

AWARD NUMBER: W81XWH-16-1-0308

TITLE: Design of a Screen-Based Simulation for Training and Automated Assessment of Teamwork Skills

PRINCIPAL INVESTIGATOR: STEADMAN, RANDOLPH H

RECIPIENT: University of California, Los Angeles
Los Angeles, CA 90095

REPORT DATE: August 2017

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

REPORT DOCUMENTATION PAGE		Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.		
1. REPORT DATE August 2017	2. REPORT TYPE Annual	3. DATES COVERED 15 Jul 2016 - 14 Jul 2017
4. TITLE AND SUBTITLE Design of a Screen-Based Simulation for Training and Automated Assessment of Teamwork Skills		5a. CONTRACT NUMBER
		5b. GRANT NUMBER W81XWH-16-1-0308
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Randolph H. Steadman, MD, MS Yue Ming Huang, EdD, MHS, Alan Koenig, PhD, John Lee, PhD, Markus Iseli, PhD, Rukhsana Khan, MPH E-Mail: rsteadman@mednet.ucla.edu		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES) University of California, Los Angeles 11000 Kinross Ave Ste 102 Los Angeles, CA 90095-2000		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT Introduction: While communication and teamwork skills are increasingly recognized as important factors in improving patient safety, team training is not routinely incorporated into training programs, and opportunities to practice teamwork skills and receive objective feedback are limited. We are developing and testing a screen-based team training to provide healthcare professionals deliberate practice on teamwork skills and improve performance through automated, individualized feedback. Methodology: During the past year (year 1) we reviewed the state of the art regarding team training and identified gaps in knowledge and practices through literature review, subject matter expert (SME) interviews and focus group facilitation. Available screen-based training modules and games were identified and reviewed. Results: Over 1500 articles were reviewed, 5 SMEs interviewed and 4 interprofessional focus groups conducted. Interviews revealed a degree of concordance between the views of experts and those in the field: teamwork is valuable and valued, albeit not meeting expectations in many instances. Providing context, repeated practice and feedback are important aspects of implementing teamwork skills. The screen-based game format will provide these elements. Conclusions: Single player games may not be suitable for teaching all teamwork skills; however, teaching every skill is less important than deliberate practice implementing selected skills in context.		

15. SUBJECT TERMS Team training, assessment, screen-based simulation, communication, leadership, situation monitoring, mutual support, psychological safety					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON USAMRMC
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	Unclassified	28	19b. TELEPHONE NUMBER <i>(include area code)</i>

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

TABLE OF CONTENTS

	<u>Page No.</u>
1. Introduction	5
2. Keywords	5
3. Accomplishments	5
4. Impact	11
5. Changes/Problems	12
6. Products	14
7. Participants & Other Collaborating Organizations	16
8. Special Reporting Requirements	20
9. Appendices	21

1. **INTRODUCTION:** Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

While communication and teamwork skills are increasingly recognized as important factors in improving patient safety, team training is not routinely incorporated into graduate training or continuing medical education programs. Opportunities to practice teamwork skills and receive objective feedback are limited. We are developing and testing a screen-based team training to provide healthcare professionals deliberate practice on teamwork skills and improve performance through automated, individualized feedback.

2. **KEYWORDS:** Provide a brief list of keywords (limit to 20 words).

Teamwork training, assessment, screen-based simulation, communication, leadership, situation monitoring, mutual support, psychological safety

3. **ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction.

What were the major goals of the project?

List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

- ❖ Major Task 1. Identify current team training practices, performance gaps, and resources (originally planned mos. 1-6, for revised completion based upon 6-month no-cost extension see below).
- ❖ Major Task 2. Create domain ontology and scenario scripts (originally planned mos. 5-8; for revised completion based upon 6-month no-cost extension see below).
- ❖ Major Task 3. Design a framework for online team training and assessment (originally planned mos. 8-11; for revised completion based upon 6-month no-cost extension see below).
- ❖ Major Task 4. Build the screen-based simulation (*Evaluation and Game-Play Modes*) (originally planned mos. 8-13; for revised completion based upon 6-month no-cost extension see below).
- ❖ Major Task 5. Conduct research using the screen-based simulation (originally planned mos. 6-8, 14-24; for revised completion based upon 6-month no-cost extension see below).

What was accomplished under these goals?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

For the purposes of this report:

Sim Team=Randolph Steadman, Yue Ming Huang, Rukhsana Khan and Maria Rudolph

Education Team=Noreen Webb, Federica Raia, Rachel Lewin and Michael Smith

CASIT (Center for Advanced Surgical & Interventional Technology) Team=Areti Tillou and Yen-Yi Juo

CRESST (Center for Research on Evaluation, Standards & Student Testing) Team=Alan Koenig, John Lee, Markus Iseli and Charles Parks

