Large Scale Adoption of Training Simulations: Are We There Yet?

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ABSTRACT

Computer-supported training simulations have been recognized for the potential and the benefits they have in supplementing the training needs of the military, yet we still do not see evidence of large-scale deployment and adoption of these systems by users in this domain. The current challenging budgetary situation suggests that the Return on Investment (ROI) will be more scrutinized than ever before, forcing communities to abandon underutilized and underperformed Modeling and Simulation (M&S) solutions. Such developments are also likely to affect global decisions related to future investments in these types of technologies. This paper presents the design and results of a study that included collection of comprehensive data on the adoption and use of training simulations in the military domain. The analysis of this data set suggests that the reasons for low use of simulations had little to do with the overall quality of hardware and software (although they were mentioned as factors), and that a myriad of other factors were found to influence the outcome to a greater extent. The understandings collected in this and other studies all attest that military training is a complex, multilayered domain that is only partially defined by the type and technical characteristics of systems being used to achieve that goal. Our work and experience in this domain give us a firm basis to hypothesize that a well selected set of strategic approaches could bring much greater results in this domain, even with a modest investment made to support that change. The findings and recommendations are highly applicable to all DoD services and other communities that plan to use these types or solutions in their training and learning practices. The study also offers a contribution towards a better understanding of general diffusion and adoption of other technical innovations in the military domain.

ABOUT THE AUTHORS

Dr. Amela Sadagic is a computer scientist and a Research Associate Professor at the Naval Postgraduate School (NPS), Modeling Virtual Environments and Simulation (MOVES) Institute, Monterey, CA, with a professional research career spanning 28 years. She has been a PI or co-PI on numerous research efforts at NPS. This research has been supported by close to $10M in funding and involved over 4500 USMC and USN personnel as subjects in user studies. In the past she was Director of Programs at Advanced Network and Services Inc. where she designed and led programs focused on the use of emerging technologies in learning. She was also responsible for coordination of a research consortium "National Tele-immersion Initiative (NTII)" that involved 30 researchers from leading US universities, who worked on the first 3D tele-immersive system over Internet2. Her expertise and research interests include: simulations; Virtual Environments; human factors and presence in VE; human subjects studies; evaluation of learning and training effectiveness in computer supported environments; multiuser collaborative environments; game-based systems; coupling of emerging technologies in support of systems for operation, training and learning; and acquisition and large scale adoption of technical innovations. Dr. Sadagic holds a PhD in Computer Science from University College London, UK.

Maj Floy A. Yates Jr. enlisted in the Marine Corps in August 1995, and attended basic training at MCRD, San Diego, CA. He served aboard Camp Pendleton, CA with MAG-39/MALS-39/Avionics as a Calibration and Repair Technician, and meritoriously achieved the rank of Corporal. In June 1998, selected under the Meritorious Commissioning Program, Maj Yates attended Officer Candidate School located in Quantico, VA. He was commissioned as a Second Lieutenant in August 1998, completed The Basic School in February 1999, and graduated from the Communications Information Systems Officer's Course in April 2000. In May 2000, Maj Yates reported to 1st Force Service Support Group 1 located at Camp Pendleton, CA and held the following billets: Deployed Network Officer-in-Charge, Platoon Commander, Data Communications Platoon, and Brigade Service

Support Group 1 S-6A. He successfully planned, installed, operated, and maintained secure and non-secure data and voice communications for numerous exercises aboard Camp Pendleton, CA, Twentynine Palms, CA, and Egypt. In June 2002, Maj Yates reported to the Defense Finance and Accounting Service, Technology Services Organization located in Kansas City, MO, and served as the Deputy Branch Head Software Development Branch, and the Deputy Division Head for the Strategic Planning and Technical Oversight Division, where he assisted with the supervision of the TSO's Software Quality Assurance Team and Software Engineering Process Group. In June 2005, Maj Yates reported to Marine Corps Air Station Iwakuni, Japan and served as the Air Station's S-6 Officer. In June 2008, Maj Yates reported to 1st Marine Division/11th Marine Regiment and served as the Regimental Communications Officer. In May 2009, Maj Yates was selected as the Commanding Officer for 1stMarDiv, HQBN, Communications Company. In April 2010, he was selected as the HQBN Detachment Commander, and deployed to Afghanistan with 1stMarDiv Forward. In June 2011, Maj Yates reported to the Naval Post Graduate School in Monterey, CA. He graduated with a master degree in Modeling, Virtual Environments and Simulation in September 2013. Maj Yates currently serves as the MAGTFTC Modeling and Simulation Officer located in Twentynine Palms, CA.

