of the Cold War, led to the abandonment of these public-messaging efforts and silenced the national discourses on how to survive a nuclear explosion (Hampton et al., 2009, pp. 20–23, 55–64). As a direct result, a generational gap now exists as today's generation lacks the knowledge needed to protect itself during a nuclear attack.

D. WHY OUR CURRENT EFFORTS JUST AREN'T ENOUGH

> Insanity: doing the same thing over and over again and expecting a different result
>
> - Albert Einstein

As discussed above, legacy nuclear preparedness campaigns have created a generational gap in the public's knowledge on what action to take following a nuclear attack (Hampton et al., 2009, pp. 20–23, 55–6). While the scientific and policy communities are largely in agreement that individual preparedness is the key to improving live-saving outcomes on a mass scale following a terrorist nuclear attack, recent data suggests the nation's preparedness efforts are stalled, leaving large segments of the public without the knowledge or skills to affect their own survival in a catastrophic disaster (Federal Emergency Management Agency, 2009, pp. 7–24).

Presidential Policy Directive 8 entitled *National Preparedness* and the recently signed *National Preparedness Goal* emphasizes a capability-based approach to preparedness that leverages all segments of society, most importantly the public, to increase the nation's resilience to all hazards (The White House, 2011, pp. 1–2, Department of Homeland Security, 2011, p. 1). With regard to the *National Preparedness Goal*, the desired end state is defined as "a secure and resilient Nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk" (Department of Homeland Security, 2011, p. 1). The driving theme behind these documents is that small actions to increase preparedness at an individual level, if replicated on a large scale, can have significant impacts during an incident, as seen during the evacuation of the WTC on September 11, 2001 (The White House, 2011, pp. 1–2; Department of Homeland Security, 2011, p. 1).

Currently, the Ready Campaign, in partnership with the Ad Council, works to improve public awareness about emergency preparedness, and ultimately, motivate the public to take action to increase the nation's preparedness level. However, while the Ready Campaign currently provides accurate guidance to the public, recent reviews suggest it lacks the impact needed in the nuclear scenario (Government Accountability Office, 2010). One of the limiting factors of the Ready Campaign is the focus on an Internet-based approach, which is inherently passive and puts the onus on citizens to locate the preparedness information they require and then act upon it (McGee et al., 2009, pp. 28–30). Additionally, the Ready Campaign relies on donations of television time slots for PSAs, which typically do not air during primetime viewing or listening hours—in 2008 about 25% of these PSAs occurred between 1am and 4am (Government Accountability Office, 2010, pp. 12–13).

These program challenges at first glance may seem localized within FEMA; however, national gains in the area of community and citizen disaster preparedness remain disappointing (Department of Homeland Security: Office of Inspector General, 2010, pp. 10–13)—especially when reviewing the public's expectations of government following a major incident.

In 2009, FEMA published the results of a personal preparedness survey of 4,461 households, chosen at random. The results provide a glimpse into the role expectations of established emergency response systems play in the effectiveness of FEMA's efforts to enhance citizen preparedness. Twenty-nine percent of those surveyed had not prepared because they planned to rely on first responders during a disaster; furthermore, over half (61%) indicated that they expected to rely on emergency responders during the first 72 hours of an emergency (Federal Emergency Management Agency, 2009, pp. 19–23). These results correspond to a 2008 disaster survey by the Global Security Group, which indicated that 67% of 1,017 polled New Yorkers expected government authorities to provide assistance in the event of a terrorist attack or other large incident (Global Strategy Group, 2008). These results are sobering, as they are in direct contrast to the principles espoused by the National Preparedness Goal, and suggest that for over half of Americans, unrealistic expectations placed on emergency responders may inhibit personal preparedness activities, such as seeking knowledge on the steps the public should take to increase the probability of their survival during a nuclear terrorism attack.

It is unrealistic to ever expect 100% of the population to achieve a preparedness level that enables self-sufficiency during a disaster. However, while it is outside the scope of this thesis to define an acceptable performance metric for public preparedness, the above data suggest the efficacy of current preparedness programs and approaches alone are not adequate to increase the public's preparedness to a level needed to save significant lives in a nuclear terrorism scenario and should be augmented by alternative communication and educational strategies.

E. CONCLUSION—A NEW APPROACH IS NEEDED

> The difficulty lies not in the new ideas, but in escaping the old ones
>
> - John Maynard Keynes,
> British Economist—Father of Modern Macroeconomics

The lifesaving benefits of robust public preparedness for the specific hazards of a nuclear detonation are too great to overlook. Given the ever-present threat of nuclear terrorism, it is important to ensure the public understand what simple steps are necessary

to save their own lives and those of their family and neighbors, should this threat come to fruition. Current national preparedness programs and approaches do not have the efficacy required to affect such a widespread result.

To improve upon the current condition of the public's preparedness for nuclear terrorism, it is necessary to explore alternative ways to close the current generational gap, while still providing technically accurate guidance that can be easily absorbed by the public. The passive nature of today's preparedness programs, combined with the stagnant level of low public preparedness, suggests an alternative approach is needed to achieve more engagement with target audiences, specifically those within today's generation who were not exposed to civil defense messages during the Cold War. Additionally, such efforts should leverage relationships with non-traditional partners who can assist in expanding potential audiences for preparedness messages. The following chapter discusses recent advancements in edutainment and messaging through video games that suggest gaming technology is one possible way to increase audience engagement, while still providing effective preparedness education (Arnseth, 2006, pp. 1–6).

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IV. VIDEO GAMES AS AN ALTERNATIVE APPROACH

A. INTRODUCTION TO VIDEO GAMES

> Nothing has captured the mind space of both students and kids and adults as games have. They are deeply immersive
>
> - Kumar Garg,
> White House Office of Science and Technology Policy

The popularity of video games in today's society is very evident. The wide propagation of affordable game platforms has made this pastime a regular part of mainstream culture (Arnseth, 2006, p. 1). As of 2009, video games were a $10.5 billion industry in the United States alone, with 273.5 million units sold. According to survey data from the Entertainment Software Association, 67% of American households play computer or video games (Entertainment Software Association, 2010, pp. 2–11).

With this expansion of this market, discussions regarding gaming technology and its potential to enhance learning are becoming increasingly common. The driving force behind these discussions is that video games provide players a motivating and rewarding experience. If combined effectively, video games have the potential to make learning fun and pleasurable by offering students a multi-modal, active learning environment (Arnseth, 2006, pp. 1–2). These principles are at the core of Prensky's Digital Game-Based Learning Theory, that video games can be employed to teach difficult or complex materials that are not intrinsically motivating (Prensky, 2001, pp. 9–34). Intrinsic motivation can be defined as "the inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn" (Ryan & Deci, 2000, p. 70). Individuals can be motivated into a behavior, such as learning, because "they value an activity or because there is strong external coercion" (Ryan & Deci, 2000, p. 69). However, those who act on intrinsic motivators are predominantly found to have greater performance and persistence in an activity when compared to those who acted due to external pressures (Ryan & Deci, 2000, p. 69).

The existence of a field of study founded in the belief that video games are powerful tools capable of intrinsically motivating deep learning is evidence of the

teaching potential behind this medium. In addition, recent evolutions have transformed video gaming from a solitary activity to one that is widely social. Today, players engage with others across the globe to collaborate, play, share strategies via networked gaming systems and online gaming communities, such as websites, blogs, and chat rooms. This behavior has challenged game theorists to rethink what constitutes a game since the social components of gaming communities can become as interactive as the games themselves (Gee, 2008, pp. 132–134).

What makes video games unique is the role of the player or players in the completion of the game design or story line. Using this definition, Gee identifies video gaming as a "new literacy" (Gee, 2008, p. 135), based on the dynamic between consumption and production within gaming mediums. Consumption and production are analogous to reading and writing of print media. With regard to print media, individuals consume a document by reading the words and interpreting their meaning. Production in this context involves documenting thoughts through the act of writing. Using this analogy, it is possible to identify a similar process within video game play as players consume the medium provided by game developers and produce an action based on their consumption (Gee, 2008, p. 135).

While many activities treat consumption and production as linear processes, video games break this paradigm and incorporate a certain amount of production within the consumption process. To succeed, players must consume the game through interpretation of and reaction to the elements of the game. According to Gee, the game design "doesn't really come into full existence until players make decisions and take actions in the game" (Gee, 2008, p. 135). In this process, players analyze the game design and utilize specific strategies and actions to achieve specific goals. This concept provides the foundation for this chapter and the argument that video games can improve the public's preparedness for nuclear terrorism by aligning the goals of video games with the skills necessary to survive a nuclear attack, as introduced in the previous chapter.

B. WHAT IT MEANS TO BE A GAME

The Merriam-Webster's Collegiate Dictionary defines a video game as "an electronic game played by means of images on a video screen and often emphasized by fast action" (Mish, 2003, p. 1394). This thin definition is inadequate for this discussion, as it provides no basis for deep analysis beyond identifying that games are associated with rapidly developing story lines. To get to the root of what potential video games can offer, it is essential to identify the elemental structure that comprise video games. According to Prensky, games have six basic elements in common that lead to true engagement—rules; goals and objectives; outcomes and feedback; conflict, competition, challenge and opposition; interaction; and representation (Prensky, 2001, pp. 118–124).