- ❖ Major Task 1. Identify team training practices, performance gaps and resources (mos. 1-14).
 - Subtask 1: Review research on existing team training literature, available products and best practices: 100% completed.
 - The purpose of this review was to examine existing literature, research, products, software, and tools to identify current team training practices and performance gaps during high stakes medical team activities. The review focused on areas of research that would be helpful for curricular framework and design of this project's screen-based simulation for training and automated assessment of teamwork skills.
 - We focused on the following topics: teamwork dimensions for team training, effectiveness of team training in healthcare, measuring acquisition of teamwork knowledge and skills, impact of teamwork training on teamwork knowledge and skills, teamwork attributes that are challenging to represent in a single player screen-based healthcare simulation, methods of simulation-based teamwork training, design issues related to authenticity of screen-based simulations, feedback and debriefing in simulated teamwork settings, screen-based simulations versus high fidelity simulators, and screen-based simulations teaching teamwork in medical settings.
 - Major findings for this review will be summarized in Subtask 5, along with a description of the methodology used.
 - Subtask 2: Perform video analysis of medical teams in action: 100% completed.
 - Videos of critical incidents (real and simulated) were reviewed by all members of the research team.
 - Videos were used to develop consensus of what the observable, assessable teamwork actions are in critical care.
 - Challenges were categorized into the following areas of opportunity for improvement: a) communication issues as they relate to noise control, handoffs, closed-loop communication, leadership and anticipating/sharing plan; and b) process issues related to role clarity and delegation.
 - Subtask 3: Interview Subject Matter Experts (SMEs) and healthcare practitioners. 100% completed.
 - The purpose of the SME interviews was to gather information from team training experts to help ascertain the strengths, weaknesses and limitations of teamwork training approaches and factors that contribute to the breakdown of teamwork processes. The research team also solicited input from SMEs on the proposed team training framework and core teamwork skills that will be incorporated in the screen-based simulation game.
 - The interviews were conducted in a semi-structured format and led by Michael Smith, due to his expertise in applied linguistics.

- We interviewed the following team training subject matter experts: David Gaba, MD, creator of Anesthesia Crisis Resource Management; David Baker, developer of TeamSTEPPS; Andrea Amodeo, TeamSTEPPS researcher; and John Holcomb, MD, a combat surgery expert. Although not formally named as an SME on this grant, the team also interviewed Christopher Hund, Director of Clinical Quality for the Health Research & Educational Trust (HRET) due to his expertise in directing TeamSTEPPS projects.
- Close analysis of the SME interviews helped inform the research team on the following: which context is teamwork crucial, what skills are important for high acuity settings, what undermines teamwork, traits and practices for a “good” team player, challenges to teaching teamwork, advantages and pitfalls of TeamSTEPPS, educational tools for teaching teamwork and military implications that affect teamwork.
- Major findings from SME interviews will be summarized in Subtask 5.
- Subtask 4: Conduct/analyze focus groups of healthcare teams: 100% completed.
 - The purpose of the focus group interviews was to gather honest impressions about teamwork and communication from healthcare professionals who work in team settings at Ronald Reagan UCLA Medical Center. The intention was to have a conversation with front-line medical personnel about their personal experience as a team leader/ and or supportive team member, in order to help inform our game development.
 - Four focus group interviews took place between June of 2017 and July of 2017. All interviews were audio recorded with consent from participants. Rachel Lewin and Maria Rudolph conducted the interviews; Ms. Lewin was the primary interviewer, while Ms. Rudolph took notes. Focus groups were comprised of 3-6 front-line medical personnel, including Emergency Medicine and Internal Medicine physicians, respiratory therapists, and nurses from the ICU and Trauma Surgery.
 - A few recurrent themes were gathered from the interviews including introduction styles from team members, roles/structure of teams, psychological safety to encourage feedback, and clear communication. A formal narrative of findings will be included under Subtask 5.
- Subtask 5: Prepare report of current practices and gaps in team training. 90% completed.
 - Information gathered from SME and healthcare team interviews is being compiled into the full report. We anticipate having a completed report in month 14 (September 2017).
- ❖ Major Task 2. Create domain ontology and scenario scripts (mos.5-21).
 - Subtask 1: Create team training core skills domain ontology: 100% completed.
 - Following completion of video review, the Sim, CASIT and CRESST team began meeting weekly to create a list of all possible assessable teamwork actions pertinent to patient care. This list forms a pool that will inform the assessable actions that will be selected for use in the screen-based simulation.
 - A final version of the domain ontology was developed based on the assessable teamwork skills and actions that were identified. Since the last quarterly report, a few modifications regarding the relationship between certain actions and teamwork skills have been made. See file “Team Training Ontology v3” in Appendices section.