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INTRODUCTION

Computer-supported training simulations have been recognized for the potential and the benefits they have in supplementing the training needs of the military. The clear need to support current training simulations and produce new ones was reflected in the amount of investment made in this domain. The Report on Department of Defense Modeling and Simulation Efforts suggested that Department of Defense (DoD) spending in the modeling and simulation (M&S) domain was an estimated $1.5B in Fiscal Year (FY) 2006, $1.8B in FY 2007, $1.6B in FY 2008, $2.2B in FY 2009 and $2.2B in FY 2010 (Citizen 2008, Citizen 2009, Citizen, 2010). The figures do not include the entire spectrum of DoD M&S activities, and the final investments in all years were higher. Parallel to this, the data collected in the study described in this paper suggest that the rate of adoption of those systems (especially their large-scale deployment) as well as the use and and adoption of the same systems by *intended* users, have still not come about. The current challenging budgetary situation suggests that Return on Investment (ROI) will be more scrutinized than ever before, forcing communities to abandon underutilized and underperformed M&S solutions. Such developments are also likely to affect global decisions related to future investments for these types of technologies. If this process is to be managed in the best possible way and provide objective information that will be used when making decisions, there is a need to understand the underpinnings of this process, including the barriers that get in the way of its full success.

The research interest pursued by the Naval Postgraduate School faculty and students include an investigation of adoption and use of different type of technologies in the military domain. The specific interests of the Modeling, Virtual Environments and Simulations (MOVES) Institute are training simulations. This includes but it is not limited to activities that would help us understand the main aspects of technology adoption and diffusion; current practices related to distribution, deployment and use of computer-supported simulations in the military training domain; type of supportive environment (physical infrastructure, domain conditions and attitudes, training approaches) understood as needed for the most effective deployment and adoption; trends related to adoption and how they could be addressed, the parameters that favorably or adversely affect adoption of computer-supported training simulations in a military training environment; and profiles of young service men and women - the attitudes and most important characteristics of the simulation adopters (Sadagic 2007; Sadagic and Darken 2006). This paper presents the design and results of a study framed to generate early answers to multiple topics of interest in this domain, and be a basis for better understanding of the overall adoption process of training simulations in the military domain.

LARGE-SCALE ADOPTION

The main reason why a large-scale adoption of any solution (idea, process, physical artifact/object) matters, is the collective change in the way adopters act and behave once the adoption occurs on a large scale, and the potential that such a change may bring to them and their community. The emergence and large-scale adoption of flight simulators, for example, allowed the aviation community to change their training programs dramatically. Today all pilots have to train and pass tests on flight simulators first before they get to physically fly a plane. A *paradigm shift* - truly and successfully enabling novel training practices, and achieving significant results, happens only when: (1) Large majority of its intended users (ideally everyone) adopts and uses those solutions, (2) they do it methodically and consistently, and (3) they have those solutions available all the time (either have full control over those resources or easy access to them).

Having an effective training solution adopted by a majority of its intended users puts that group in an optimal position of achieving the best results that the training solution can deliver. (It is important to note here a starting premise: the training solution in question needs to be proven to have such potential; large-scale adoption by itself is not the only necessary ingredient to achieve those results.)

THEORIES OF DIFFUSION OF INNOVATION

Several theories of diffusion of innovation - a wide spread of ideas, practices or artifacts - have been designed and promoted in the past. Colleagues who work in the domain of social sciences have adopted different models. Everett M. Rogers and his team (Rogers, 1999; first edition published in 1963) described diffusion of innovation as “the process in which an *innovation* is communicated through certain *channels* over *time* among the members of a *social system*.” The notion of the process also comes across in Richerson et al. (2001) where they suggest that “The concept of diffusion of innovations usually refers to the spread of ideas from one society to another or from a focus or institution within a society to other parts of that society.”

General diffusion models that were inclusive of innovations in any field, needed to be fine-tuned to bring the specifics of technical innovations, and as such provide a better fit for the systems at hand. Technology Acceptance Model (TAM) introduced by Davis, 1986, was developed and tested to augment general understandings with the user acceptance processes and become a basis for testing of user acceptance prior to system development (special emphasis was on information systems and the perspectives of managers and users). The model starts with design features, goes over cognitive and affective responses and ends with behavioral responses i.e., adoption and system use, or non-use. The main parameters influencing the process and user motivation were related to 'perceived usefulness' ("the degree to which an individual believes that using a particular system would enhance his or her job performance”) and 'perceived ease of use' ("the degree to which an individual believes that using a particular system would be free of physical and mental effort"). Both influenced a formation of user attitudes towards using the system. The same model was used in a number of subsequent research studies: a study that was focused on testing TAM model (Davis, 1993), a theoretical extension of TAM model to TAM2 that included more specific details of 'perceived usefulness' (Venkatesh and Davis, 2000), and even served as a basis to develop a new theory - Unified Theory of Acceptance and Use of Technology or UTAUT (Venkatesh et al., 2003). It is interesting that all models of technology adoption put an emphasis on users' attitudes towards the innovations - they identify it is as a key ingredient of technology adoption (Rogers, 1999; Davis et al., 1989), and some models incorporate it in performance expectancy (Venkatesh et al., 2003).