Rules provide the essence of a game. They define the boundaries and ensure that each player follows the same course in pursuit of goals. Without rules, there is no game—there is simply free unorganized play. Goals and objectives are also essential to games, as they provide the foundation for player motivation. According to Prensky, this attribute is what differentiates games and toy, as toys may be used in many different ways depending on the player's intent. Games, on the other hand, challenge players to envision a specific goal, develop a strategy to achieve that goal based on established rules, and take action based on the strategy. The result of this process is not only achievement of the goal, but also a sense of fulfillment and pleasure. For that process to function, a game must provide outcomes and feedback. Outcomes are what players are measured against; in basic terms, determining to what extent players have attained the goal(s) within the game does this. Feedback is provided to players throughout the game in terms of progress toward stated goals and whether actions taken are in line with the rules; however, in video games, the uniqueness of feedback is that it is almost instantaneous. In fact, the immediacy of feedback in video games is the essence of their interactive nature (Prensky, 2001, pp. 118–122).

Conflict, competition, challenge and opposition provide the core of the gaming experience, as they are the problems and issues that the player is attempting to resolve. These elements are what pull the player into the game and increase excitement and emotional involvement. Good game developers maximize this effect by ensuring conflict,

competition, challenge, and opposition are balanced with a player's changing skill level—see Figure 1 (Prensky, 2001, pp. 122–123). This challenge-versus-skill balance results in a phenomenon known as "flow" (Dignan, 2011, pp. 6–8; Prensky, 2001, p. 124) discussed in detail in Section 4.5 (Dignan, 2011, pp. 6–8; Prensky, 2001, pp. 124–125).

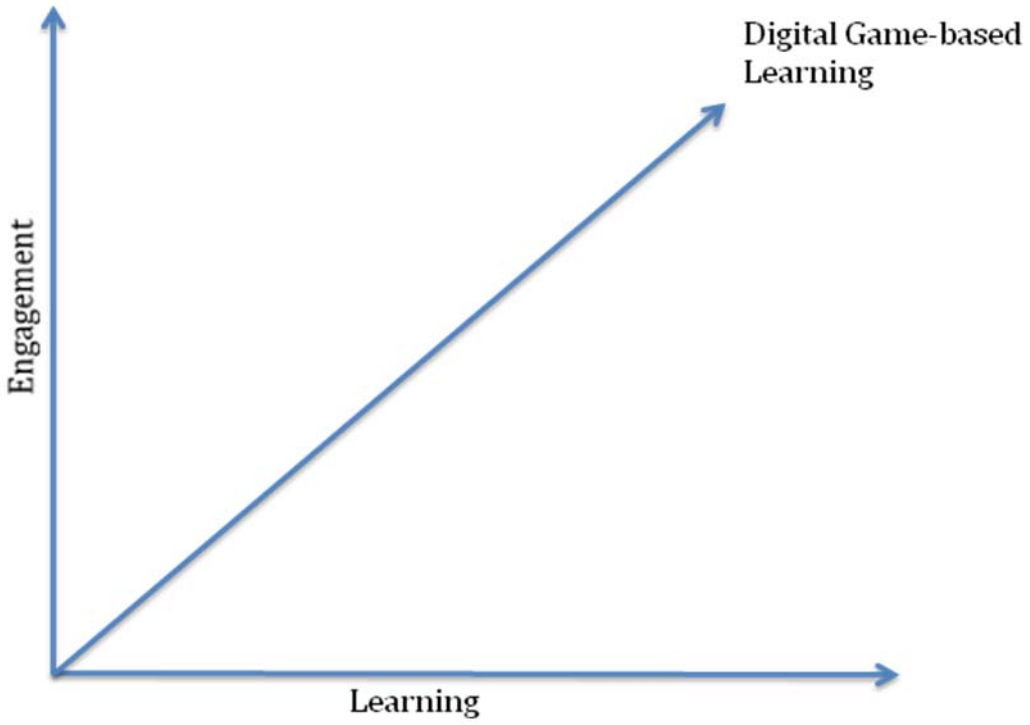

Figure 4. Digital Game-based Learning's Relationship between Engagement and Learning (From: Prensky, 2001, p. 150)

The interactive nature of video games allows for immediate feedback, as discussed above, but also enhances the player's experience by allowing social interaction (Prensky, 2001, p. 123). However, these social interactions are not limited to the game medium itself. The creation of websites, chat rooms, and various other game-related forums have created a gaming community in which players can exchange strategies and discuss games in a way that magnifies the overall effect games have on players' lives. This exchange with players outside the confines of the video game produces additional opportunities for learning, as players compare and contrast strategies and their

effectiveness within the complexities of the game (Gee, 2008, pp. 132–134). Within the context of this thesis, such collaborations could lead to beneficial discussions on the necessity to shelter to avoid fallout exposures, the quality of various shelter types, and effective strategies for selecting an adequate shelter during an incident.

Finally, representation provides the story or plot of the game and defines for the player what the game entails. Representation not only provides the background for the game but also includes elements of fantasy, which help to define where the game ends and reality begins (Prensky, 2001, pp. 123–124; Gee, 2008, pp. 123–124). Prensky's game framework demonstrates that games, while seemingly simple, are in fact complex dynamic media and provides the foundation for the following discussion regarding games and their potential to teach a wide audience certain skills. Using this framework is essential to unlocking the true potential of video games beyond mere leisure.

C. LEARNERS HAVE CHANGED

> I never try to teach my students anything. I only try to create an environment in which they can learn.
>
> - Albert Einstein

When discussing the use of video games as education tools, it is first crucial to consider the audience. A key to understanding today's gamers is the realization that learners have changed over the past few generations. While previous generations learned primarily through passive interaction, such as traditional classroom settings and watching television, today's learners actually learn better through a more hands-on approach. Prensky calls this cohort of learners the "games generation" (Prensky, 2001, p. 47) and describes them as active participants who prefer interactive technologies, such as video/computer games and the Internet to just watching television. This preference is explained in the fact that this generation has been raised in a technologically rich environment, which has influenced the way these people experience the world around them (Prensky, 2001, pp. 35–65). It is currently estimated that the average American born after 1970 will have played approximately 10,000 hours of video game before reaching the age of 21 (Dignan, 2011, p. 19; Prensky, 2001, pp. 37–38). This statistic shows that

today's generations not only prefer, but actively seek activities that contain rules; goals and objectives; outcomes and feedback; conflict, competition, challenge and opposition; interaction; and representation.

Having engaged in these activities for what equates to approximately 1,250 eight-hour workdays,[5] it is clear that modern gamers have dedicated significant portions of their lives to reprogramming their minds to accept information in a much different way than previous generations (Prensky, 2001, pp. 35–65). This phenomenon of re-wiring the way the brain accepts information is known as neuroplasticity, which simply put, means that minds are constantly creating, altering, or removing cognitive pathways based on usage (Dignan, 2011, p. 21). Thus, members of the games generation desire processing information quickly, multi-tasking, non-sequential information processing, rich images, virtual interactions, learning by doing, work through play, and feedback through rewards (Prensky, 2001, pp. 35–65).

According to Patricia Marks Greenfield, professor of psychology at the University of California—Los Angeles, video games have allowed the games generation to hone specialized skills, such as inductive learning through observation, trial and error, and testing hypotheses; comprehending multi-dimensional imagery; and comprehension of scientific simulations. Greenfield argues that these video game characteristics create an unparalleled learning environment capable of motivating students who reject traditional educational settings to seek out instruction or even becoming instructors to their peers (Greenfield, 1984, pp. 97–125). Simply put, today's games generation not only prefers the low consequence trial and error learning environment provided by today's video games, they are preferentially wired to interpret this sensory input as an effective and efficient way of experimentation and learning. This generation's preference for highly interactive learning and the fact that they also comprise the generational gap with regard to knowledge of fallout avoidance actions suggests that video games are an appropriate vehicle to increase this segment of the population on this important issue.

[5] 10,000 hours divided by eight workday hours equals 1,250 workdays.

D. VIDEO GAMES AS TEACHERS

> One wonders whether there's any limit to what can be done in merging the addictive elements of computer games with effective instruction.
>
> - Bob Filipczak
> Training Magazine

Relative to traditional educational systems, video games are a recent technological development; however, they have already influenced the way people think about learning and cognition. According to Gee, understanding and learning in humans is maximized when it is possible to simulate an experience. In other words, individuals go beyond simple memorization and place themselves in hypothetical situations to test the effectiveness of various actions needed to accomplish a certain goal (Gee, 2008, pp. 23–24). Arnseth, who argues that video games are relevant in an educational context, supports this learning-by-doing approach as it provides the player or players with a "contextually situated form of practice" (Arnseth, 2006, p. 1). Thus, games are effective at teaching skills and allowing players to practice their application within realistic scenarios (Arnseth, 2006. p. 1).