- Subtask 2: Create a set of features, affordances, and actions for user interface: 100% completed.
 - Using the game development software, Unity, an early test environment for the game was developed to highlight potential interactivity elements (Parks).
 - Acquired 3D assets (game avatars) including hospital room and medical personnel (Huang).
 - Created a test environment for recognizing speech on a Macintosh computer (Koenig).
 - Working on modes of interactivity for the user interface (e.g., how to direct communication to the desired avatar).
 - Currently working on programming a mock-up of the first scenario for presentation to the research team for feedback on interactivity elements and sequencing of events (Parks)
 - Developed an Action Level Ontology that includes possible actions and the related game mechanics. See file “Team Training Ontology - Action Level Ontology” in Appendices section (Iseli, Koenig, & Lee).
- Subtask 3: Create a range of scenario settings/events: 90% completed.
 - A subset of the research team composed of the Sim Team and CRESST, met to establish the learning objectives, setting, sequence of events and player affordances for the first scenario of the game.
 - It was decided that the first scenario would focus on teaching leadership and communication in the setting of the trauma bay with a patient involved in a motor vehicle accident (MVA), who also has a femur fracture.
 - An inventory of skills appropriate for the scope of practice for the roles of the player and non-player characters (NPCs) for this first scenario was also created.
- Subtask 4: Create a knowledge assessment (baseline team skills) scenario: 75% completed.
 - The baseline scenario (MVA) will serve as a pretest for player/student Knowledge, Skills and Abilities (KSAs); assessing the player’s knowledge and skills related to teamwork without any feedback until after scenario completion.
- Subtask 5: Create 3 scenarios with different settings, events and skill requirements: 30% completed.
 - The research team brainstormed a series of events and skill requirements to be incorporated in the game. As stated under Subtask 3 above, the learning objectives, setting and sequence of events for the first scenario of the game has been created.
 - The team is currently working on establishing the possible branching points the player may take should they not follow the optimal sequence of events delineated.
 - Subsequent scenarios are currently in development, and are following the same model and structure used for this first scenario. We will incorporate the information gathered from the SME and focus group interviews into each of these subsequent scenarios.
 - All scenarios include the same basic and advanced teamwork skills, including conflict resolution (under leadership and mutual support).
- ❖ Major Task 3. Design a framework for online team training and assessment (mos. 8-16).
 - Subtask 1: Design the automatic assessment engine: 80% completed
 - A Bayesian Network (BN) has been created from the ontologies. The BN is used to infer competencies related to the teamwork skill constructs. The main constructs (top level nodes) include: leadership, situation monitoring, communication, mutual support, and conflict resolution. At the observable level, there are the types of actions the player can take and the components of each action that the simulation captures and scores. See file named “Bayesian Network of Teamwork Skills” in Appendices section.

- Subtask 2: Design the simulation interface: 80% completed.
 - Gameplay mode: The simulation interface includes several affordances through which the player can carry out various actions, along with a text input for spoken dialogue (note: this will incorporate natural language processing for relating text to game actions)
 - Evaluation mode: The interface will look mostly similar to the Gameplay mode, with differences being this will have video controls to play and pause the scenario, along with an interface for the player to provide written comments about noteworthy teamwork skills observed (correctly or incorrectly).
- Subtask 3: Design the after-action reporting: 80% completed.
 - Player performance will be presented and explained, including evaluation of player actions with descriptive feedback, and general instruction on the specific team skills required in the game scenario.
- Subtask 4: Pilot storyboard workflows for quality assurance piloting: 75% completed.
 - Storyboarding is complete; currently vetting with medical SMEs.
- ❖ Major Task 4: Build screen based simulation (Evaluation and Gameplay modes) (mos. 8-21).
 - Subtask 1: Develop software specifications: 70% complete.
 - Agile development of software specifications based on use-cases, with specific associated development sub-tasks. Process consists of Specify -> Develop -> Test -> Iterate/Refine, which inter-links Subtasks 1, 2, and 3.
 - Subtask 2: Develop software-based prototype of two simulation modes: 40% complete.
 - Development is occurring using an agile development methodology (see Subtask 1, above).
 - Due to unanticipated personnel shortfalls, we are behind schedule on the programming. To mitigate the risk this poses to our schedule, we are in the process of hiring additional programming help. We are also preparing a request for a no-cost extension of six months.
 - Subtask 3: Perform software testing for quality assurance: 40% complete.
 - Testing is occurring using an agile development methodology (see Subtask 1, above).
- ❖ Major Task 5. Conduct research using the screen-based simulation (mos. 6-8, 21-30).
 - Subtask 1: Obtain IRB approval from UCLA and USAMRMC HRPO: 100% completed.
 - We submitted the UCLA IRB application in December 2016 and received approval on February 15, 2017. We also submitted a Protocol Submission Form for USAMRMC HRPO on March 28, 2017 and received approval on May 11, 2017. No study activities have taken place yet.

What opportunities for training and professional development has the project provided?

If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. “Training” activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. “Professional development” activities result in increased knowledge or skill in one’s area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Nothing to Report.

How were the results disseminated to communities of interest?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

Nothing to Report.

What do you plan to do during the next reporting period to accomplish the goals?

If this is the final report, state “Nothing to Report.”

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

The research team plans to continue holding weekly full team meetings to meet the goals of the project. A subset of the research team has been holding separate weekly meetings to focus on game development and will continue to hold these meetings to accomplish this goal. We are also in the process of hiring additional programmers (at no extra cost) to advance progress in building the screen-based simulation.

4. **IMPACT:** Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

Nothing to Report.

What was the impact on other disciplines?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

We anticipate that this study will inform the defense community and private sector on the effectiveness of screen-based simulation for teamwork skills training of healthcare providers. We also hope to provide the design methodology for the development of screen-based simulation training on other topics and for other disciplines.

