Redefining Training Envelopes to Ensure Operational Readiness: Benchmarking Human Activity

Dr. Christopher John Huffam Ph.D.
Canadian Armed Forces
Kingston, Ontario, Canada
Christopher.Huffam@forces.gc.ca

Dr. Gregory Krätzig Ph.D.
Royal Canadian Mounted Police
Regina, Saskatchewan, Canada
Gregory.Kratzig@rcmp-grc.gc.ca

ABSTRACT

Using simulation as a means of delivering information permits trainers and educators to provide students with personally meaningful lesson content that is grounded in an understandable, immediately obvious context. It also provides trainers and educators with a means of assessment that faithfully represents aspects of the real world work environment relevant to the competencies assessed, and are strong indicators of student ability to perform specified functions in the working environment. This paper will explore the relationship between the dominant Live, Virtual and Constructive (LVC) model of instructional simulation and the Eightfold Path model, illustrating how a blended perspective permits rapid identification potential solutions to perceived performance issues. The impact of applying tailored simulation using this approach in Individual Training and Education outcomes, as well as related performance support issues will be shown, using case studies drawn from Canada's Department of National Defence and other participants in the Canadian Federal "Whole of Government" training initiative.

ABOUT THE AUTHORS

Major Christopher Huffam Ph.D. joined the Canadian Forces' Military Personnel Generation Headquarters in 2014. His research focus is on Learning Transfer in a simulated environment, and mapping real world working environments to establish the requirements for designing effective and efficient simulations and simulators. Chris holds a PhD in Educational Technology from the University of Calgary and a Master of Arts in Distributed Learning from Royal Roads University in Victoria, British Columbia. Dr. Huffam has written eight peer-reviewed publications and has one book in process. His eleven national and international presentations include three previous occasions at I/ITSEC. His 26 years of experience as a Training Development Officer with the Canadian Forces includes teaching, training consultancy, designing new training programs within capital acquisition projects, and establishing training programs for the Afghan National Police.

Dr. Gregory Krätzig joined the Royal Canadian Mounted Police (RCMP) Training Academy. His research focuses on how skills are acquired in a simulated environment and how well those skills transfer to a real world setting. His expertise has resulted in him leading leads several national and international simulation research studies. He has 11 peer reviewed publications, 1 book chapter, and 25 peer reviewed presentations. He has presented to the College of European Police Sciences, the Interservice Industry, Training, Simulation and Education Conference, INTERPOL, and FLETC. Greg is a member of the several professional psychology associations, was awarded the Queen Elizabeth II Diamond Jubilee Medal, and has won over $1.5 million to further his work, with most of this support coming from the Centre of Security Science through Defence Research Development Canada (DRDC-CSS) and the Natural Science and Engineering Research Council of Canada (NSERC).

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Dr. Christopher John Huffam Ph.D.
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CHRISTOPHER.HUFFAM@forces.gc.ca

Dr. Gregory Krätzig Ph.D.
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Gregory.kratzig@rcmp-grc.gc.ca

INTRODUCTION

The use of simulation as a means to prepare the individual to perform a set of tasks acknowledges that learning these new tasks or skills in the workplace may be difficult or dangerous to oneself or others (Flexman & Stark, 1987; Krätzig, Bell, Groff, Ford, 2010). This idea is based on the idea that an apprenticeship style approach to training may be too time consuming to provide each learner multiple iterations of the to-be-learned task. Conversely the learning exposure may be incomplete due to a dearth of opportunities to build personally meaningful experiences that will allow the learner to demonstrate proficient performance in difficult or hazardous tasks of infrequently used skills. This may in turn lead to a lack of standardization in training. These training challenges may be a result of the complexity or related situational concerns of the task (e.g., emergency vehicle operation in a civilian environment; Krätzig, et al., 2010). Some notable early attempts to address these types of training challenges can be found by looking at Madame De Couderay's obstetrical training machine (circa mid-1750's; Gelbert, 1998; Leroy, 2001), or the even earlier use of cadavers as a representation of a living patient for training physicians and surgeons observed by the Islamic scholar Avicenna (e.g., 980-1037 A.D.; Goodman, 1992). Even earlier examples that could be considered were the use of live simulation involving military weapons and tactics training that predate the writings of the Roman General Scipio Africanus around 220 B.C. (Grant, 1996) in support of activities during the Greek and Persian wars (Hooker,1996).