Arnseth's comparison of "playing-to-learn" and "learning-to-play" (Arnseth, 2006, p. 4), while deceptively simple, cuts to the core of the current debate, which pits content against structure. Supporters of playing-to-learn emphasize the skill that should result from the gameplay. The end states of this line of thought can be seen in edutainment products that draw on game features to teach specific skills, such as algebra or reading. While these programs easily dovetail into existing curricula, their skin-deep gaming features, such as poor design, repetitiveness, and overly simplistic tasks, have limited their overall success (Arnseth, 2006, pp. 4–7).

Alternatively, those in the learning-to-play camp regard learning as an integral part of mastering the game. This group centers itself around the belief that to teach students an alien concept, the learning must be based on something familiar that the students find interesting, motivating and meaningful. This approach turns traditional

educational approaches on their head by emphasizing the educational value of play, vice using play as a reward for learning, which allows learners to apply skills learned in situations with similar contexts (Arnseth, 2006, pp. 7–11).

This playing to learn approach is supported by Gee's description of situated learning. At a macro level, the difference between learning and situated learning is analogous to the difference between simply passing an academic exam and actually applying knowledge gained in real world situations. According to Gee, situated learning is the ability to associate knowledge with a particular meaning in a way that allows the person to apply that knowledge to solve actual problems. The characteristics of video games provide for a rich situated learning environment that allows players to have a guided learning experience within specific contexts that enhances the learning process (Gee, 2008, pp. 143–146). Through situated learning, players will be able to apply preparedness knowledge within a game scenario that not only demonstrates the importance of specific protective actions, but also the consequences that can result if ill-advised strategies are chosen.

Gee (2008) argues that the unique ability of video games to relate the goals, beliefs, values, and feelings of the player and the virtual character within the game is the foundation for this learning experience (pp. 68–72). Gee (2008) terms this phenomenon the "projective stance" (p. 68), which he defines as "a double sided stance towards the world (virtual or real) in terms of which we humans see the world simultaneously as a project imposed on us and as a site onto which we can actively project our desires, values, and goals" (p. 68). Through this projective stance, a relationship is established whereby the goals of the virtual character and the goals of the player are combined with the powers and limitations of both in a specifically designed virtual world. See Figure 2. Finding the right combination of these goals, powers, and limitations is necessary for the successful completion of the game.

To describe this phenomenon, Gee (2008) discusses the concept of a "surrogate" (p. 68) in the form of a virtual player. "Virtual characters have virtual minds and bodies. They become the player's surrogate mind and body… as a player, you must—on the basis of what you learn about the game's story and the game's virtual world—attribute

certain mental states (beliefs, values, goals, feelings, attitudes, and so forth) to the virtual character. You must take these to be the character's mental states; you must take them as a basis for explaining the character's actions in the world" (Gee, 2008, p. 68). Through these surrogates, players are able to test various post-detonation response strategies. Through effective construction of the video game environment, game designers can guide players through this process and demonstrate to players the attributes and draw backs of various fallout avoidance strategies. Video games offer specific processes to guide this process, which is discussed in the following section.

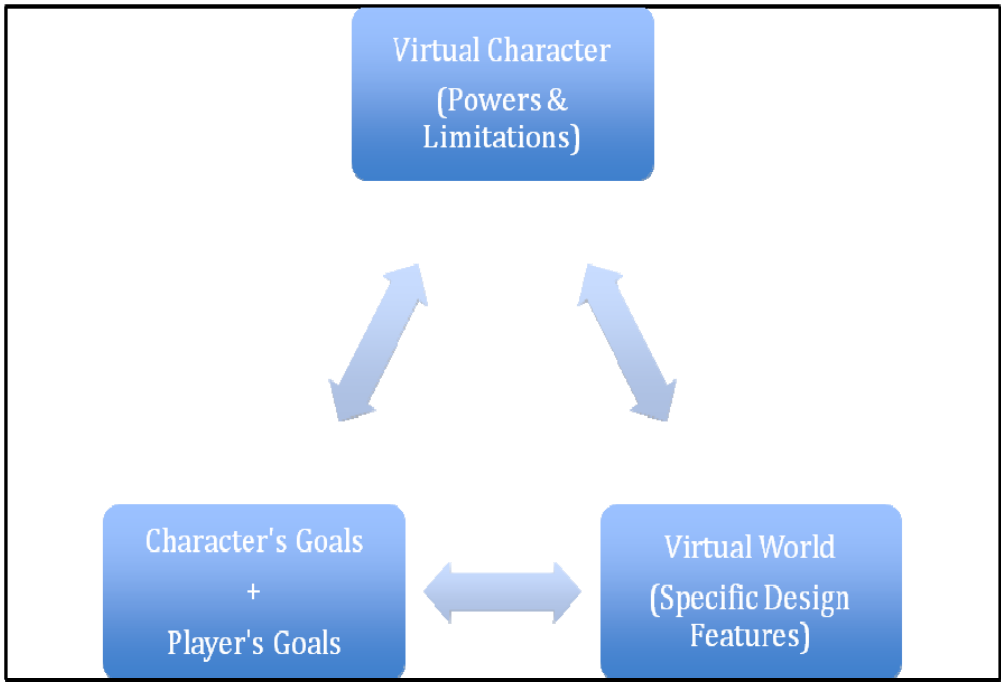

Figure 5. The Projective Stance Relationship in Video Games (From: Gee, 2008, p. 70)

E. GROKING AND FLOW

As discussed above, video games are enjoyable activities that also offer many opportunities for learning. Dignan (2011) argues that this relationship between games, fun and learning is no coincidence and is directly related to the fact that human minds are "learning machines" (p. 4). Games offer players an opportunity to learn new skills and

new information. Mastering these skills and processing new information are requirements to complete the game successfully. As players develop new skills or knowledge based on encounters in the game, they feel a deep sense of satisfaction. Dignan (2011) describes the link between challenge seeking and satisfaction through accomplishment as groking, "to understands it so thoroughly that it becomes a part of you" (pp. 4–5). The pleasure associated with groking can be explained neuroscientifically, by the release of opioids when new information is mapped. Dignan (2011) defines opioids as pleasure related chemicals released by the body, and based on their link to mastering new skills, he suggests peoples' love of groking new information is rooted in their biological composition (pp. 4–5).

While mastering skills can generally result in pleasure, it requires a delicate balance of skill and challenge. According to Csikszentmihalyi, this balance between skill and challenge is essential to achieving an optimal experience. Lack of balance can prove to be disruptive, since too much challenge results in frustration and too little can lead to boredom. See Figure 3. Optimizing the experience to increase challenges as skills are attained is what Csikszentmihalyi (1990) calls the "flow experience" (pp. 40–41, 71–77). To achieve flow, an individual's skills must be "adequate to cope with the challenges at hand, in a goal-directed, rule-bound action system that provides clear clues as to how well one is performing" (Csikszentmihalyi, 1990, p. 71). Persons in this state experience a deep sense of concentration in which thoughts, intentions, and feelings are all concentrated on the same goal. What results from flow are higher performance and a distortion of reality that leads to higher states of consciousness and even a distortion in the perception of time (Csikszentmihalyi, 1990, pp. 40–41; 71–77).

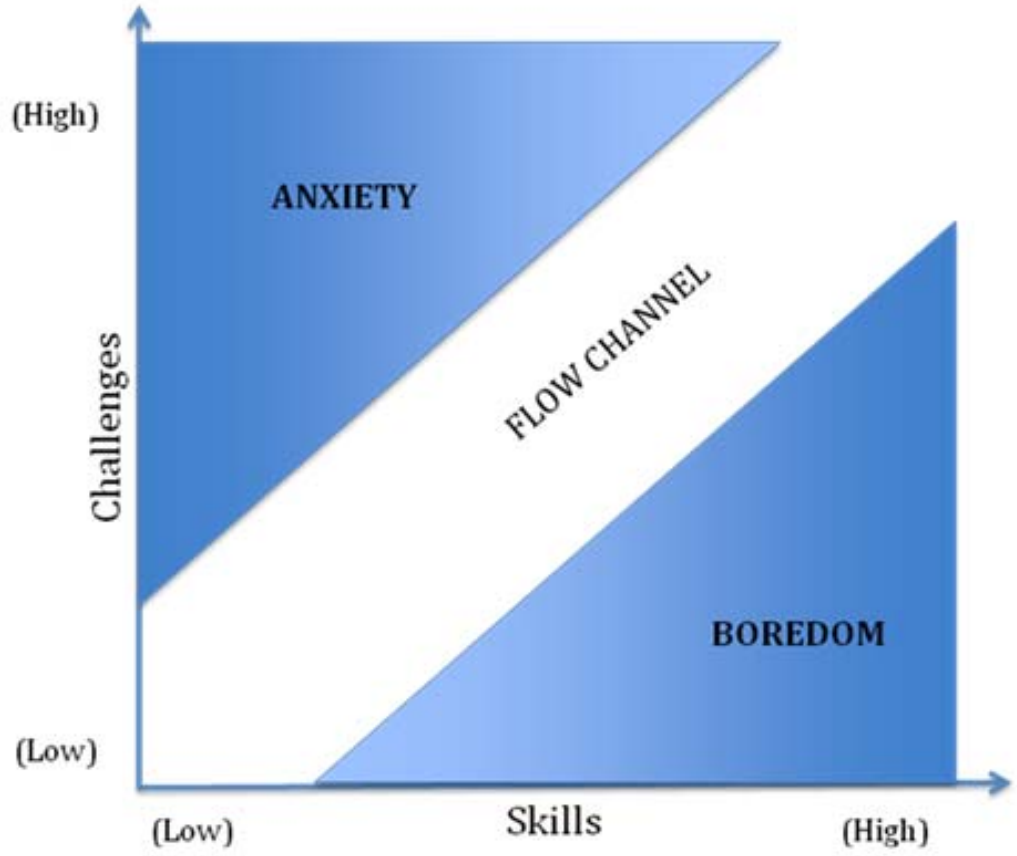

Figure 6. Diagram of the Flow Experience (From: Csikszentmihalyi, 1990, p. 74; Dignan, 2011, p. 7)