What was the impact on technology transfer?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

Nothing to Report.

What was the impact on society beyond science and technology?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

Nothing to Report.

- 5. CHANGES/PROBLEMS:** The Project Director/Principal Investigator (PD/PI) is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, “Nothing to Report,” if applicable:

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes.

Remember that significant changes in objectives and scope require prior approval of the agency.

Nothing to Report.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

We have found that establishing the details and sequence of events for scenarios has taken longer than expected, thus have tasked a subset of the research team to meet weekly to make progress in this area. We are also behind in game programming due to unanticipated personnel shortcomings. To mitigate the risk of falling behind schedule, we are in the process of hiring additional programmers (at no extra cost). Programming funds are being reallocated to result in no change in programming costs. One programmer is already in position and the source for a second additional programmer has been identified. The second programmer will be onboarded in the next 4 weeks. We are also creating a programming task list with timeline and dependencies to ensure timely completion of tasks. Programmers will also be assigned stand-alone tasks to optimize work. Lastly, we are in the process of preparing a 6-month no-cost extension request to ensure completion of the project and have modified our timeline accordingly.

Changes that had a significant impact on expenditures

Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

Nothing to Report.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

Nothing to Report.

Significant changes in use or care of vertebrate animals.

Nothing to Report

Significant changes in use of biohazards and/or select agents

Nothing to Report

6. PRODUCTS: List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state “Nothing to Report.”

- **Publications, conference papers, and presentations**

Report only the major publication(s) resulting from the work under this award.

Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume; year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to Report.

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Abstract submitted on 8/24/2017 to American Educational Research Association (AERA) 2018 Annual Meeting. Currently under review and we anticipate status of acceptance on 11/2/2017. See file “AGILE Methodology for Developing a Game-Based Assessment of Teamwork Skills” in appendices section below.

Authors: Alan Koenig, PhD, John Lee, PhD, Markus Iseli, PhD and Randolph Steadman, MD, MS

Title of Abstract: AGILE Methodology for Developing a Game-Based Assessment of Teamwork Skills

Other publications, conference papers, and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

Nothing to Report.

- **Website(s) or other Internet site(s)**

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to Report.

- **Technologies or techniques**

Identify technologies or techniques that resulted from the research activities. In addition to a description of the technologies or techniques, describe how they will be shared.

Nothing to Report.

- **Inventions, patent applications, and/or licenses**

Identify inventions, patent applications with date, and/or licenses that have resulted from the research. State whether an application is provisional or non-provisional and indicate the application number. Submission of this information as part of an interim research

performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Nothing to Report.

- **Other Products**

Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment, and/or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

- *data or databases;*
- *biospecimen collections;*
- *audio or video products;*
- *software;*
- *models;*
- *educational aids or curricula;*
- *instruments or equipment;*
- *research material (e.g., Germplasm; cell lines, DNA probes, animal models);*
- *clinical interventions;*
- *new business creation; and*
- *other.*

Nothing to Report.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source

of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate “no change.”

Example:

Name: Mary Smith
Project Role: Graduate Student
Researcher Identifier (e.g. ORCID ID): 1234567
Nearest person month worked: 5

Contribution to Project: Ms. Smith has performed work in the area of combined error-control and constrained coding.
Funding Support: The Ford Foundation (Complete only if the funding support is provided from other than this award).

Name: Randolph Steadman, MD, MS
Project Role: Principal Investigator
Researcher Identifier: N/A
Nearest person month worked: 2.7
Contribution to Project: Dr. Steadman has performed work in the area of literature and product review, video analysis. He serves as clinical content expert for development of game scenarios. He has also provided direction and oversight of the project as principal investigator.

Name: Yue Ming Huang, EdD, MHS
Project Role: Co-Investigator; Project Manager
Researcher Identifier: N/A
Nearest person month worked: 1.8
Contribution to Project: Dr. Huang has overseen the administration and management of the project. She has also performed work in the area of literature and product review, video analysis and provided input for game design and objectives.

Name: Rukhsana Khan, MPH
Project Role: Research Assistant
Researcher Identifier: N/A
Nearest person month worked: 2.28
Contribution to Project: Ms. Khan has provided assistance in project management. She has also performed work in the area of literature and product review, video analysis, game development and completion of IRB application.

Name: Noreen Webb, PhD
Project Role: Co-Investigator
Researcher Identifier: N/A
Nearest person month worked: 2.88
Contribution to Project: Dr. Webb has performed work in the area of literature and product review, video analysis and provided input for game design and objectives. She has also helped write the literature review report.

Name: Federica Raia, PhD
Project Role: Co-Investigator
Researcher Identifier: N/A

Nearest person month worked: 3.0

Contribution to Project: Dr. Raia has performed work in the area of literature and product review, video analysis and provided input for game design and objectives. She has also helped write the literature review report.

Name: Michael Smith
Project Role: Graduate Student Researcher
Researcher Identifier: N/A

Nearest person month worked: 3.0

Contribution to Project: Mr. Smith has performed work in the area of literature and product review, video analysis and provided input for game design and objectives. He also led subject matter expert interviews and helped write a summary of those findings.