Diffusion of Innovation model (Rogers, 1999) introduced a number of novel concepts. It defined five adopter categories: innovators, early adopters, early majority, late majority and laggards, and identified major characteristics of each group. It identified the concept of 'change agent' (an individual who 'seeks to secure the adoption of new ideas'), 'aids' ('less than fully professional change agent who intensively contacts clients to influence their innovation-decisions') and opinion leaders. This model suggests that four major elements influence diffusion: (a) innovation itself, (b) communication channels used to spread the information about innovation, (c) time, and the (d) members of a social system. The variables recognized as influencing the rate of adoption fall into five major groups: (1) perceived attributes of innovation (relative advantage, compatibility, complexity, trialability, observability); (2) type of innovation-decision (optional, collective, authority); (3) communication channels; (4) nature of the social system (norms, degree of network interconnectedness), and (5) extent of change agents' promotion efforts. These all collectively influence the rate of adoption of innovation. The study and the data collection reported in this paper included questions that were aimed at all aspects and variables of this model.

TRAINING-CENTERED DIFFUSION OF INNOVATION MODEL (TC-DIM)

The model we designed and used for this study incorporated all elements of Rogers Diffusion of Innovation model (Rogers, 1999), and extended it with elements significant for training with computer supported simulations - we named it Training-Centered Diffusion of Innovation Model (TC-DIM). The complexity and nuances of computer-supported systems and complexity of the training domain motivated us to identify and classify additional variables that influence the rate of adoption (the global elements of TC-DIM are depicted in Figure 1):

1. **Technical Characteristics** (additional/new variable): robustness and reliability of the software and hardware, processing capability, technical infrastructure (includes networks), fidelity of input and output

devices, immersiveness (technical characteristic of the system - a degree to which the information 'envelops' the user (Slater and Wilbur, 1997)),

2. **Human Factors (**addition to 'perceived attributes of innovation' variable): usability of human-computer interfaces, level of realism (as perceived by the user), sensory fidelity and how it maps to training objectives, user acceptance of technology, and user attitudes towards technology,

3. **User Community** (addition to **'**nature of the social system' variable): leadership endorsement and involvement in the process (also includes involvement in training sessions), organizational structure and supporting infrastructure, training requirements as identified and endorsed by the community-appointed group in charge of this activity, and acquisition office processes,

4. **Training Domain** (additional/new variable): instructor certification, existence of full training package (includes tested advice on how to use training system most effectively), dissemination of simulations in the units, train-the-trainer program, access to simulation, scheduling and throughput issues, user attitudes towards training event, thorough planning of training event, support of After Action Review (AAR), and support of latest Tactics, Techniques, and Procedures (TTP).

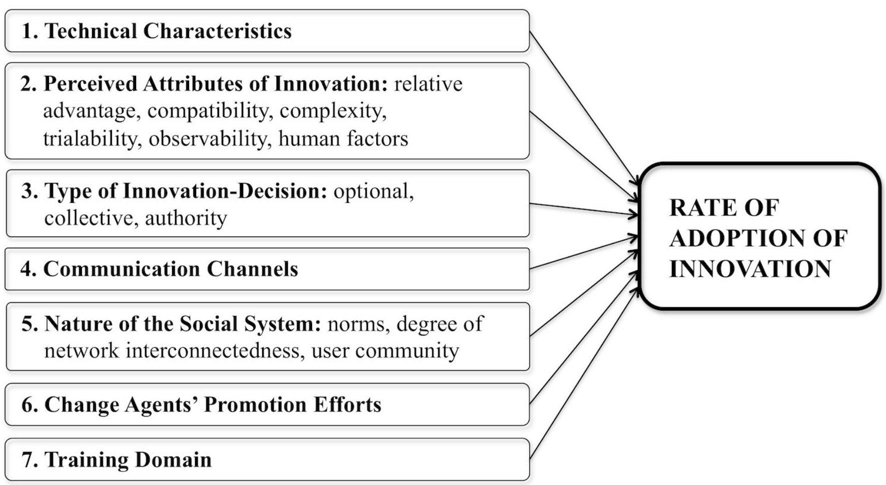

Figure 1. Training-Centered Diffusion of Innovation Model (TC-DIM)

These are the starting global elements of TC-DIM model, and our goal is to continue refining the model, and to engage in validation of the model through longitudinal studies.

USER STUDY

Objectives and Methodology

The main objective was to acquire more detailed understanding about the process and different parameters that influenced adoption of computer-supported training simulations in the military domain. To our knowledge no such data collection was organized on a large scale; we have conducted data collection in the past as a part of the VIRtual Training and Environments (VIRTE) program, however the selection of questions was not as comprehensive and it included questions related to training on physical training ranges. This time we wanted to learn more about the current practices when it came to the distribution and use of training simulations, elements of a supportive environment (physical infrastructure, instructors), domain conditions, user profile (the ownership and use of digital devices, attitudes towards technology, knowledge about simulation capabilities on the base), promotion efforts and communication.