Technology based examples of using simulation to prepare individuals to perform complex tasks in an operational setting without a period of supervised on-the-job experience first appeared around 1910. Individual training of aircrew on both sides of the Great War involved the use of devices that represented aircraft controls, which combined elements of the aircraft's cockpit with representations of either reaction to control input by the aircrew or of the ground as seen from the air (Moore, 2002). A related example that combined the use of models with prepared sites was the preparation of the Canadian Expeditionary Force for the Battle of the Somme in 1914, which was the first modern use of simulation that supported collective training (King, 2013). More recent examples of technology based approaches to preparing individuals to perform tasks without the benefit of building experience under supervision on actual equipment can be found with manned space flight such as the Mercury, Gemini, Lunar Module and initial shuttle orbiter flights (Launius, Fries & Gibson, 2006).

Simulation can be classified in a number of different ways; 1) how it functions (Nance & Watson, 1999), 2) how the technology is used [AMSP-01(A), 2009], and 3) its intended purpose (Alessi, 1988). From a practical perspective, simulation can be divided into either naturalistic (i.e., experimental) or instructional in nature (Wagner, Polkinghorne & Powley, 1992). Flexman et al (1987) suggests that the main reasons for the use of instructional simulation to teaching support and performance assessment are for the preservation of life, the safeguarding of equipment in high-risk situations, the reduction of equipment maintenance costs, or the impact of equipment shortages and availability. It is suggested here that adding a legislative consideration and risk to the environment that results from using real equipment be added as recognition of both the potential adverse impact of live training and potential training accidents may result in legal action under the Environmental Protection Act or its local equivalent.

The perspective of credentialing authorities is undergoing a gradual evolution away from a strict dependence on teaching through an apprenticeship model (i.e., initially learned through observation and assistance in task performance before using real equipment) to accepting the use of instructional simulation (i.e., use of artificial, constructed and controlled environments and circumstances). The application of instructional simulation as a method of content delivery and learning management allows educators and trainers to construct a personally meaningful learning environment by scaling the level of detail or complexity of the material to be learned and the level of detail in the supporting learning environment to the capabilities of the student (Driskell, Owen, Hays & Mullen, 1995; Miller, 1974; Williges, Roscoe & Williges, 1973). However, to support the initial learning and assessment of competency in performing complex compound tasks it is more effective to use a simplified approach to instructional simulation and build on it gradually to minimize the learner being overwhelmed or distracted (Chechile, Flieschman & Sadowski, 1986).

The gradual change in terms of the way in which artificial representations of reality were conceived and eventually accepted, as identified above, involved a perspective shift. This was due to organizations being driven by a need to find the best fit and the least resource intensive approach that meets their training and certification needs. This shift in perspective could not be done without being linked to economics and the realization that there were finite resources to draw from. This shift in perspective may also result in the re-examination or re-purposing of existing technologies and approaches.

Discussion

Use of simulation as a teaching and assessment methodology forces a demonstrable rather than a simple declarative assessment of competence, and it permits the incremental measurement of transfer of learning. This is done initially as a diagnostic of a learners initial capability (i.e., formative assessment), to their final performance (i.e., summative) assessment and in in a growing number of cases the re-certification of skills competency. However, use of this methodology must consider two major areas; 1) the nature of the content to be presented (the simulation; Alessi, 1988); and 2) the way in which it is presented (the simulator; Nance & Watson, 1999).

Considerations for effectively identifying, selecting, and employing the combination of simulator and simulation for training, education and assessment purposes should include:

1. Maintaining a perspective of technological agnosticism. Identification of the objective and consideration of the limits of local infrastructure, available resources, and acceptance of solutions by the user community and acceptance that there are several forms of technology that provide working solutions for the target audience are key to success (Huffam, 2014);
2. Acceptance of the validity of learning theories that support a structured approach to performance based learning and assessment. Failure to do so may result in the selection of inappropriate tools and ineffective assessments (Huffam, 2012); and
3. Acceptance that the process of designing effective content delivery and assessing the transfer of knowledge (i.e., building individual and group competencies) is common across domains of knowledge. Specifically, the same rules apply for selecting effective simulators and designing simulation across aviation, medicine, industrial and military applications (Gaba, 2008; Huffam, 2010a; Kinnear, 2010; Kapur, Parand, Soukup, Reader, & Sevdalis, 2015), and this approach has been accepted as a best practice across the above industries (Chatham & Braddock, 2001; Gaba, 2008; Landolt & Evans, 2000; Miller, 2010; Watchtel & Walton, 1985). An example approach for this will be discussed further in this paper.