Name: Rachel Lewin
Project Role: Graduate Student Researcher
Researcher Identifier: N/A

Nearest person month worked: 2.88

Contribution to Project: Ms. Lewin has performed work in the area of literature and product review, video analysis and provided input for game design and objectives. She also led focus group interviews of healthcare teams and helped summarize those findings.

Name: Markus Iseli, PhD
Project Role: Co-Investigator
Researcher Identifier: N/A

Nearest person month worked: 1.5

Contribution to Project: Mr. Iseli has helped plan and design the domain ontology and screen-based simulation interface.

Name: Alan Koenig, PhD
Project Role: Co-Investigator
Researcher Identifier: N/A

Nearest person month worked: 2.15

Contribution to Project: Dr. Koenig has provided leadership over the planning and design of the domain ontology and screen-based simulation interface.

Name: John Lee, PhD
Project Role: Co-Investigator
Researcher Identifier: N/A

Nearest person month worked: 1.35

Contribution to Project: Mr. Lee has managed the CRESST team's deliverables specifically pertaining to the design and development of domain ontology and screen-based simulation interface. He also contributed to the completion of the IRB application.

Name: Charles Parks
Project Role: Programmer
Researcher Identifier: N/A
Nearest person month worked: 7.08
Contribution to Project: Mr. Parks has performed work in framework design and programming test environments for the screen-based simulation game.

Name: Yen-Yi Juo, MD
Project Role: Research Fellow
Researcher Identifier: N/A
Nearest person month worked: 2.04
Contribution to Project: Dr. Juo has provided clinical direction in the development of potential game scenarios and its objectives.

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to Report.

What other organizations were involved as partners?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.

Provide the following information for each partnership:

Organization Name:

Location of Organization: (if foreign location list country)

Partner’s contribution to the project (identify one or more)

- *Financial support;*
- *In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);*
- *Facilities (e.g., project staff use the partner’s facilities for project activities);*
- *Collaboration (e.g., partner’s staff work with project staff on the project);*
- *Personnel exchanges (e.g., project staff and/or partner’s staff use each other’s facilities, work at each other’s site); and*
- *Other.*

Nothing to Report.

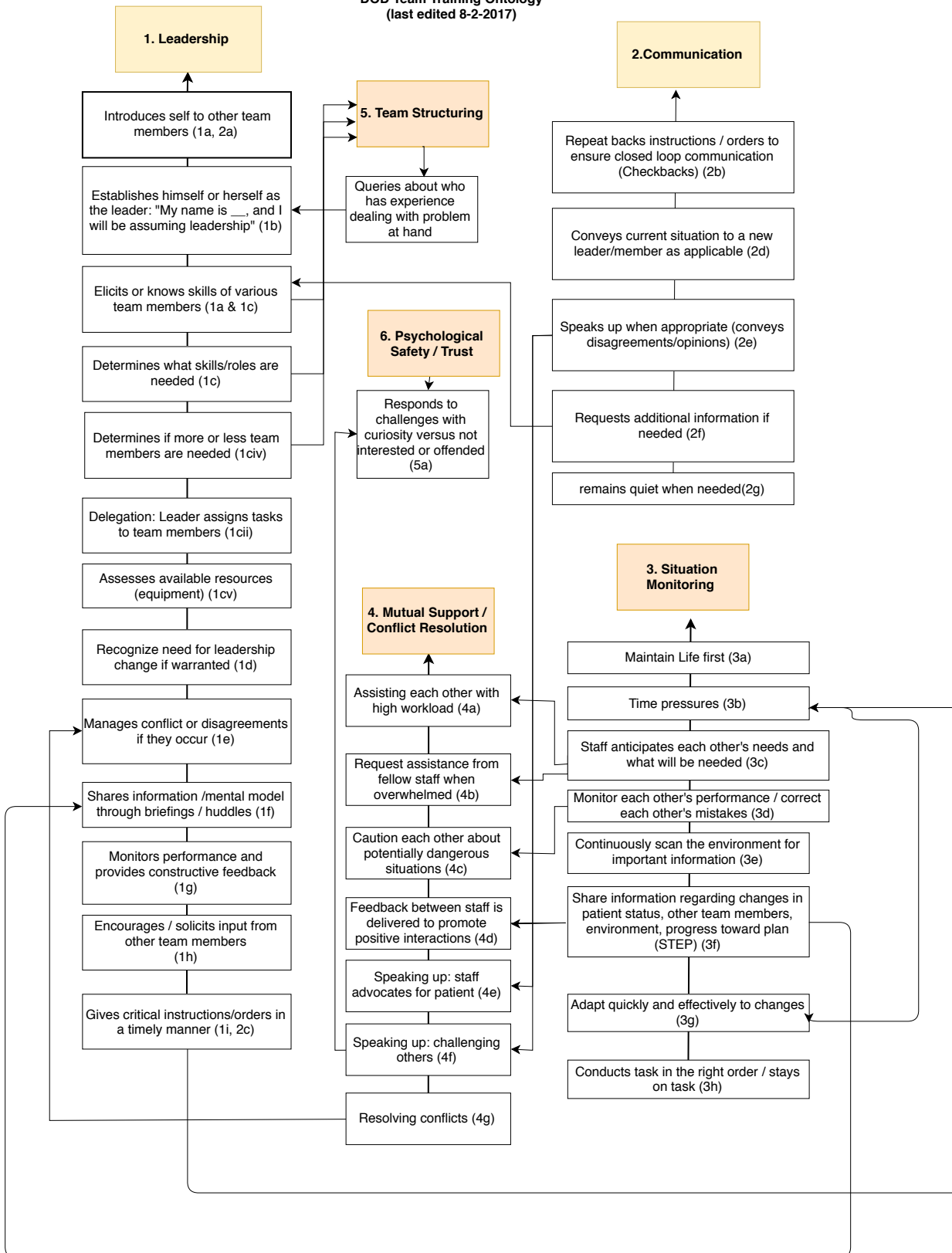
8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: For collaborative awards, independent reports are required from BOTH the Initiating PI and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to <https://ers.amedd.army.mil> for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on <https://www.usamraa.army.mil>) should be updated and submitted with attachments.