Using Csikszentmihalyi's definition, it can be seen that video games are compatible with the principles of flow. As discussed earlier in this chapter, video games are goal-oriented, rule-bound systems that provide regular performance feedback to players. The escalating challenges provided by games support the central premise of flow by providing the player a systematic way to enhance skills or develop new skills to progress within the game (Dignan, 2011, pp. 6–8). Additionally, Prensky's digital game-based learning theory supports the need for flow within video games to enhance learning. While Prensky does not use the term flow specifically, he does identify the need to balance engagement and learning within the game structure. While variances in terminology exist, the processes described by both Csikszentmihalyi and Prensky are highly compatible, as challenges can be easily linked with engagement, and, likewise, the

attainment of skills considered learning. Both models are also visually compatible, as seen in the comparison of Figures 1 and 3. This analysis demonstrates that to invoke true learning, video games must balance challenges and engagement with learning and skill development to keep players in a state of flow. Maintaining flow will maximize player enjoyment by feeding the primordial desire to groke or master new information or skills, and thereby, creating the intrinsic motivation to continue the learning experience. Leveraging this effect, the preparedness community can overcome the major obstacle of motivating the public to consume available information on nuclear terrorism preparedness, which, as discussed in Chapter II, is a significant challenge of the current approach.

F. LEVERAGING THE FUN FACTOR

In 1989, an adolescent research subject at the Massachusetts Institute of Technology used the term "hard fun" (Dignan, 2011, p. 31) to describe building a complex structure using building blocks (Dignan, 2011, pp. 30–31). This term, while seemingly elementary, reinforces the notion that video games fulfill a human need for challenging mental activities to learn, or groke, new things. In his argument supporting learning through play, Arnseth (2006) states, "one striking feature of game play that seems to be particularly relevant for education is the fact that children and adolescents seem to invest a considerable amount of time and effort in accomplishing tasks that are often very difficult and time consuming" (p. 2). This premise that video games offer an environment that naturally motivates players to learn difficult concepts demonstrates the true power of the video game medium.

This concept is also what differentiates video games from digital or computer-based training (Prensky, 2001, pp. 145–151). People participate in training due to external motivators, such as work or school; however, video games command their audience primarily by feeding the intrinsic motivations of hard fun. Any game developed to teach people the skills necessary to survive a nuclear detonation must be created in the spirit of hard fun and provide audiences a challenging experience that will motivate participation in the game and teach them valuable survival skills in the process.

G. TIME TO GET SERIOUS ABOUT GAMES

> More and more we are recognizing in the twenty-first-century that the kind of problems we face globally are genuinely complex. They involve many interrelated variables: things related to climate change or international trade, for example. Games are systems, and they offer a good way to explore complex systems, a way we didn't have before.
>
> - Suzanne Seggerman
> Founder of Games for Change

An emerging field of games studies known as "serious games" (Rockwell & Kee, 2011, p. 7; Schollmeyer, 2006, p. 35) seeks to leverage the power of modern video games to address significant challenges facing the world today (Rockwell & Kee, 2011, p. 7). According to Schollmeyer (2006), these games transcend the limitations of traditional video games and address serious political, social and cultural issues, such as Middle East peace, emergency management, and public health (p. 35). These games are developed to influence a population, to increase understanding on a particular issue, or as Bergeron (2006) states, "to simply make a point" (p. 27).

Sawyer's 2002 white paper on serious games that called for greater cross-pollination between game developers and institutions, such as government, academia, and NGOs, echoes Bergeron's definition of serious games and provides a roadmap for their application. According to Sawyer, the potential for these games to influence change has already been proven through a variety of initial development projects. The key to continued success is providing an environment fertile for enhancing collaboration between games developers, the keepers of this communications tool, and government, academic and NGOs striving to affect positive changes in the world (Sawyer, 2002, pp. 2–3).

Evidence of Sawyer's argument can be seen in the various titles of serious games produced. *Darfur is Dying*, developed as part of mtvU's Darfur Digital Activist Contest, is one such example. In this simple flash-based web-game, players experience a small picture of what life is like for more than two million refugees displaced by the crisis in the Sudan. In the game, the player assumes the role of one refugee and must deal with forces that threaten to kill the entire refugee camp (mtvU, 2008). Players are challenged

to collect water, grow crops, and escape murder by roaming Janjaweed militias. At its core, the game drives home the message that daily life is extremely dangerous and cruel for refugees in this crisis. As of 2010, over three million had played the game, and of them, over 50,000 were moved to take action, such as seeking new information, petitioning Congress, or making a donation, as a result (Chatfield, 2010, pp. 182–187; MTV Networks On Campus, Inc., 2008). *Darfur is Dying* serves as a precedent that video games can facilitate learning by allowing players to groke new information through a challenging game framework that ultimately drives players to alter their behavior and/or perception based on knowledge gained through the act of playing.

Video games do not have to address weighty social issues as complex as genocide in the Sudan to be considered serious games. In fact, several serious games have been developed to teach people how to protect the environment. Through games, such as *Fate of the World*, in which players must navigate complex sociopolitical issues, such as energy, populations, agriculture, and natural disasters to maintain global harmony, and *Face the Waste*, in which players literally sort trash and recyclables to earn points, developers are imparting environmental protection messages to players (Snider, 2011, p. 3B).

The use of video games to deliver a focused message or teach particular lessons is a viable communications strategy, as seen in the above referenced titles, which represent only a small segment of the growing serious games niche. What is particularly interesting is that Sawyer describes the momentum behind serious games as disruptive, a concept discussed in the next section, not only to the gaming industry but also to those wishing to collaborate with them. In Sawyer's (2002) mind, correctly managing this disruption to capitalize on its strengths and affect a repeatable positive outcome is key to the long-term success and acceptance of this medium (p. 24).

H. SERIOUS GAMES ARE DISRUPTIVE, IN A GOOD WAY

> Just as energy is the basis of life itself, and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress.
>
> - Theodore Levitt
> American Economist and Harvard Professor

As discussed above, serious games are an emerging sub-genre of video games that leverage the engaging characteristics of games to improve society. While Sawyer (2002) uses the term disruptive to describe this sub-genre and mentions that it must be correctly managed to realize its true potential, he does not provide any analysis to inform any such management (p. 24). However, lessons within the business community specific to disruptive technologies are useful to this discussion. These lessons provide the basis for applying serious games within the nuclear terrorism preparedness mission.

Christensen (1997) describes disruptive innovations as those technological advancements that alter the landscape within a particular market space and redefine both performance and value within that market (location 191 and 522). What all disruptive technologies have in common is that they are developmental in nature. In other words, they arrive in an immature state and typically underperform when competing with established technologies in mainstream markets. They generally appeal to smaller customer populations that value their unique features and are first brought to market in emerging or insignificant markets (Christenson, 1997, locations 186–215). According to Christensen (1997), "disruptive technologies that may underperform today, relative to what users in the market demand, may be fully performance competitive in that same market tomorrow" (location 202). Thus, disruptive technologies have the capability to redraw the market landscape and disrupt those market inhabitants that have not adequately prepared for the emergence of a particular innovation.

To illustrate the emergence of disruptive technology, Christensen uses the concept of trajectory maps to demonstrate the evolution of product performance over time within

a market space. This concept is particularly useful in identifying disruptive technologies in comparison to established market technologies. Figure 7 provides an example of a trajectory map.