The use of Simulation for content delivery or assessment supports the creation of personally meaningful learning moments. It is important to note that the manner in which it is implemented varies between individuals as much as with the content and level of detail being presented (Driskell et al, 1995). As the effective introduction of new content to a learner starts with simple then progresses to complex concepts, while moving similarly from easy to perform to more complex and difficult tasks, it is important for designers of instructional simulation to create a defined event which is a controlled, artificial set of circumstances that provide significant appropriate cues to represent the real world working environment. The design requirements of the simulator (i.e., the environment in which the event or simulation occurs) are based on the identified feedback cues required by the human in the loop needed to accurately perform the defined activity. Activities that are highly dependent on multiple sources of cues require more realistic representations than those which involve mental processes that manipulate abstract concepts as cues. Also the level of abstraction, which is relative to the level of detail presented, will vary according to defined need and the purpose of the simulation. Abstraction in this context refers to the level of detail removed from the representation as it would either distract users or is not relevant to the aim of the simulation event, based on instructional design considerations (Huffam, 2010a). Providing we accept a definition of simulation as a constructed set of circumstances that represents human activity, any simulation can be staged using content appropriate approaches that support participant interactivity and by using personally meaningful cues as needed to support the objective(s) of the simulation as the event unfolds.

The requirements of demonstrating competency within the instructional simulation have to be similar enough to performing the task in the related real world working environment to create a sense of participant focus. Depending on the nature of the cues required by the learner to sustain the role within the simulation, a 1:1, high fidelity representation of the workplace surroundings may not be required to support task performance (Huffam, 2010a; 2011). To support this shift in perspective, the primary focus should be on task fidelity that supports the intended outcomes, instead of the fidelity of the supporting environment. A working example of this perspective can be found by examining the success of highly abstracted representations of activities such as board games, which is evidenced by observing player engagement. The phenomenon of participant engagement would partially explain why players of strategy games such as Go, Chess or Risk™ become personally immersed or focused on a highly abstracted representation of reality that represents potentially complex strategic interactions. Players report being fully engaged while playing these types of games, which is an important observation as the phenomenon of engagement observed corresponds with Witmer & Singer's (1998) definition of presence. This definition includes the perception of being enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experience. In this sense, engagement or immersion refers to the manner in which the individual interacts with the simulation or game. Participants are considered to be immersed if they are focused on the event and are unresponsive to cues in the real world surroundings that are peripheral, instead responding to cues and interacting within the game in a manner similar to or identical to how they would interact *in that situation* in the real world (Slater, 2004).

Effective instructional simulation is purposefully designed to represent the performance of a function or to illustrate relationships between related objects in a specified set of circumstances. In order to design effective instructional simulation, a commonly understood and universally applied set of definitions is required. While definition sets for specific applications exist, they are not necessarily universally accepted or applied. A specific example of this is the working definition within the industry for the term synthetic. Depending on the role of the individual involved and their experience, it will be interpreted to refer to an artificial representation of the real world where any number of participants may interact, as within the perspective of instructional design (Vol.1, A-PD-9050), or be more specific to computer sciences and refer to a computer based representation of the real world [AMSP-01 (c)]. While such distinctions appear minor, the effect of a misunderstanding based on unclear definitions can cause significant confusion and have adverse impact on projects.

Similarly, there is a need to examine the current interpretation of the concepts of live, virtual and constructive (LVC) environments. This discussion is critical as the terms Live, Virtual and Constructive form the basis for the most widely used classification system for instructional simulation within military, aviation, and engineering applications of instructional simulation. These definitions, as presently set out by the NATO subcommittee on Modeling and Simulation, have evolved over time (AMSP-01, 2009; 2012, 2015), but are still open to interpretation. "The categorization of simulation between live, virtual and constructive is problematic because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorization also suffers by excluding a category for simulated people working on real equipment."[AMSP-01(b) 2012, p. E-4].

The LVC continuum is a technology oriented model that evolved through common usage over time, where it was initially informally recognized that phenomena could be intentionally, artificially reproduced using the available technology of the day. Recognition of LVC simulation as a tool set that can be described as a continuum of technology predates Wagner et al (1992). Although they appear to be the first to use the term, earlier applications of this approach focused primarily on the use of computer supported content delivery. The concept was initially referred to as the Advanced Learning Environment (ALE) within the American academic community, and was identified as the Advanced Learning Environment (ALE) within the US military at that time (Helms, Frank & Triplett, 1997). Subsequent to Frank, et al, (2000), the terminology was standardized. Although the category definitions that make up the LVC are broad and, to an extent, overlap each other, this model provides a simple framework for identifying technology based training solutions.