9. **APPENDICES:** Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.

DOD Team Training Ontology
(last edited 8-2-2017)



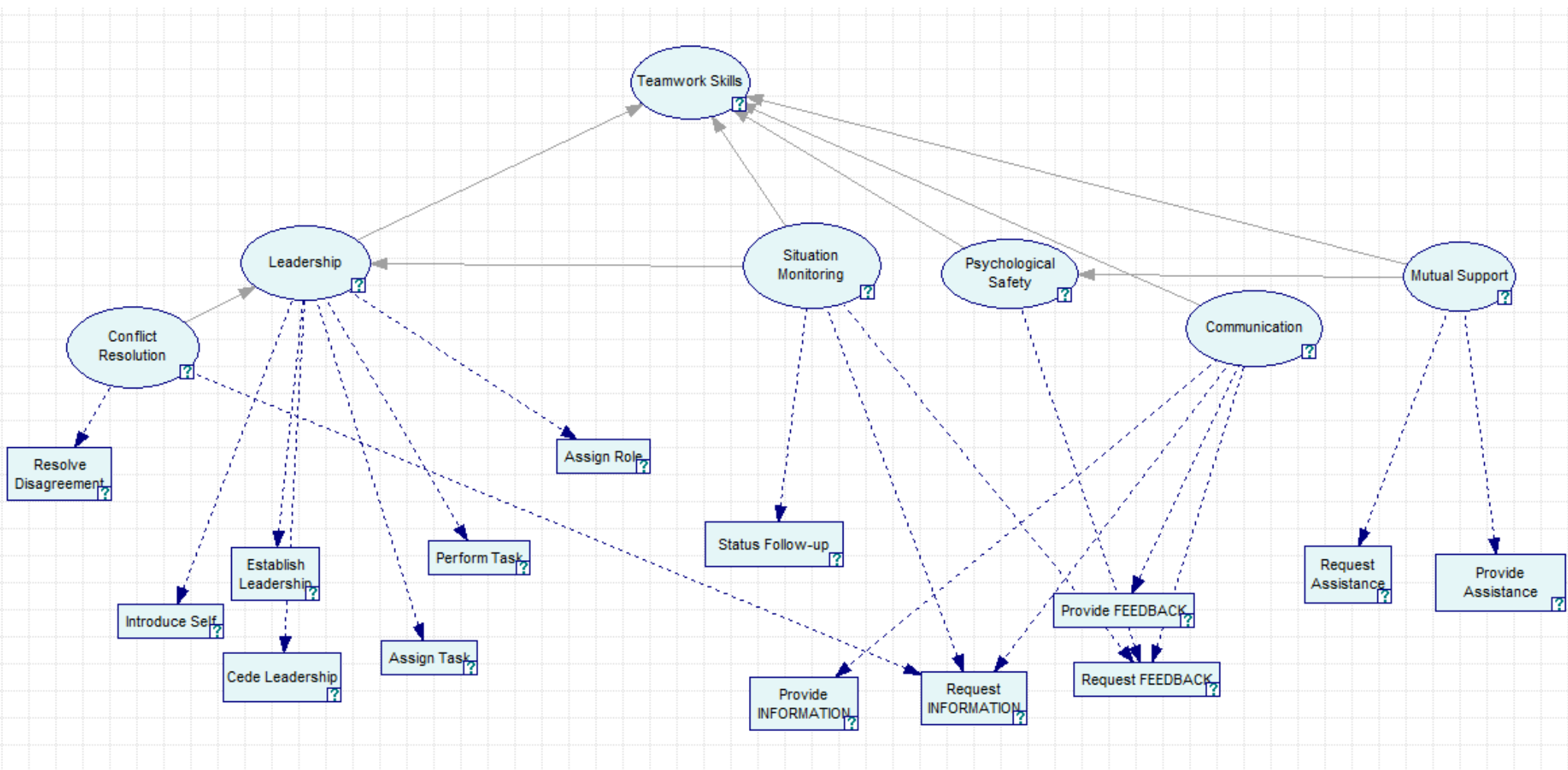
Team Training Ontology - Action Level Ontology