For context, consider the following scenario. A certain market has existed for some period of time based on established technological standard, seen in Figure 7 as Technology A. Technology A dominates the market place based on customer needs and through incremental improvements it steadily improves in performance over time. At some point, a disruptive innovation appears in the market place, seen in Figure 7 as Technology B. Technology B currently underperforms when compared to Technology A, but it offers unique features that appeal to some consumers. Leveraging this attribute, disruptive technologies begin to service a new set of consumers underserved by the existing technologies, and thereby, facilitate the creation of new markets (Christensen, 1997, location 2573). Overtime performance improvements to Technology B narrow the performance gap between both technologies, until that future point when Technology B overtakes Technology A and becomes the dominant technology in the market (Christensen, 1997, locations 425–786).

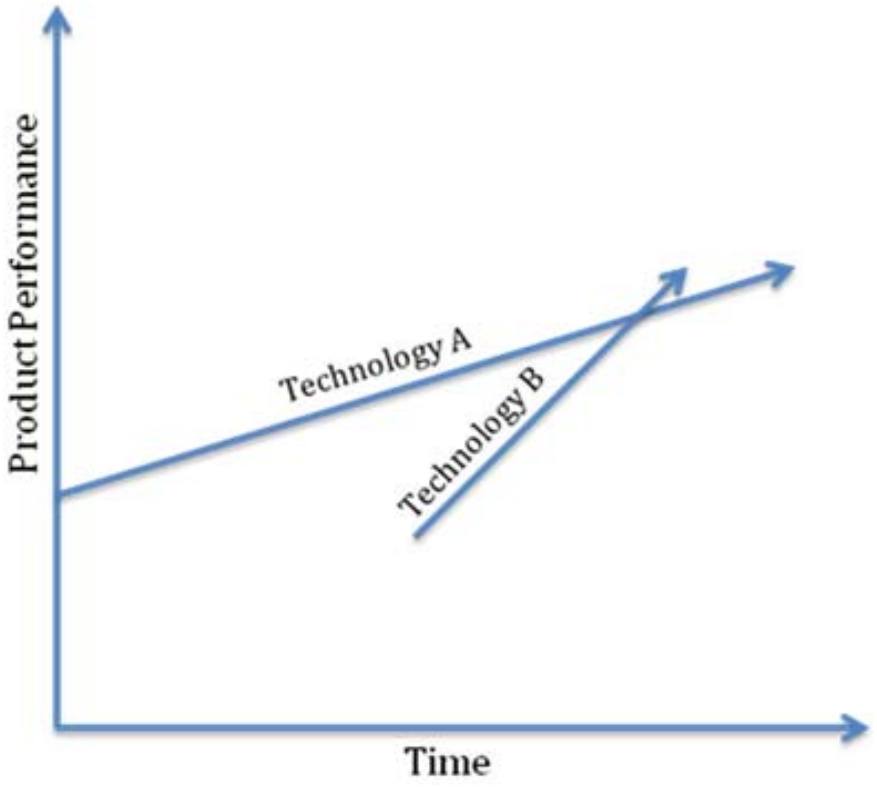

Figure 7. Hypothetical Trajectory Map

Using Christensen's description, it is possible to identify many parallels with serious games. As an emerging field, serious games currently exist in niche markets. While titles, such as *Darfur is Dying*, have reached millions of people (Chatfield, 2010, pp. 182–187), their sphere of influence is orders of magnitude smaller than that of commercial mainstream video games, of which some 273 million units were sold in 2009 (Entertainment Software Association, 2010, p. 11). Still, these serious games offer unique attributes that commercial games do not, such as the ability to participate, albeit via avatar, in current world affairs or events that appeal to various audiences.

By taking Christensen's concept of a trajectory map and comparing current preparedness efforts or technologies with serious games, an even more interesting correlation can be seen. See Figure 8. As discussed in Chapter II, current preparedness efforts to improve the public's readiness for future disasters have plateaued (Federal Emergency Management Agency, 2009, pp. 13–26). Given this seemingly low

performance improvement rate over the past several years, a nearly horizontal line demonstrating near-similar performance from year to year represents these efforts. Serious games, on the other hand, have advanced considerably since their advent only a decade ago. In fact, serious games are emerging so well that organizations, such as *Games for Change*, have emerged with the specific mission to further this developing field and aid in its growth (Games for Change, 2011). Based on these developments in serious games, they are represented in Figure 8 as increasing performance over time. Absent specific numbers, Figure 8 suggests that the trajectories of these two technologies will intersect, and that at some point in the future, serious games have the potential to surpass the performance of current preparedness methodologies and dominate the market.

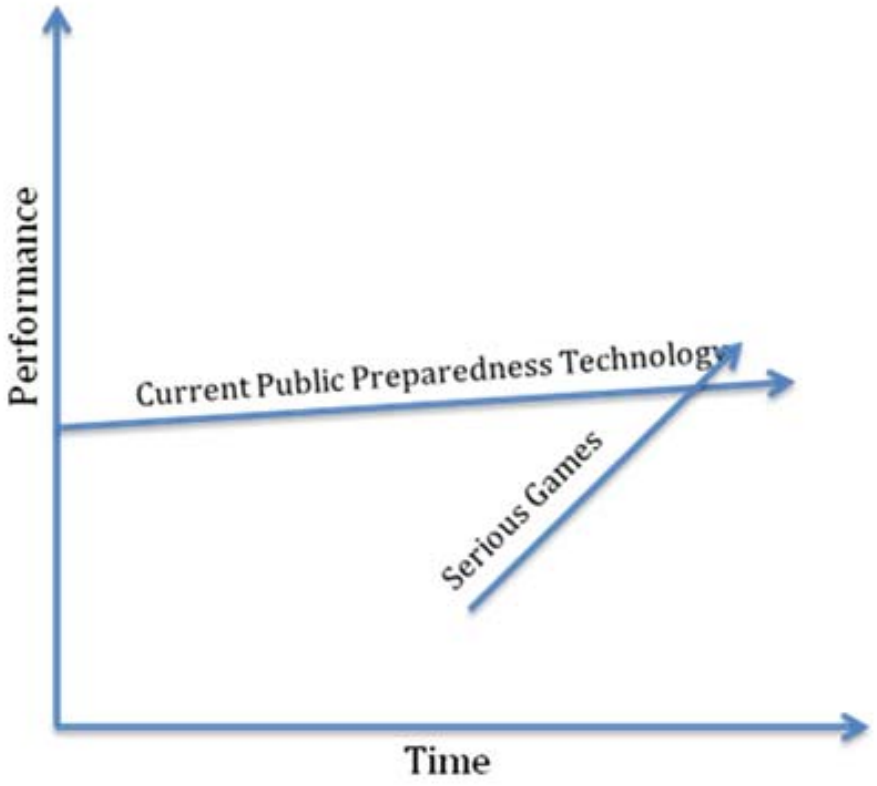

Figure 8. Trajectory Map Comparing Current Preparedness Techniques or Technology and Emergence of Serious Games

As seen above, the emergence of serious games represents a disruptive technology within the preparedness community, reaffirming Sawyer's position. While the effort in its current form exists within a niche community and cannot yet compete with existing preparedness programs, the development and maturation of the field over the past few years suggests continual improvement into the future. If current preparedness programs continue to struggle in influencing greater numbers of the public to take action to prepare for future disasters, the conditions will be ripe for serious games to overtake current preparedness programs at some point in the future. Given this forecast, serious games represent an opportunity for the preparedness community to improve the nation's preparedness by leveraging the disruptive nature of these games to reach segments of the population with whom current efforts are less than effective. However, as Sawyer aptly highlighted, management of this disruptive potential will be critical to a successful integration of serious games within the preparedness community.

I. CONCLUSION—IMPLEMENTATION METHODOLOGY MATTERS

Drawing again on the comparison between education and preparedness, Arnseth's discussion of game-based approaches to traditional learning can provide additional insight for nuclear preparedness. As discussed above, educational products that centered on a specific skill set with limited gaming features showed limited effectiveness, while edutainment products that provided a true game-like experience enjoyed greater success. Combined with the social psychological theories of Prensky, Dignan, Gee, and Csikszentmihalyi, a critical lesson is provided to inform the use of games to enhance nuclear preparedness. To achieve greater effectiveness, the preparedness community should avoid games that focus solely on preparedness skills in favor of games that teach preparedness skills through a rich and challenging game interface. In other words, a game that teaches players to save their avatar's[6] life during a nuclear blast to achieve a larger goal within a scenario would be more effective than a one-dimensional program focused specifically on teaching these lifesaving skills. Moreover, imbedding that scenario within a larger game narrative would provide multiple layers of depth to said game and provide

[6] An avatar is a virtual human within the game that represents and is controlled by the player (Darkin, Sullivan, & Shilling, 2002, p. 40).

the complexity necessary to provide progressively more difficult challenges as players' skills increase, which would enhance the flow effect of the experience and provide the hard fun necessary for players to groke new skills. While this learning to play approach has proven challenging in the traditional education setting, as teachers have struggled to have students apply learned skills, such as math in different contexts outside a game (Arnseth, 2006, pp. 6–7), this situation is less problematic for nuclear preparedness as real-life incident characteristics will very closely mirror those experienced in the gaming environment, which suggests greater application of nuclear preparedness skills in real-life nuclear incidents.