Scope and Focus: The main focus of our data collection was on computer-supported training simulations that were available to the units of the US Marine Corps (USMC). These types of training solutions included the simulations that were mandatory, but also included a wide range of solutions and training opportunities that were optional to the unit - those were made available either through the simulations centers or they were a part of the Deployable Virtual Training Environment (DVTE) suites that (at the time) were in the possession of the battalions, which could use them at any time in training events organized for and by smaller units.

Diffusion of innovation model: The decision was made to use the diffusion of innovation model proposed by E. M. Rogers (Rogers, 1999), augmented by elements identified in our past research and our knowledge of the military domain as a user group (its mission, members, organization, resources available, rules and regulations, customs, patterns of behavior and similar) and the training domain. The details of this model are presented in Section Training-Centered Diffusion of Innovation Model (TC-DIM).

Data collection: The major thrust of data collection included online surveys (questionnaires) and investigative focus group discussions (group interviews) that provided opportunities to garner an in-depth understanding of a range of issues relevant to this domain. Participants were asked to fill in the questionnaires first, after which they were offered an opportunity to take part in investigative focus group discussions. Our attempt to collect an objective data set on the actual usage of training simulations could not be supported: the simulation center had a manual and only partial log of all training events, with no exact data on how many Marines took part in the event, and unit records on the same topic were nonexistent.

Selection of the military base: One of the goals of our study was to survey a diverse subset of the military community, i.e., to include Military Occupational Specialties (MOSs) that were more likely to use these types of training solutions in their training regimen, as well as the segments that were less likely to opt for these solutions. A desire was also to do the study at a base with a number of active units that had a need to diversify their training solutions, and where there was a simulation center with Subject Matter Experts in the domain of training simulations and the necessary hardware and software infrastructure to provide a significant resource to the units when it came to both training of trainees (Marines) and training of the trainers.

Participants

The final data collection was organized at MAGTFTC, Twentynine Palms, CA. Multiple units were recruited to support data collection among their service men and women. Participation of each individual was voluntary.

Groups of participants: The basic underpinnings of diffusion of innovation theory (E.M. Rogers model) were used to identify four groups of users to be surveyed: (1) Base Leadership - the decision makers and top management of training programs on the base level with the power to endorse different training solutions; (2) Unit Leadership - the decision makers when it comes to establishing training requirements and overall supervision of training programs for the unit; (3) Trainers - instructors who plan, deliver and actively support training programs, who can be both military or civilian; and (4) Trainees - the recipients of training programs and solutions. Due to the extremely busy operational tempo experienced at the time of our data collection, the researches were unable to engage the members of Base Leadership.

Procedure and Apparatus

Institutional Review Board (IRB): Prior to the start of the study, the research team designed, and got approved, a set of IRB documents that supported the proposed study and its methodology. As in other user studies, participation in the study was voluntary, with full anonymity and subject protection provided to its participants.

Surveys: A set of online surveys was prepared using the capabilities of Naval Postgraduate School (NPS) Lime survey and data collection tools. All participants completed an online survey for their user group in the presence of the experimenter who confirmed what group they belonged to and what survey questions they were to have available.

Investigative Focus Group Discussions: Each participant was offered an opportunity to participate in a short discussion organized in the form of a focus group, in a reserved space where the group would not be disturbed. A selected set of questions was prepared in advance, and flexibility for free discussion was allowed, depending on the answers generated during that session and the interest of participants. Each focus group met after the participants completed their surveys, which allowed researchers to avoid group discussion and group opinion influencing individual responses collected in the surveys.

RESULTS

Demographic and Technology Ownership Data

The initial four categories of individuals who were directly connected to the diffusion process were Base Leadership, Unit leadership, Trainers, and Trainees. We were unable to recruit members of Base Leadership, therefore data about them is not available. We also realized that a profile of instructors in the Simulation Center (all but one of whom were civilians) will most likely be different from the profile of instructors (trainers) in the units, and decided to split this group in two - Trainers (military instructors) and Simulation Instructors (Sim. Center instructors). Table 1 presents the major characteristics of each group. The youngest group was Trainees: average age was 22.1 (sample size 220; min age=19; max age=29; st.dev.=2.21); Trainers: average age 26.6 (sample size=28; min age=21; max age=37; st.dev.=4.04); Unit Leadership: average age 32.5 (sample size=35; min age=25; max age=58; st.dev.=7.80); Sim. Instructors: average age 49 (sample size=11; min age=30; max age=68; st.dev.=10.46).