Used in isolation, it has two major issues; as stated earlier, the lack of clear definitions as to what falls cleanly into each category, [AMSP – 01(b)] and its focus on technology rather than the involved human activity to be represented. The recognized limitations of the existing LVC model can be addressed by reconciling it against and blending it with the Eightfold Path model (Huffam, 2010a,b; 2011) focused on a human activity oriented approach to mapping appropriate technologies to human activities involved in training and assessment.

The Eightfold Path model (Huffam, 2010a, b; Huffam 2011) is a technology agnostic model. It classifies instructional simulation from the perspective of common human activities involved in the processes of training, educating and assessing. The model contains eight categories:

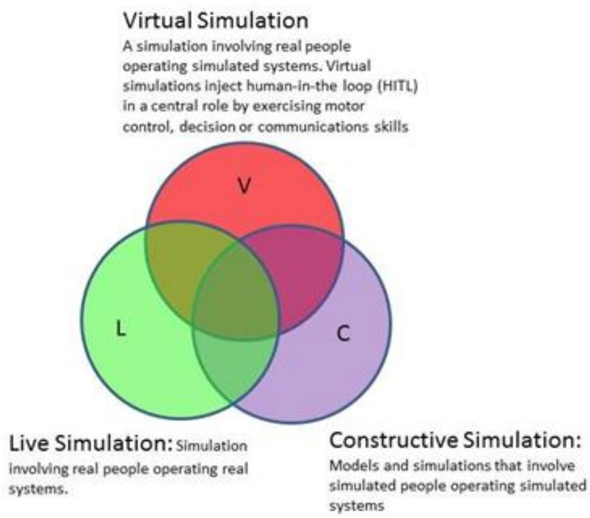

Figure 1. The Live, Virtual and Constructive Continuum Model

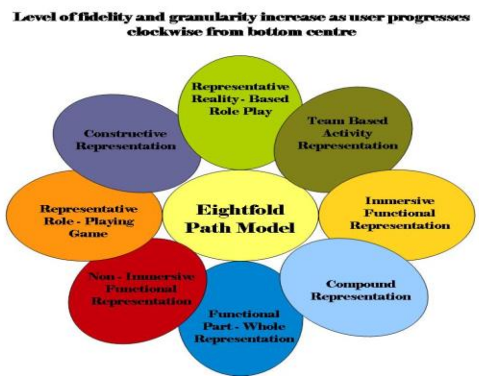

Figure 2. Eightfold Path Model Diagram (Huffam, 2010b).

1. Functional Part Whole Representation (FPWR), allowing an abstracted, non-natural perspective representation of elements of objects that may not otherwise be experienced, which the learner can interact for training, educational or assessment purposes.

2. Non - Immersive Functional Representation (NIFR) provides users with accurate representations of the physical characteristics of portions of equipment, objects or entities and can be directly experienced and interacted with by the user.

3. Role Playing Games (Games) are serious games, involving the individual being immersed in a scenario in which tasks reflective of a real world oriented activity are either being taught or assessed. In this instance, the scenario that the participant is engaged in may not be based on the physical or social laws of the universe of which the participant is normally a part. The scenario is a structured event that may be group or individually oriented and which is reflective of "real world" activities. Scenarios may either be based on past history, fantasy (alternative universe with physical laws different than our own and established prior to play commencing) or may be based on the rules of the universe of which the subject is normally a part.

4. Constructive Representation requires the subject(s) are immersed in a scenario in which specific activities require them to construct and hold a mental picture of the relationships between their own role and those of other players or objects within the scenario, or make use of a shared, commonly experienced abstracted representation of the situation which permits a global representation. This form of simulation is based on real world physics and the restrictions of the scenario. It generally involves some level of abstraction rather than realism in the representation of reality maintained by the individual to permit timely management of information.

5. Reality Based Individual Role Play Activities (Role Play) involves the participant to assume a role or an identity in order to either learn a process or procedure or demonstrate proficiency in a setting that contains aspects of the

real world environment in which the tasks would be performed. In common usage, these activities are small-scale events that may be used for demonstration and practice or for either formative or summative evaluation.