The recent advent of serious games provides an opportunity for the preparedness community. The fact that game developers are focusing their skills in developing engaging gaming experiences toward socially conscious ends shows a natural synergy between the communities. If harnessed correctly, the creative initiative of the emerging serious games movement has significant potential to impact positively the nation's preparedness for a nuclear terrorism incident.

Since serious games can be viewed as a disruptive technology, any successful use of video games in a preparedness context will require a sound implementation strategy. Not only will the preparedness community be challenged to provide a rich gaming experience, but it must also account for the novel nature of this approach, which presents not only opportunity in the form of enhanced message distribution and impact, but also significant challenges, such as access to resources and expectation management. The following chapter addresses this need by examining salient business and public health strategies relevant to this discussion, specifically focusing on entertainment as an educational medium and the power and challenge of disruptive innovations.

V. CONCLUSIONS, FINDINGS, AND RECOMMENDATIONS

While it is easy enough to discuss the application of video games to teach players preparedness principles, implementation of this approach poses a unique set of challenges. Properly addressing these challenges to ensure the highest probabilities of success requires not only expertise in the art of good game design, as discussed in Chapter IV, but a sound marketing strategy that accounts for the unique challenges and opportunities such an approach will bring. Recognizing that the concept of serious games within preparedness is an emerging disruptive technology, this chapter examines how business and public health communities have dealt with similar issues and draws relevant conclusions and recommendations to inform the use of video games to enhance the public's resilience to nuclear terrorism.

A. LESSONS LEARNED IN MANAGING EMERGING DISRUPTIVE TECHNOLOGY

> Some people say, 'Give the customers what they want.' But that's not my approach. Our job is to figure out what they're going to want before they do. I think Henry Ford once said, 'If I'd asked customers what they wanted, they would have told me, "A faster horse!"' People don't know what they want until you show it to them. That's why I never rely on market research. Our task is to read things that are not yet on the page.
>
> - Steve Jobs
> Founder and CEO of Apple

The business sector is regularly challenged to maintain market dominance in the face of disruptive changes. In his book, *The Innovator's Dilemma: When Technologies Cause Great Firms to Fail*, Christensen analyzes the effectiveness of certain sectors' efforts to manage and implement disruptive technologies. The uniqueness of Christensen's approach is how he uses these data to identify successful and unsuccessful strategies to manage disruptive technologies in an effort to inform future efforts to harness the potential in disruptive innovations. One powerful example discussed by Christensen (1997) is the introduction of hydraulic technology within the mechanical earthmoving equipment market (locations 1420–1683).

Since the market's inception in the 1830s, massive machines powered by either steam or diesel fuel and operated by a system of cables and pulleys to move large amounts of earth for large civil works projects dominated the mechanical earthmoving equipment market. In fact, early models were so large that they were transported using rail systems and primarily used for rail or canal construction; however, in the 1950s, hydraulics were introduced as a new way to operate the excavating arm and bucket on earthmoving equipment. While this developing technology could not initially compete with the capabilities of established cable driven excavators, which drove many builders of these machines to reject hydraulics since it could not meet their customers' requirements, the promise of this new technology convinced several firms to begin experimenting with designs for hydraulic excavators called backhoes (Christensen, 1997, locations 1420–1485).

These early backhoes were limited in capacity, power and reach, and therefore, did not appeal to conventional excavator customers. However, their small size allowed them to be mounted on the back of farm equipment and greatly appealed to residential and utility contractors, who previously were unable to use mechanical excavating equipment due to the large size of conventional cable driven machines and the associated high costs. The small hydraulically driven backhoes were better suited for their smaller projects and allowed these customers to complete work rapidly that previously would have been dug by hand (Christensen, 1997, locations 1485–1498).

Eventually, the capabilities of hydraulic excavators produced by these smaller businesses did advance to the point where it met the demands of customers who demanded more in terms of capacity, power, and reach. Once this occurred, the producers of conventional cable driven excavators were essentially driven from the market and replaced by those firms that developed and improved hydraulic machines, as customers found new hydraulic driven machines were more reliable and safer than their cable driven ancestors (Christensen, 1997, locations 1570–1587).

While discussing mechanical earthmovers in a thesis about serious games may appear at first glance to be a comparison of apples and oranges, the disruption hydraulics had within this market highlights several key considerations when managing disruptive

technology. According to Christensen, the evolution of the mechanical earthmoving market to include hydraulic technology typifies the effect disruptive technology can have on a market. As this example shows, established companies tend to avoid a disruptive technology since it cannot initially satisfy their mainstream customers' needs—a decision that often leads to loss of market dominance and profit. The companies that successfully manage these innovations are those that place the disruptive technology into autonomous or semiautonomous organizations, which freed them of the requirement to meet the demands of the current market while the technology improved in capability. These successful companies employed discovery-based planning to explore emerging markets with new customers who valued the attributes inherent in the new technology rather than attempting to compete the disruptive technology in traditional markets immediately. This thinking allows these companies to plan to take small risks and leverage small wins, while eventually developing the technology until it matures enough to compete within the traditional market (Christensen, 1997, locations 321, 1535–1565, 2070–2127).

1. Entertainment-Education—An Example from Public Health

A modern example employing Christensen's principles to manage disruptive innovations can be seen in the pubic health community's use of Entertainment-Education (E-E) approaches to increase the public's knowledge on certain issues of concern. E-E is a communications strategy that uses specifically designed media messages to both entertain and educate to bring about behavioral or social change. To date, E-E strategies have primarily targeted radio and television audiences through a variety of approaches from small messages incorporated into existing popular entertainment programs to entire entertainment series constructed around the E-E strategy (Singhal & Rogers, 2004, pp. 5–9).

The Centers for Disease Control and Prevention (CDC) has embraced E-E's disruptive potential and funded the establishment of the Hollywood, Health and Society (HH&S) initiative through a grant to the University of Southern California's Norman Lear Center. Through this grant, HH&S provides writers and producers with accurate and timely health content for the scripts that not only enhances the drama, but also educates

the audience on key health topics via these popular media venues. HH&S is regarded as a credible resource for Hollywood scriptwriters, and in 2006, responded to over 200 inquiries for information. In this role, HH&S is positioned to significantly influence the health dialogue on key health issue with viewing audiences throughout the United States (Movius, Cody, Huang, Berkowitz, & Morgan, 2007, p. 6).

This example shows the relevance of Christensen's principles to the implementation of innovations within the social sciences. HH&S' success in increasing the public's knowledge of specific health issues through popular media using CDC grant funds reinforces Christensen's theory that autonomous organizations are best positioned to manage, develop, and market disruptive technologies successfully. Given the conceptual similarities between E-E and using video games to enhance the public's preparedness for nuclear terrorism, HH&S' model can inform how the preparedness community can successfully integrate serious games.

B. CONCLUSIONS RELEVANT TO IMPLEMENTATION

When compared to existing preparedness approaches, serious games represent an emerging disruptive technology. The continued maturation of serious games into the future suggests that a some point in the near future serious games could overtake establish preparedness efforts in terms of effectiveness, similar to what occurred within the mechanical earthmover market place as emerging hydraulic excavators drove cable driven excavators out of the market. Additionally, as a disruptive technology, serious games have the potential to reach segments of the population currently underserved by traditional preparedness programs.

While this condition suggests serious games represent a potentially viable mechanism for the preparedness community to increase its impact, as seen in the mechanical excavator case study, specific strategies should be utilized to manage this disruption properly. Primarily, it must be realized that serious games will currently underperform when compared to current preparedness initiatives; however, through managed risk and small successes over time, the capability of serious games to impact the preparedness market will likely improve. Recognizing the current state of serious games

as an emerging disruptive technology, integration of serious games into the preparedness market place should be done through an organizational structure separate and distinct from existing preparedness programs. Doing so will ensure these games have the access to the resources needed to develop and allows exploration into emerging market places as seen in the above case study.

C. FINDINGS

Pre-incident nuclear terrorism preparedness education warrants significant attention given the magnitude of the lifesaving benefits associated with an informed public empowered with the knowledge necessary to save their own lives, as well as those of their family and neighbors, during a terrorist attack with an IND. Unfortunately, as discussed in Chapter II, the current inventory of preparedness programs to educate the public lacks the efficacy needed to prepare the public adequately for the low probability and high consequence effects of nuclear terrorism. Given this challenge, an alternative approach is needed that goes beyond passive information passing and allows for greater engagement with target populations, while still providing the audience with technically accurate guidance.

The analysis of gaming principles suggests that the implementation of a game-based approach to nuclear terrorism preparedness would stimulate audience engagement while simultaneously imparting to those players the skills necessary to survive. With the ubiquity of games within society today, researchers have found that citizens under the age of 40 not only prefer these highly interactive media, but they learn and process information more efficiently when it is delivered in this format. Not only is this medium acutely suited to reach this segment of the population, but this audience also specifically requires knowledge on surviving a nuclear explosion as the drawdown in Cold War era civil defense messaging would have limited their knowledge of these survival techniques (Hampton et al., 2009, pp. 55–62). These data suggest that the use of video games within the nuclear terrorism preparedness problem space could increase the public's preparedness level by reaching segments of this population with which today's preparedness programs are less than effective.