Table 1: Basic Demographic Data

	Trainees	Unit Leadership	Trainers	Sim. Instructors
Sample Size (#)	220	35	28	11
Average Age	22.1	32.5	26.6	49.3
Years of Service	2.55	10.46	6.53	(19)
Gender: Male	99.09 % (218)	100.00 % (35)	96.43 % (27)	100.00 % (11)
Gender: Female	0.91 % (2)	0.00 % (0)	3.57 % (1)	0.00 % (0)

Table 2 details some elements of ownership of technology; we looked into ownership of several most common digital devices like laptop/desktop, tablet, smartphone, cellphone, game console, e-reader, digital media player, digital camera, and video camera. Trainees owned 850 devices (extremes: four Marines owned seven devices and four Marines owned eight devices; only one Marine reported having none); Unit Leadership members owned a total of 190 devices (extremes: six Marines owned seven devices and six Marines owned eight devices; everyone had at least two devices); Trainers owned a total of 152 devices (extremes: five Marines owned seven devices and seven Marines owned eight devices; only one person had one device and everyone else had two or more); Sim. Instructors owned a total of 49 devices (extremes: two individuals owned six devices and three individuals owned seven devices; one person reported having none).

Table 2: Ownership and Use of Technology in Private Life (% of Sample in a Given Group)

	Trainees # 220, av.age 22.1	Unit Leadership # 35, av.age 32.5	Trainers # 28, av.age 26.6	Sim. Instructors # 11, av.age 49.3
Laptop/Desktop	78.64 %	100.00 %	96.43 %	90.91 %
Tablet	21.36 %	57.14 %	50.00 %	27.27 %
Smartphone	90.91 %	97.14 %	85.71 %	54. 55 %
Game console	73.18 %	65.71 %	64.29 %	36.36 %
Total # of devices owned by the group	850 av/person = 3.8	190 av/person = 5.4	152 av/person = 5.4	49 av/person = 4.4
Internet connection in barracks/ at homes	81.36 %	97.14 %	92.86 %	90.91 %
Facebook	90.00 %	80.00 %	85.71 %	72.73 %
Twitter	20.45 %	2.86 %	7.14 %	0.00 %
YouTube	90.90 %	71.43 %	92.86 %	54.54 %
Email	85.90 %	97.14 %	92.85 %	100 %
Blogs	5.09 %	11.43 %	10.71 %	9.09 %
First Person Shooter games (FPS)	77.27 %	51.43 %	60.71 %	27.27 %
Online Multiplayer games	62.73 %	45.71 %	46.42 %	18.18 %

Collected data suggest that the laptop, smartphone, game console, and Internet connection are the most commonly owned digital resources by all user groups. It is very interesting that the largest portion of the younger participants, Trainees (the group with the lowest pay), owned the three most expensive items from our list - smartphone, laptop/desktop, and game console. They were also more likely to play games on a daily basis than the other groups. Simulation Instructors were more likely to own/use a cellphone, while the other three groups are more likely to own and use a smartphone.

The information about the use of different games was also collected: First Person Shooter (FPS), flight simulation, racing games, other sport games, social networking games, puzzle/strategy/card/board games, online multiplayer games, adventure/fantasy/role playing games, and arcade games. The results suggest that the most popular type of game played by Trainees was First Person Shooter - FPS (77.27 %; with daily use being the case among 32.27% of Marines; 17.27 % used them on laptop/desktops, and 32.27 % on game consoles), followed by online multiplayer games (62.73 %). The daily use of FPS by Unit Leadership dropped to 2.85%. Facebook is an example of the most frequently used web resource: 75 % Trainees used it on daily basis (61.36 % on laptop/desktop, and 81.82 % on smartphone).

Attitudes Towards Technology

User attitudes were indicated as one of the most important factors that influence technology adoption. Examples of this type of question are: "I am among the first people to buy new technology devices." - Table 3 (and the 'flip' question " I am among the last people to buy new technology devices."), "I always look for information about the latest technological devices", "I wait until I hear about technology devices from others before I buy them", "I am one of the first people to buy new applications or games" (and the 'flip' question "I am among the last people to buy new applications or games"). Questions that garnered users attitude towards simulation technology included examples like "I feel very confident in the training capabilities of computer-supported training simulations" and "I strongly support the use of game-based training systems in order to train my Marines."(Table 4).

Table 3: "I am Among the First People to Buy New Technology Devices"
(% of a Full Sample in a Given Group (Frequency in Given Group))

	Trainees # 220, av.age 22.1	Unit Leadership # 35, av.age 32.5	Trainers # 28, av.age 26.6	Sim. Instructors # 11, av.age 49.3
7 = strongly agree	0.00 % (0)	2.86 % (1)	0.00 % (0)	0.00 % (0)
6 = agree	4.55 % (10)	2.86 % (1)	10.71 % (3)	9.09 % (1)
5 = somewhat agree	14.55 % (32)	20.00 % (7)	14.29 % (4)	9.09 % (1)
4 = neither agree nor disagree	22.73 % (50)	14.29 % (5)	17.86 % (5)	18.18 % (2)
3 = somewhat disagree	10.91 % (24)	11.43 % (4)	3.57 % (1)	9.09 % (1)
2 = disagree	23.18 % (51)	31.43 % (11)	25.00 % (7)	27.27 % (3)
1 = strongly disagree	24.09 % (53)	17.14 % (6)	28.57 % (8)	27.27 % (3)
Agree (7+6+5)	19.10 % (52)	25.72 % (9)	25.00 % (7)	18.18 % (2)
Disagree (3+2+1)	58.18 % (128)	60.00 % (21)	57.14 % (16)	63.63 % (7)