ActionID	Description: Player...	Category	Available Action	Game Mechanics	
PCintroducesSelf	introduces him/herself	Supply information	Introduce Self	click on "address all" button, free text	
PCassumesLead	assumes leadership role, makes their role clear	Supply information	Assume Leadership	click on "address all" button, free text	
PCcedesLead	relinquishes leadership role	Supply information	Relinquish Leadership	click on "address all" button or on NPC, free text	
PCassignsTasksRoles	assigns tasks to team member(s)			click on NPC, select task from menu "do X"	
PCreassignsTasksRoles					
PCperformsAssignedTask	performs task that has been assigned to him/her			click on "do myself" button, select task from menu "do X"	
PCrequestsInfo	requests information from or consults with people (inside/outside of team, family member) or other resources (e.g. game)	Request information	Get Information	click on NPC, select from menu "ask me" or "ask me face-to-face", free text	
PCprovidesInfo	tell team members about status of patient/situation, express what you are thinking, etc. compare with PCbriefsNPCs	Supply information	Provide Information	click on "address all" button or on NPC, free text	
PCanswersQuestion -> PCprovidesFeedback	answers questions from team members	Supply information	Answer Questions		
PCprovidesFeedback	gives feedback to other team member(s) (e.g. "well done!", "next time, please make sure you look at the monitor when doing ..."), answers questions, ...	Supply information	Provide Feedback		
PCencouragesFeedback	elicits feedback	Supply information	Encourage Feedback		
PCfollowsUpOnIncompleteTasks	follows up on incomplete tasks (e.g. by reassigning tasks, doing tasks him/herself, or taking other corrective action)	Request information		depends on next action chosen	
PCfollowsUpOnIncompleteInformation	follows up on incomplete information (e.g. if information was given but incomplete)	Request information	Clarification	depends on next action chosen	
PCbriefsNPCs	briefs team members (e.g. with the help of team members, player assesses situation and makes a plan) Short session prior to start to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies	Supply information	Brief	click on "address all" button, select from menu "brief", choose text from multiple-choice menu	
PChuddlesWithNPCs	huddles with team members (e.g. player initiates information sharing with team members and adapts plan if necessary)	Supply information	Huddle	click on "address all" button, select from menu "huddle", choose text from multiple-choice menu	
PCdebriefsNPCs	debriefs team members (e.g. After action review: PC states/reflects what went well and what could be improved) Informal information exchange session designed to improve team performance and effectiveness through lessons learned and reinforcement of positive behaviors	Supply information	Debrief	click on "address all" button, select from menu "debrief", enter free text	
PCobjects	objects (speaks up) to other team members (e.g. to prevent a possible mistake)	Supply information	Object / Speak up		
PCprovidesHelpToNPCs	provides help to other team members	Supply information	Provide help		
PCvoluntarilyPerformsTask	performs task on own initiative (e.g. player sees that nobody was assigned to do a needed task, thus player performs task him/herself)			click on "do myself" button, select task from menu "do X"	
PCpositionChange	changes his/her position in room (e.g. to get perform a task, to have a better vantage point, to make room for other team members, etc.)			should be based on movement in the physical space (e.g., foot of bed, or elsewhere)	
PCasksForAssistance	requests assistance from other team member	Help seeking			
PCasksLeaderForPermission	if PC is not the leader, asking the leader for permission	Request information	Ask Leader for Permission		
These player actions will be scored on a selection of the following dimensions:					
appropriateness (i.e. was the action required or would another action have been a better choice? was the action helpful?)					

Team Training Ontology - Action Level Ontology

ActionID	Description: Player...	Category	Available Action	Game Mechanics	
	timeliness (i.e. was the timing of the action ok?)				
	appropriate addressee (i.e. if the action was related to communication with another team member: Was the communication addressed at the appropriate member or would another member have been a better choice?)				
	manner (i.e. if the action was related to communication with another team member: Was the communication made in a polite, respectful, and/or supportive manner? or Did the player make eye-contact with the addressee?)				
	quality (i.e. was information complete, accurate, was action done vountary without being asked)				

Bayesian Network of Teamwork Skills



AGILE Methodology for Developing a Game-Based Assessment of Teamwork Skills

Team training using synthetic, software-based environments – whether as the primary modality, or as an augment to in-person, classroom-style training – is highly desirable to educators. Indeed, a cornerstone to developing effective team management and behavioral skills is having the ability to practice those skills in fidelity-relevant settings (McGaghie et al., 2011). However, while in-person, role-playing modes of pedagogy can be beneficial, they are not always practical nor desirable, as limitations on environment, resources, personnel, and other deficiencies to authenticity can limit the validity to such exercises. In contrast, synthetic environments in the form of computer-based games or simulations can provide robust, authentic settings in which to teach, practice, and assess team skills using scenario features & resources deliberately aligned to instructional and assessment objectives (Nyssen et al., 2002; Schwid et al., 2001; Kreutzer et al., 2016).