Along these lines, the emergence of serious games represents a viable opportunity to leverage the unique power of video games toward this significant national issue. The developers of these games apply the core qualities of traditional video games outside a purely entertainment context. What has resulted from this innovation is a spectrum of games that addresses important social and political issues, such as Middle East peace, global warming, emergency management, and public health. As the serious games community is still emerging, the opportunity is ripe for private/public collaboration within the nuclear terrorism preparedness mission space. If managed correctly, this approach has the potential to enhance the public's understanding of how to maximize the ability to survive a nuclear detonation, while simultaneously educating segments of the population with whom current preparedness efforts are less than effective.

D. RECOMMENDATIONS

The following policy recommendations will guide DHS and FEMA in the implementation of a video game-based approach to nuclear terrorism preparedness. These recommendations are based on the key findings and conclusions above, as well as the analysis and literature presented throughout this thesis.

1. Launch a Proof of Concept Pilot Project Using a Serious Games Platform

> Innovation distinguishes a leader and a follower
>
> - Steve Jobs
> Founder and CEO of Apple

It is recommended that DHS/FEMA execute a pilot project to evaluate the efficacy of video games to reach members of the gaming generation who are currently underserved by today's preparedness approaches. This pilot should use a serious games platform to engage this audience, while still providing the valuable information needed to avoid fallout exposures post-detonation effectively.

Video games provide a dynamic and engaging learning environment that use problem solving, goals and objectives, conflict, collaboration, competition, and interaction within a rule-bound system. As such, these games provide audiences with a

contextually situated form of practice that balances skill development and learning with challenge. The end result of this dynamic is a situation in which players are intrinsically motivated to engage and continue the experience as their skill levels increase consistent with elevated levels of challenge presented.

An emerging gaming innovation, known as serious games, leverages these concepts to address current issues in today's world, such as genocide, cultural conflict, or even global warming. While a seemingly good fit with today's messages of personal preparedness, compatibility of ideals in not enough to ensure success, since as an innovation, otherwise known as a disruptive technology, it requires unique management techniques because in many ways, the concept of serious games is still maturing. While much promise does exist in utilizing this approach to enhance preparedness, it will in the near term underperform when compared to larger national preparedness programs. This is not to say that it will not be an effective preparedness tool; however, this approach must be properly managed to ensure it reaches its full potential.

As such, this proposed pilot should be managed outside the confines of current preparedness programs, such as within FEMA's IND Response and Recovery Program, which is managed within FEMA's Response Directorate (U.S. Department of Homeland Security, 2008, pp. 47–49) to ensure it receives the necessary attention and resources, while at the same time, freeing it from the near-term requirement to compete with these programs. Also, this pilot should employ discovery-based planning to explore new audiences for these preparedness games, possibly within populations currently underserved by the current preparedness message vehicles. Finally, this pilot should be designed to succeed by identifying challenges in need of further analysis, taking small risks and leveraging both successes and failures to inform a cycle of regular improvement.

2. Establish a Stakeholder Group Comprised of Traditional and Non-traditional Partners

It is recommended that DHS/FEMA develop and execute the proposed pilot project through a stakeholder group comprised of DHS/FEMA, DHS Office of Science &

Technology, the U.S. National Laboratories, organizations, such as Games for Change, and video game developers. Games are complex and dynamic media that contain very specific elements to ensure a challenging environment also enjoyable to play. Game developers are experts at wielding their craft to develop these games. While the government is proficient in developing guidance, and subsequent messages based on science, it does not possess the requisite core competencies to develop these games. As such, active collaboration amongst this stakeholder group is essential.

Developing the pilot project in this fashion aligns with Ben Sawyer's recommendation for enhanced private/public collaboration with game developers. Additionally, this approach will help ensure that the pilot project's gaming features are not merely skin deep and that it contains the core elemental structures necessary to invoke true learning through a complex balance between challenge and learning that if combined correctly will produce the intrinsic motivation and flow necessary to capture the audience's attention.

3. Utilize Results from This Pilot to Inform a Broader Application of Games Within the Preparedness Mission Space

Public preparedness for disasters is clearly not an issue unique to nuclear terrorism. While this thesis focused primarily on gaps in the public's preparedness against nuclear terrorism, the theme of using serious games in an educational context to enhance public preparedness has several applications outside the nuclear terrorism scenario. Additionally, as this thesis was based almost entirely on theory, the proposed pilot project represents an opportunity to collect a substantive amount of quantitative data on the applicability of this approach and should, therefore, be rigorously analyzed, possibly by a third party or academic partner. Such analysis should include statistics on efficacy of knowledge transfer, the criticality of flow to the act of learning by playing, the motivations that drove participation and play, public acceptance of these games, and the efficacy of behavioral modification based on game play and learning. The findings from this analysis should be utilized to inform the use of serious games within a broader preparedness context to increase the public's preparedness for other high-consequence incidents.

E. OPPORTUNITIES FOR FURTHER RESEARCH

1. What Are the Ethical Implications of Preparedness Messaging Through Games?

While outside the scope of this thesis, several questions are left unanswered regarding the ethical considerations of using communication vehicles, such as video games, to deliver messages to the public. Given the current debates on video game violence and the long-term effects of video game use (Grossman & Degaetano, 1999), further study on these topics is warranted to inform better the application of serious games to enhance preparedness.

Additionally, given the gravity of the topic at hand and the fact that understanding of these protective action concepts can mean the difference between life and death on a large scale following a nuclear attack, focus must be given to the ethical nature of a public messaging approach that primarily targets only one segment of the population—in this case those that engage in playing video games. While significant portions of those within the generational knowledge gap can be categorized as members of the games generation, other audiences outside the gaming community require a firm understanding of these survival principles. This thesis focuses primarily on gaming populations; however, additional research is needed to inform the nesting of this approach within a larger public messaging strategy to ensure these nuclear terrorism protective action principles are disseminated to the widest audience possible.

2. How Can a Game-based Approach Be Used to Enhance the Public's Preparedness for All-Hazards?

Should a serious games prototype be developed specific to nuclear terrorism, as suggested above, quantitative data, such as efficacy of knowledge transfer, the criticality of flow to the act of learning by playing, the motivations that drove participation and play, public acceptance of these games, and the efficacy of behavioral modification based on game play and learning, should be collected during this project. These data should then be analyzed and used to inform a broader game-like approach to enhance the public's resilience to other disaster scenarios, such as earthquakes, hurricanes, and other terrorist attacks.

As discussed earlier, significant progress in the public's level of preparedness for significant disasters has stalled. While video games are but one possible solution to this issue, a quantitative analysis of the application of video games to preparedness could inform other alternative approaches to this continuing problem. This analysis could also be used to inform FEMA's overall approach to preparedness outside of a video environment, and as such, look to enhance the efficacy of today's preparedness messaging techniques by applying the similar techniques as those that make today's video games so appealing, such as feedback and flow. This game-like approach to messaging could look to social media and other emerging forums to maximize effectiveness while building enhanced interfaces to increase the public's resilience to many types of disasters.

3. How Does Preparedness for the Unique Effects of Nuclear Terrorism Fit Within an All-Hazards Approach to Public Preparedness?

While the detonation of a nuclear weapon on U.S. soil remains a significant risk, other catastrophic scenarios can impact the nation. Thus, the importance of an all-hazards approach to preparedness should not be overlooked. Recent Presidential guidance in the form of Presidential Policy Directive 8 emphasizes the all-hazards approach to preparedness by mandating the development of a National Preparedness System "built around basic plans that support the all-hazards approach to preparedness and functional or incident annexes to describe any unique requirements for particular threats or scenarios" (The White House, 2011, p. 3).

Given the need for an all-hazards approach, more research is needed to inform the provision of all-hazards preparedness guidance, while simultaneously ensuring the public has the knowledge needed to react to incident specific characteristics. Such an approach should consider the public's limited attention span, the similarities and differences in actions required of the public in various scenarios, and the delivery protocols for preparedness or public action messages.

APPENDIX. BUSINESS CASE FOR THE ESTABLISHMENT OF READY GAMES

A. OVERVIEW

Project Title: Ready Games

Project Purpose: To develop a video game platform to increase the public's knowledge of required protective actions in the event of a nuclear terrorism attack.

B. BACKGROUND

Current scientific analyses have identified elementary steps the public should take to increase the likelihood of survival in the event of a nuclear terrorism incident. Those actions include taking immediate shelter in a basement, subterranean parking structure, or the center of the middle floors of a multi-story building. Once sheltered, they should remove any fallout particles that may be on their person by discarding any contaminated clothing and washing or showering if at all possible.