Table 4: Confidence in Training Capabilities and Support of Computer-supported Training Simulations
(% of a Full Sample in a Given Group (Frequency in Given Group))

	"I feel very confident in the training capabilities of computer-supported training simulations"		"I strongly support the use of game-based training systems in order to train my Marines."	
	Trainees # 220, av.age 22.1	Unit Leadership # 35, av.age 32.5	Trainees # 220, av.age 22.1	Unit Leadership # 35, av.age 32.5
7 = strongly agree	6.82 % (15)	8.57 (3)	7.73 % (17)	14.29 % (5)
6 = agree	19.55 % (43)	34.29 % (12)	15.45 % (34)	20.00 % (7)
5 = somewhat agree	16.82 % (37)	20.00 % (7)	20.91 % (46)	37.14 % (13)

4 = neither agree nor disagree	36.82 % (81)	34.29 % (12)	37.73 % (83)	20.00 % (7)
3 = somewhat disagree	5.00 % (11)	0.00 % (0)	4.09 % (9)	0.00 % (0)
2 = disagree	4.55 % (10)	2.86 % (1)	4.54 % (10)	2.86 % (1)
1 = strongly disagree	10.45 % (23)	0.00 % (0)	9.54 % (21)	5.71 % (2)
Agree (7+6+5)	43.18 % (95)	62.86 % (22)	44.09 % (97)	71.43 % (25)
Disagree (3+2+1)	20.00 % (44)	2.86 % (1)	18.18 % (40)	8.57 % (3)

Current Use of Computer Supported Training Simulations

The type of facility that most Trainees and Unit Leadership have heard of, used or were familiar with, was a training facility that housed Indoor Simulated Marksmanship Trainer - ISMT - 68.57 % (Table 5). The biggest surprise was that 91.82% of Trainees and 74.29% of Unit Leaders had never heard of, used, or were not familiar with, was DVTE. Regarding the knowledge about, and use of simulations in support of combined arms training, the Trainees reported very modest use of Virtual Battle Space 2 - VBS2 (7.27 %) and Combined Arms Network - CAN (1.36 %); both simulations were expected to be used more frequently (Table 6). (Other acronyms used in Table 6 and Table 7: Battle Simulation Center (BSC), Indoor Simulated Marksmanship Trainer (ISMT), Supporting Arms Virtual Trainer (SAVT), Combined Arms Command and Control Trainer Upgrade System (CACCTUS), and Forward Observer Personal Computer SImulation (FOPCSIM)).

Table 5: Knowledge of Base Training Facilities with Training Simulations, (Have Heard of, Used, and/or Familiar with the Simulation (% of a Full Sample in a Given Group (Frequency in Given Group))

	BSC	Camp Wilson	Bldg 1707 - ISMT or DVTE	ISMT	SAVT	DVTE
Trainees # 220, av.age 22.1	10.91 % (24)	49.09 % (108)	50.91 % (112)	68.18 % (150)	18.64 % (41)	8.18 % (18)
Unit Leadership # 35, av.age 32.5	42.86 % (15)	60.00 % (21)	74.29 % (26)	80.00 % (28)	68.57 % (24)	25.71 % (9)

Table 6: The Use of Simulations in Support of Combined Arms Training (Have Heard of, or Used) (% of a Full Sample in a Given Group (Frequency in Given Group))

	CAN	VBS2	CACCTUS	FOPCSIM
Trainees # 220, av.age 22.1	1.36 % (3)	7.27 % (16)	4.09 % (9)	11.81 % (26)
Unit Leadership # 35, av.age 32.5	11.43 % (4)	40.00 % (14)	14.28 % (5)	37.14 % (13)

When we asked about the reasons for such low use of simulations the responses had little to do with the overall quality of hardware and software (although they were mentioned as factors). A myriad of other factors were reported to influence the outcome to a greater extent. Table 7 and Table 8 illustrate the characteristics of training simulations that the users frequently mentioned as the ones they 'liked most' or 'disliked most'.