6. Team Based Activity Representation (TBAR) are collective exercises that personnel may work through. These are scripted, branching scenarios that function in a controlled setting while using actual equipment, within the actual working environment. This differs from simple role play in that team based exercises take place on collective or group levels and in that the focus is on team or group function as opposed to individual function. It differs from Immersive functional representation in that it uses actual equipment in controlled circumstances, as opposed to using partially functional representations

7. Immersive Functional Representation (IFR) allows individuals or groups to interact with a functional representation of objects or equipment found in the real work environment, within predefined scenarios in a representative environment. This environment consists of the representation of objects within the work area, the immediate or near environment and a far environment which provides peripheral cues.

8. Compound Representation are combinations of the foregoing seven simulation methodologies, blended for the purpose of instruction or assessment of specific aspects of complex tasks under defined conditions.

Blending these models provides the established general categories of simulation with more specific labels to identify the human activities involved and related forms of technology. Further, it will allow a clear linkage between the proposed representation of human activity and the practical limitations of identified, appropriate technology through the use of the Interactive Media Instruction concept suggested by Straus, Shanley, Burns, Waite & Crowley (2009).

Blending these models will also will permit the use of procedures developed using the Eightfold Path Model for identifying the requirements for new build, activity appropriate forms of simulation, and for using a verification approach for checking the utility of an existing form of simulation to a proposed use (Huffam, 2012). This model identifies four basic functions found in instructional simulation (introduction, action, consequences, and exit), and allows for differing levels of technology to be employed as the basis for the simulation, which provide the design user communities with some choice in how content is to be delivered or performance assessed, based on resource availability and such factors as local infrastructure (Huffam, 2014). This approach also provides the M&S community with a revised concept model that satisfies the requirements of a set of established metrics for building a theoretical model (Thagard, 1992), which the LVC does not do at present. The Eightfold Path model was designed with these criteria as considerations.

Figure 3. Blended LVC/Eightfold Path Model.

Thagard (1992) proposes nine critical considerations for a theoretical model to be viable. He states that concept models or theories (such as the LVC or Eightfold Path) must have symmetry, a set of established and constant relationships between the overall concept and each component element. However, he also states that they may either be mutually supporting and compatible or discrete and not mutually supporting. Each theory should also have adequate explanations of function for theoretical components that show a clear and uncomplicated relationship to the information the theory attempts to explain. The more complicated the explanation, the less the theory should be trusted. Thagard (1992) suggests that similar hypothesis which explains similar pieces of evidence may be related and generalizations between them made.

Thagard (1992) suggests that preference is to be given to evidence based information that is independently accountable, and that forms of data should be given less weight. Further, level of acceptance is limited to the ability of the theory to explain all rather than just some of the phenomena in question. Thagard (1992) emphasizes the importance of explanatory breadth. In this instance it means that the proposed theory explains a greater range of facts than alternative theories. Lastly, Thagard (1992) is concerned with simplicity. He suggests that preference should be given to theories that require fewer special assumptions.

Methodology

Using this blended approach to defining the requirements for designing effective simulation initially follows an Instructional Systems Design (ISD) strategy for identifying and defining task, skill and knowledge statements (Mager, 1962; Vol. 1, A-PD-9050). Should the user community wish to use a competency based approach, the additional detail may be added to the defined task statements by including a considerations section (i.e., which would include resources available and denied, reflective of the real world working restrictions), and a description of the environmental conditions under which the task would be performed. Task, knowledge and skill statements are input to a spreadsheet, creating a basic scoring matrix to track the identification of degree of knowledge or skill required to effectively perform a task. Performance requirements are scored from 1 (i.e., elementary, performed only under supervision) to 5 (i.e., expert).

Detail on potential representation of the environment required to support the task/competency being taught or assessed is detailed through the use of a content oriented, time slice exercise using subject matter experts to identify and record required aspects of content elements, with identification of which of the human senses are used for each critical task performance recorded on the same matrix as the tasks. Senses to be identified are visual, auditory, olfactory, tactile, vestibular and proprioceptive. Each sense is scored in order of priority, from 1 to 5, with a value of 0 awarded in task performance for senses not used. For selection of appropriate forms of simulation the classification system from Huffam (2010a, b; 2011) is used. Selection of appropriate simulation technologies is based on a combination of the involved, identified human activities, the specific content to be taught or assessed, and the sensory cues identified as required to successfully perform the identified task/ demonstrate the identified competency. Simulation requirements that are not complex (i.e., involving cues from visual, auditory or a combination of the two) can be represented as highly abstracted (i.e., removed from their natural surroundings) while retaining a high level of granularity or object fidelity. Representation of environments that require content appropriate cue input from combinations of three or more of the visual, auditory, olfactory, tactile, vestibular or proprioceptive senses are complex in comparison, and require a broader and more detailed set of content appropriate cues for adequate representation.