While a seemingly simple message, dissemination this message traditional preparedness messaging means is problematic as the legacy of Cold War civil defense messages have left the public skeptical of these types of public action messages. Additionally, recent studies have indicated that these direct approaches left audiences with a sense of skepticism and thoughts that such information is merely government propaganda.

While Cold War messages were somewhat problematic, they did inform a certain portion of the population as to basic effect of a nuclear detonation and the value of sheltering to avoid fallout. With the draw down in the civil defense program, there no exists a generational knowledge gap currently exists with regard to the public's understanding of these required actions. Unfortunately today's preparedness initiatives do not have the efficacy required to impact significant improvements in this area.

However, video games, more specifically a sub-genre of games known as serious games, are unique postured to address this knowledge gap. Serious games are video games specifically crafted to inform their audience of a particular issue of concern. They take the leverage the attributes of traditional entertainment focused games and overlay them with socially conscious messages to improve a particular situation.

Video games are currently being explored as a way to improve traditional educational systems as they provide a motivating, enriching and engaging educational medium. No only do they allow for a more engaging learning environment, but also they are unique in that they address the emerging educational needs of today's Games Generation, which has been inundated with technology since birth. Research has shown that this technology savvy generation not only prefers learning through interactive engagement, but their brains are preferentially wired to accept and process information in this form. In short, this suggests that to close the knowledge gap within this generation specific to nuclear terrorism interactive learning methods such as video games represent an effective way to communicate with this population in a form that will be readily accepted.

C. PROJECT DESCRIPTION

Scope: This project will be conducted in two distinct phases. The first phase will be focused on the development and assessment of a proof of concept pilot to test the efficacy of a serious games platform to inform a targeted audience on the fallout avoidance principles necessary to survive a nuclear detonation. To inform the execution of phase 2, this initial phase will be rigorously evaluated through qualitative and quantitative means to measure areas of interest such as the efficacy of knowledge transfer, the criticality of engagement to the act of learning by playing, motivations that drove participation and play, public acceptance of the themes and messages within the game, and the efficacy of behavioral modification based on game play and learning.

The second phase of the project will utilize the data and analysis from phase 1 towards two ends. First, the data will be used to improve this video game-based approach specific to nuclear terrorism preparedness. Second, this data will be used to inform a

broader application of this public messaging technique to improve the Nation's resilience to other high-consequence events and will consider the public's limited attention span and the similarities/differences in actions required of the public in various scenarios.

Project Results:

Phase 1:

- Prototype nuclear terrorism preparedness video game
- Analytical report analyzing the efficacy of a video game-based approach to preparedness education

Phase 2:

- Finalized nuclear terrorism preparedness video game
- Analytical report on the application of video-game based approaches to all-hazards preparedness education

D. ALIGNMENT WITH DHS/FEMA GOALS AND PRIORITIES

Goals and Priorities Supported by Program

FEMA Strategic Plan 2011-2014

- FEMA Priority #1: Strengthen the Nation's Resilience to Disasters. "FEMA must enable individuals, families, and communities to withstand disruption, absorb or tolerate disturbance, act effectively in crisis, adapt to changing conditions, and grow stronger over time" (Federal Emergency Management Agency, 2011b, p. 5).

DHS Strategy for Improving the Nation's Response and Recovery from and IND Attack

- Objective 1.2: Provide Emergency Public Information. "A robust public information campaign is a critical element to the successful management of an IND incident, both prior to and following a burst. The necessity of a prevent campaign is largely due to three factors: (1) An IND is a singular threat; however the incident itself involves multiple hazards including: fire, radiation, blast and mechanical injuries. (2) There are many misperceptions regarding the IND threat, including confusion with traditional thermal nuclear weaponry and the no-notice probability of an IND. (3) The limited ability to quickly establish communications with the public post-incident when protective actions are most critical" (Department of Homeland Security, 2010, p. 4).
- Cross-Cutting Objective CC.1: Public Information Awareness. "A well defined public information awareness campaign is required prior to an

> IND incident. This campaign includes all public awareness tools and information products that would be required by the public both prior to and directly following an IND incident. These tools and products would be used to raise awareness of IND preparedness and provide in-depth information to the public on how to prepare for and respond to an IND detonation. This campaign and products also need to provide detailed protective action recommendations to the public. Pre-event information materials should provide consistent, detailed, scientifically-based information to the public on how to prepare and respond, as well as instructions for where to locate additional information" (Department of Homeland Security, 2010, p. 16).

E. PARTNERS: INTERNAL AND EXTERNAL

Leadership: FEMA Response Directorate—Planning Division—CBRNE Branch

Steering Group: To ensure the highest value and impact from the video game products developed during this project an interdisciplinary steering group is required to ensure all aspects of this project are thoroughly analyzed. To this end, the steering group will be comprised of government and non-governmental entities such as:

- FEMA Response Directorate (Chair)
- DHS Office of Science and Technology
- The National Laboratories
- The Video Game Development Community

Steering Group Level of Involvement: The steering group will be charged with directly contributing to the scope, content, direction, and target audience for all products developed under this project. Additionally, the steering group will also approve the scope and final content of all analytical reports generated throughout all phases of this effort.

Internal FEMA Participants:

- Office of Chief Counsel
- Office of Public Affairs
- Office of Program and Policy Analysis
- Office of Response and Recovery
- National Preparedness Directorate
- Recovery Directorate
- Office of the Chief Procurement Office

F. ANALYSIS OF ALTERNATIVES

Alternatives Considered: One alternative to this project is to utilize the messaging protocols with the Ready Campaign to increase the public's knowledge of the immediate actions necessary to save their lives following a nuclear terrorism incident.

However, this course of action is not adequate for the following reasons:

- Several recent report have highlighted the challenges faced by the Ready Campaign, such as lack of engagement with target audiences, the need for alternative delivery mechanisms, and a greater link between messages delivered and behavior modification. This project seeks to address these challenges.
- Today's preparedness protocols do not take into account the learning dynamics of today's generation. Recent literature on education highlights that today's generations learn in a significantly different way than past generations. This is primarily attributed to the fact that today's generation came of age in a technology rich environment that changed the way they accept and process information. Consequently, today's generation actively seeks highly interactive learning environments, such as video games and the internet, that foster learning through experimentation and testing vice more linear learning formats, such as television or lectures. This project capitalizes on this change in learning style and uses it as a foundation to a new approach to preparedness education.

G. PROGRAM IMPACTS

Operational: This project will be developed, operated and maintained with the Response Directorate as part of the existing IND Response and Recovery Program, which was established in 2009, per the direction of the Secretary of Homeland Security, to improve the Nation's resilience to nuclear terrorism and address critical gaps in national capabilities required for response and recovery to such a catastrophic incident.

Staffing: This project will unitize existing full-time employees assigned to the IND Response and Recovery Program.

Program Goals/Milestones:

- Phase 1
  - Stakeholder Identification: 1 month
  - Scoping: 2 months
  - Prototype Development: 6 months

- Prototype Testing and Evaluation: 6 months
- Draft Analytical report analyzing the efficacy of a video game-based approach to preparedness education: 1 month
- Draft Analytical report analyzing the efficacy of a video game-based approach to preparedness education: 2 months

- Phase 2
  - Final Modifications to Prototype: 3 months
  - Draft Analytical report on the application of video-game based approaches to all-hazards preparedness education: 1 month
  - Draft Analytical report on the application of video-game based approaches to all-hazards preparedness education: 2 months

H. COST ANALYSIS

Table 1. Estimated Cost Profile for Ready Games

	Fiscal Year 1	Fiscal Year 2	Total
Phase 1	$1,125,000.00	$30,000.00	$1,155,000.00
Travel	$20,000.00	$0.00	
Equipment	$5,000.00	$5,000.00	
Contracts	$1,100,000.00	$25,000.00	
Phase 2	$0.00	$515,000.00	$515,000.00
Travel	$0.00	$10,000.00	
Equipment	$0.00	$5,000.00	
Contracts	$0.00	$500,000.00	
		Total Project Costs	**$1,670,000.00**

I. BENEFIT ANALYSIS

1. Tangible Benefits

Timeline: 18 months

Description: This project will improve upon the public's preparedness level for a nuclear terrorism incident and address a critical gap in current National capability.

Certainty of Benefits: Current literature and theory on the application of video game-based approaches to learning suggests the probability of success within the scope of this project is high. Through the support of key stakeholders, the identification of a highly

capable game development company with expertise in both entertainment focused games and serious games, and a well-crafted roll-out strategy FEMA can maintain a high probability of success.

2. Intangible Benefits

Timeline: 18+ months

Description: At the completion of phase 2, FEMA will have an analytical report that can inform a transformation in current approaches toward preparedness education toward a more engaging dynamic—the applications of which are nearly infinite.

Certainty of Benefits: Current literature and theory on educational approaches supports the correlation between engagement and application of knowledge received. Given this theoretical link, this project provides a rich opportunity to make practical use of that learning paradigm to inform a transformation in FEMA's approach toward preparedness. While directly linked to the analysis of the tangible benefits expected from the project, the certainty of this intangible benefit is considered high.

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