Table 7: Most Frequent Free Comments About the Characteristics of Training Simulations That the Users 'Liked Most' (% of a Full Sample in a Given Group (Frequency in Given Group)

	Trainees # 220, av.age 22.1	Unit Leadership # 35, av.age 32.5	Trainers # 28, av.age 26.6	Sim. Instructors # 11, av.age 49.3
Realistic aspects	19.34 % (70)	8.33 % (7)	8.16 % (4)	15.38 % (4)
Ability to improve MOS skills	8.84 % (32)	7.14 % (6)	20.41 % (10)	19.23 % (5)
Fun, cool, game-like environment	8.29 % (32)	0.00 % (0)	0.00 % (0)	3.85 % (1)
Prepares you better for the real exercise	6.08 % (22)	5.95 % (5)	10.20 % (5)	0.00 % (0)

Effective / Good training	4.97 % (18)	0.00 % (0)	0.00 % (0)	0.00 % (0)
Multiple scenarios; ability to practice on events numerous times	4.97 % (18)	14.29 % (12)	10.20 % (5)	7.69 % (2)

Table 8: Most Frequent Free Comments About Characteristics of Training Simulations That the Users 'Disliked Most' (% of a Full Sample in a Given Group (Frequency in Given Group)

	Trainees # 220, av.age 22.1	**Unit Leadership** # 35, av.age 32.5	**Trainers** # 28, av.age 26.6	**Sim. Instructors** # 11, av.age 49.3
Did not feel realistic; too accurate for realism	26.67 % (80)	28.99 % (20)	15.22 % (7)	17.65 % (3)
Technical issues; buggy; froze; glitches	15.67 % (47)	8.70 % (6)	17.39 % (8)	5.88 % (1)
Throughput Issues	7.33 % (22)	1.45 % (1)	0.00 % (0)	0.00 % (0)
Boring; lose interest; too repetitive	6.67 % (20)	1.45 % (1)	0.00 % (0)	0.00 % (0)
Not enough time to use sim. Too difficult to use, learn, or understand	5.67 % (17)	0.00 % (0)	2.17 % (1)	0.00 % (0)
Can be inaccurate	4.00 % (12)	0.00 % (0)	4.35 % (2)	0.00 % (0)
Poor graphics	3.67 % (11)	5.80 % (4)	4.35 % (2)	5.88 % (1)
Marines not taking them seriously	3.00 % (9)	2.90 % (2)	8.70 % 94)	23.53 % (4)

Results of Investigative Focus Group Discussions

A total of three focus groups were assembled during the data collection effort; a video record was made during interviews with two groups (data were subsequently transcribed), and discussion from the third focus group was taken in the form of researcher's notes (shortened transcription of the group discussion). At the time of our data collection at the base, the operational tempo of the units did not allow for wide participation in this study segment, and a decision was made to combine both Trainers and Trainees in the same focus groups. The questions ranged from positive and negative experiences with, attitudes towards training simulations, game-based training systems, opinions about specific training simulations (ISMT), current training practices, to desires for the forms of training in the future (detailed results can be found in Yates, 2013). A small subset of participants' comments collected in these discussions included the following:

- Maintenance and sustainment of software/hardware infrastructure posed a difficulty in adoption process.
- Knowledge about user interface for each simulation was perishable and Marines needed to be re-trained.
- Not enough time in the training regimen to experiment and get to know different training simulations.
- Scheduling and throughput issues minimized the use of simulations during white space periods.
- When used, training simulations were identified as good tools to build the confidence of junior Marines.
- Some trainees treated training simulations like games, which diminished training effectiveness.
- Elements of both positive and negative training transfer with different simulations have been identified.
- Trainees' opinion about the receptiveness of their unit leaders towards the use of simulations was on both sides of the spectrum. Some believed their unit leaders would be supportive of using this type of training solutions if they trusted that positive training results would be generated, while others believed that their unit leadership would not take it as 'serious training' and would not even try.
- ISMT was singled out as a good training solution, but it supported outdated weapons and graphics.
- Training events with simulations were often treated as check-in-the-box and not like other training events, such as physical training ranges.

Discussion

The analysis of the collected data set suggests that the use of computer supported training simulations was very low. There was no single simulation that reached the point of being adopted on a large scale. The most frequently used simulation was ISMT with 68.18 % of Trainees who heard of or visited the facility that housed ISMT; 49.09 % of trainees actually used it during the two years prior to the date of our data collection, with the note that the majority of these individuals used it 1-3 times during that period (36.82 %). This appears to be a trend: the largest percentage of users of any training simulation reported using those simulations 1-3 times during the two years prior to our date collection. Given the fact that both individual and team (group) military skills are complex and often require multiple multi-hour long training sessions to master each skill, one can hypothesize that those training simulations were not the only tools used in their training. It is also conceivable that in some cases those sessions represented one-time experimentation on the part of the unit, after which they may have decided not to use that training option in the future. More extensive data collection would need to be conducted to capture the reasons why 1-3 uses in two years is the norm. The data sets collected in the study do not provide evidence of there being innovators and first adopters in any user group; however, we did identify strong indications of groups of early and late majority adopters. Detailed results generated in this study can be found in Yates, 2013.

The overall impression we acquired from the investigative focus group discussions, as well as the data sets collected in the questionnaire was that users in all groups were very receptive towards the idea of using training simulations. The most frequent reason for not using some training simulation was the fact that units did not know about the existence of the training simulation at all. This clearly points toward the need for additional efforts that acquisition operations should undertake in the future; in this case the actions might be directed towards better promotion and familiarization of training forces with the training options available, as well as stronger endorsement from leadership and an increased number of change agents and their aids.