Existing simulation which is under consideration for re-purposing to a user community that was not part of the design audience can be done using a similar structured approach to task or competency identification. In that instance, using the IACE approach and scoring criteria (Huffam, 2012) for verification and validation, provides an evidence based chain of logic from an educational perspective for the decision of whether or not to use a pre-existing instructional simulation.

Supporting Evidence

The following are series of examples drawn from the training practices of the Canadian Armed Forces (CAF), Policy Horizons Canada, and the Royal Canadian Mounted Police (RCMP). These examples are illustrations of current practice, and how reclassification and potentially re-purposing applications might demonstrate more effectively use of existing technologies.

Two recent aircraft acquisitions for the CAF use the concept of a computer-based functionally accurate virtual aircraft to support interactive graphically based virtual simulation. The specific example is of an interactive, animated set of functional aircraft system schematics that are driven by a high fidelity virtual model of the related aircraft. This graphical representation is connected to a functional representation the cockpit controls and is part of the training suite for the C 130J Hercules and the CH 47 F Chinook. Each set of virtual controls interacts with the related animated schematics, which illustrates how the system functions by responding to control input using a detailed functional model of the aircraft. This approach is used as a procedural trainer for each aircraft type, which illustrates the effects of function of controls on aircraft systems in a non-naturalistic manner. It has the capability of showing the student the results of control input under ideal and emergency conditions for the operators, as well as for fault finding as content delivery and student assessment tool for aircraft maintainers. Using the LVC classification, this would be described as a Virtual Part Task Panel Trainer. Under the proposed blended model, it would be referred to as a procedural training device that uses a Virtual Functional Part Whole Representation. This distinction in terminology indicates that the simulation is based on a software application and can potentially represent either a single aircraft system in isolation or can represent how individual systems function and ensembles of systems interact. In this instance, the representation of individual aircraft systems is based on a set of interactive aircraft models and can represent normal and emergency conditions, permitting introduction of concepts and relationships between system elements and each individual aircraft system for teaching as well as student assessment. This example was designed using the Eightfold Path model, and the difference in approaches to simulation resulted in a single tool being designed that could be used by a total of four discrete operator groups; the pilots and three maintenance specialties, each with their own technical focus.

This Functional Part Whole Representation meets the criteria for instructional simulation in that includes an introduction function that bounds the training event, explains the interaction between the user and the simulation. It also provides instruction on how to interact with the simulation while setting goals for the activities involved (Huffam, 2010a, 2014). This approach is symmetrical in the manner in which the involved concepts (i.e., systems) are presented and clearly shows the relationships between components of the content involved. Content presented is shown in context as are the relationships between cause and effect. Generalizations are not attempted across aircraft systems unless the functions are clearly explained and information is restricted to specific content relevant to equipment use and the intention of the simulation. All relevant aspects of the individual aircraft are included, and tasks are clearly described and all with appropriate levels of detail available in the interactive model. The model is, in each instance, as simple as it can be while retaining functional accuracy relative to design purpose.

Policy Horizons Canada is a Federal government think tank that hosts a Government of Canada Serious Games Community of Practice (CoP). Members of this CoP are focused on finding applications of serious games to the process of training and education across the various departments of the Federal Government of Canada. One such application developed under contract and used as a concept demonstrator is a board game called Impact. This game is designed to teach and reinforce strategic decision-making processes for the development and employment of emergent technologies, and to provide learners with an opportunity to assess the potential impacts of these identified technology trends on society. One of the functions of using this approach is to teach learners to explore and assess the unanticipated consequences of emergent technologies on society. This format was selected as the tasks involved are strategic in nature and the relevant cues are not dependent on having a naturalistic or live perspective on the area concerned. While the minimalistic nature of the board game contributes to the scenario of the game, the game itself is technologically agnostic.