But while the benefits of using simulation to teach and assess team skills are well understood (Rosen et al., 2008), the functional implementation of a synthetic environment tailored to support specific team-training pedagogy is not a trivial undertaking. Indeed, not only must the simulation properly represent the relevant constructs and features of the domain (e.g. an emergency room in a hospital with relevant personnel, equipment, patient information, etc.), but it also must overlay varied and modifiable human traits and behaviors resident within each of the synthetic team members. Furthermore, the training and assessment arising from the simulation must be able to distinguish and decouple a player's domain knowledge & skill with their skills specifically pertaining to teamwork proficiency.

In this paper, we describe a methodology employed in the design and development of just such a simulation used to train and assess medical personnel to more effectively function in ad-hoc teams in critical-care situations. Although this effort did result in the development of sophisticated, interactive game-style software, this paper's focus is on the process and methodology employed in the development, rather than on the end-product itself. Specifically, we present a process that addressed competing stakeholder perspectives and requirements – i.e. that of educators focused on instructional and assessment design of team training, and that of medical personnel focused on performance criteria of a player's (and team's) medical actions and decision-making.

Like with the development of so many pedagogical games and simulations, educators can find themselves at odds with the subject matter experts and stakeholders for whom they are building training. To address this, our team of educators and medical personnel utilized an AGILE-inspired development methodology - highly iterative in nature, breaking tasks into small, chunk-sized modules that could be built, tested, and refined, and in which all stakeholders maintained an active involvement from the project's start to finish (Douglass, 2016). This had the benefit of not only teasing out, designing, and testing ideas in rapid fashion, but provided an efficient platform for incorporating competing stakeholder requirements, and allowed unforeseen issues to surface early, with opportunities for low-cost corrective action. This

approach offers utility not only to team training simulation, but to any pedagogical simulation development.

References

- Douglass, B. P. (2016). Chapter 2 – What Are Agile Methods and Why Should I Care? In *Agile Systems Engineering* (pp. 41–84). <http://doi.org/10.1016/B978-0-12-802120-0.00002-3>
- Kreutzer, C., Marks, M., Bowers, C., & Murphy, Curtiss. (2016). Enhancing Surgical Team Performance with Game-Based Training. *International Journal of Serious Games*, 3(1), 43–52.
- McGaghie, W. C., Issenberg, S. B., Cohen, M. E. R., Barsuk, J. H., & Wayne, D. B. (2011). Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Academic medicine: journal of the Association of American Medical Colleges*, 86(6), 706.
- Nyssen, A.-S., Larbuisson, R., Janssens, M., Pendeville, P., & Mayné, A. (2002). A comparison of the training value of two types of anesthesia simulators: computer screen-based and mannequin-based simulators. *Anesthesia & Analgesia*, 94(6), 1560–1565.
- Rosen, M. A., Salas, E., Wilson, K. A., King, H. B., Salisbury, M., Augenstein, J. S., ... & Birnbach, D. J. (2008). Measuring team performance in simulation-based training: adopting best practices for healthcare. *Simulation in Healthcare*, 3(1), 33-41.
- Schwid., H. A., Rooke, G. A., Michalowski, P., & Ross, B. K. (2001). Screen-Based Anesthesia Simulation With Debriefing Improves Performance in a Mannequin- Based Anesthesia Simulator. *Teaching and Learning in Medicine*, 13(2), 92–96.

Award Number: W81XWH-16-1-0308



Award Amount: \$1,148,000

- Aim 1:** Identify team training practices, performance gaps and resources
- Aim 2:** Create domain ontology (necessary actions, decisions and their inter-relationships) and scenario scripts
- Aim 3:** Design a framework for online team training and assessment
- Aim 4:** Build screen-based simulation (evaluation and game-play modes)
- Aim 5:** Conduct research study using the screen-based simulation

A literature review will identify gaps in team training, limitations of current training methods and essential behavioral skills. This phase will identify the core teamwork skills that will be the focus of the simulation-based systems we develop. We will then create the ontology and scenario scripts and conceptualize the framework for the screen-based simulation. Finally, we will evaluate the training effectiveness and user interface of the screen-based simulation systems.



Image of proof of concept/prototype

Accomplishment: Since the last submission on 4/14/2017, we have made progress in the development of our screen-based simulation system; finalizing the domain ontology and establishing learning objectives and sequence of events for our first scenario. We have also completed the team training literature review and SME and focus group interviews.

[illegible]

- ✓ Literature and video review
- ✓ Interview subject matter experts and focus groups

- ☐ Complete domain ontology and study scenarios
- ☐ Complete framework design for online team training and assessment
- ☐ Complete programming of the interactive environment
- ☐ Recruit subjects to test screen-based simulation

- ☐ Continue to recruit subjects
- ☐ Perform qualitative and quantitative data analysis

Encountered delays in programming and scenario development.
Timeline adjusted with 6-month no-cost extension (request in progress).

Projected Expenditure: \$1,148,000

Actual Expenditure: \$478,559.19

Updated: (08/11/2017)