CONCLUSIONS

The main contributions of the data collection effort presented in this paper fall into several categories: we (1) produced a profile of a trainee, unit leader, instructor and simulation instructor; (2) acquired detailed knowledge about simulation capabilities at the base; (3) acquired an understanding of training audience misconceptions, 'likes' and 'dislikes' among users; (4) identified a need for an extended role for leadership and change agents in the adoption process; (5) identified a greater need for the role of peer advertising in the adoption process; (6) identified the areas where additional or different approaches may be needed; (7) produced guidance on how to increase adoption that is applicable to other USMC bases and other Department of Defense (DoD) services.

Recommendations: The results of the data analysis and our understanding of the military training domain helped us derive the following recommendations: (1) augment the acquisition process - any system needs to be delivered as a 'full package' i.e. it needs to include *tested advice* on how to use that simulation most effectively; (2) augment training approaches - introduce training pedagogies that will guarantee more effective training as well as counter the cases of disengagement, boredom and the sense of repetitiveness; (3) engage the members of Base Leadership; (4) increase the number of change agents and their aids – the adoption process needs to be supported by individuals who will engage in active promotion of these training capabilities; (5) use peers to advertise and promote effective simulations and successful training practices.

Future Work: Multiple directions for future research activities have been identified for this domain: (1) conduct more comprehensive service-wide data collection, and include acquisition and training offices; (2) design and execute a longitudinal study in collaboration with multiple bases and units, in which a number of trends and elements identified in the study would be addressed with recommended solutions, and monitor the effectiveness of proposed changes; (3) further refine and validate the Training-Centered Diffusion of Innovation Model (TC-DIM); (4) design an Adoption Framework (service-wide, and DoD wide).

A short answer to our question "Are we there yet?" could be stated as - When it comes to large scale deployment and use of training simulations that are available as optional training tools, military domain still has a long way to go. Additionally, the nature of training as a domain - its complexity and the interdependence of its major characteristics - determines that there is no single parameter that will guarantee the success of a training solution or training event. Underestimating the influence of variables that are 'outside' of technology can only be detrimental to the overall success of adoption process. A good starting and ending point is in striving towards a training solution that most effectively and most efficiently ensures that all training objectives are supported. The understandings collected in this and other studies all attest that military training is a complex, multilayered domain that is only partially defined by the type and technical characteristics of the systems being used. Our work and experience in this domain gives us a firm basis to hypothesize that a well-selected set of strategic approaches could bring a much greater result with only a modest investment made to support the changes. These findings and recommendations are highly applicable to all DoD services and other communities that plan to use these types of solutions in their training and learning practices.

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REFERENCES

Citizen, J. (2008). Report on Department of Defense Modeling and Simulation Efforts (Contract Number N61339–03-D-0300, Task Number DO #221). Washington, DC: Office of the Director, Defense Research & Engineering.

Citizen, J. (2009). Report on Department of Defense Modeling and Simulation Efforts (Contract Number N61339–03-D-0300, Task Number DO #221). Washington, DC: Office of the Director, Defense Research & Engineering.

Citizen, J. (2010). Report on Department of Defense Modeling and Simulation Efforts (Contract Number N61339–03-D-0300, Task Number DO #221). Washington, DC: Office of the Director, Defense Research & Engineering.

Davis, F. D. (1986). *Technology acceptance model for empirically testing new end-user information systems: theory and results* (MIT PhD Thesis) 1986

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, Volume 13 Issue 3, p. 319–339

Davis, F. D.(1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts, *Int J. Man-Machine Studies*, (1993) 38, p. 475-487

Richerson, P. J., Mulder, M. B., & Vila, B. J. (2001). *Principles of Human Ecology*. retrieved from http://ir.nmu.org.ua/bitstream/handle/123456789/137600/f421ad5b4779127542f358ad0e1f746e.pdf.

Rogers, E. M. (1995). *Diffusion of Innovations*. New York, NY: Free Press, 4th edition

Sadagic, A. (2007). The Deployment and Use of Virtual Training Simulations: What Does it Take to Serve the Needs of Majority of Its Users?, *Proceedings of the New Learning Technologies Orlando 2007*.

Sadagic, A., Darken, R. (2006). Combined Arms Training: Methods and Measures for a Changing World, *NATO workshop Virtual Media for Military Applications*, US Military Academy, West Point, NY 2006.

Slater, M. and Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments, *Presence: Teleoperators and Virtual Environments,* 6(6), p. 603-616

Venkatesh, V., and Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46, p. 186–204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27, p. 425–478.

Yates, F. A. (2013). *Diffusion and Large-scale Adoption of Computer-supported Training Simulations in the Military Domain* (NPS Master Thesis) Sep 2013. Available from NPS Calhoun database.