Serious games can take one of several primary forms; they can be either pen/pencil and paper based, board based, computer-based, or be hybrid in design (Breurer & Bente, 2010; Choi, 1997). Those games which have computer-based components fall under the Virtual category of the LVC. Using the LVC classification, the computer based version of the game Risk™ qualifies as a strategic simulation, but the board game (on which the computer based version is based) does not, although it may as a Constructive simulation. By adopting the blended model, regardless of the level of technology through which they are presented, Structured or Serious Games can be classed as a form of instructional simulation if they meet the essential criteria of simulation as identified in Huffam (2010a; 2014). Use of the blended model would allow this example to be classified under “games” within either Virtual (if computer based) or Constructive (highly abstracted activities). The game Impact meets the requirements of being a simulation because the rules of play include the use of an umpire (i.e., neutral arbiter), and it has a discrete introduction or explanation of the rules, roles, and purpose of the event. The game also has action and consequences, which may be immediate or delayed, and the game has an exit function (i.e., a learner can pause play, return to a previous point, stop, or start from the beginning or at a predetermined point; Huffam 2010, 2014). This approach is symmetrical in that it has the ability to present the concepts and the relationships between them at a highly abstract level, while providing sufficient detail in a structured approach that supports a decision making process. Content is presented in context, with the relationship between cause and effect established by the players according to a set of guidelines. This approach prioritizes evidence based information where it is available, and allows for distinction to be made between discrete concepts and related activities. This approach to instructional simulation allows the exploration of content related possibilities in a same, non- threatening environment, and to examine potential secondary and tertiary effects of a technology’s implementation.

The last example to be explored here is the use of synthetic environments for marksmanship training at the Depot Division of the Royal Canadian Mounted Police (RCMP). Common learning convention suggests that the most effective approach to teaching novice firearms users is to learn how to shoot in situ, owing to the perspective that recoil, percussion blast and the smell of gunpowder are critical to learning how to shoot. However, research suggests otherwise (Kratzig, 2013; Kratzig & Hudy, 2011; Kratzig, Parker, & Hyde, 2011). In order to facilitate transfer of learning, there needs to be sufficient similarity between the actions expected of the learner as part of activities represented in simulation and the ability to employ a service pistol effectively and appropriately in the real world of policing. This requires identification of and training in the ability to employ appropriate environmental cues to guide the effective use of an appropriate procedure, as well as learning which cues can be ignored.

The critical skills required of novice shooters are the same in either the live or synthetic environments (Kratzig, 2013). Effective performance in either environment requires shooting accuracy under the pressure of time and at various distances. Differences in the level of fidelity for certain environmental cues, such as lack of recoil, inability to create malfunctions, and lock-back (i.e., rounds depleted and magazine is empty) are often cited as critical considerations (Kratzig, 2013, Kratzig et al, 2011). While on the surface these differences may appear to be significant, in a synthetic range environment the novice shooter and their instructors can focus on learning responses to task critical skills, such as effective sight-alignment, trigger control, grip, stance and breathing, which when mastered, will result in the "bullet going where the shooter wants it, when the shooter wants it to." This application is in line with Thagard's (1992) points, as failure to master these skills in simulation result in a reduced ability to perform effectively under live and real world conditions (Kratzig, 2014). Using a blended model of training (live-simulation) will facilitate the acquisition of the skill through a better understanding of the fundamental required. Through simulation the fundamentals of grip, sight-alignment, trigger control can be explained, taught and demonstrated all without the "noise" of the percussion blast and recoil that comes after the trigger is pulled. Once the skill has been acquired and the learner can demonstrate proficiency based on pre-determined criteria the skill confirmation can occur in a live environment. Confidence with a firearm can then be acquired, as well as skills such as re-acquiring the sight, can then be experienced and reinforced. The traditional method of live training is a good method in which to train, using a blended approach saves time, and develops the learner faster than some traditional methods.

CONCLUSIONS

The objectives of this paper were to impartially identify the known shortcomings of the existing means of classifying instructional simulation, suggest a solution to the problem, and introduce both a methodology for selecting future instructional simulation and a set of metrics that might be used in the future to assess other options. Training is becoming increasingly complex owing to the trend to continually add foundational requirements to novice training while at best maintaining funding at current levels. As a result, the role of simulation in training will become increasingly important if we are to meet current needs, let alone any future requirements that are identified. Instructional simulation should therefore not focus strictly on technology. Technology is a lever. To be effective for teaching, learning and assessment, instructional simulation must instead use technology appropriately, effectively and as economically as possible to accurately represent human activity.

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