

Early Synthetic Prototyping: When We Build It, Will They Come?

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ABSTRACT

One of the challenges facing the Army today is the ability to explore innovative concepts and capabilities in a resource constrained environment to develop materiel, doctrinal, and organizational solutions for the future force. Early Synthetic Prototyping (ESP) is a process and a set of tools that will enable Soldiers and technologists to rapidly assess how technologies might be employed within a game environment. ESP is envisioned to be a persistent game network that allows Soldiers to play scenarios and provide experiential feedback to concept and capability developers. An operational test has been conducted that leveraged VBS3 to explore four future concepts: Virtual Pointer, Counter Unmanned Aerial System, Aerial Resupply, and the Next Generation Close Combat Vehicle A total of 76 Soldiers participated in the test. The test allowed the prototyping of ESP tools and processes, along with answering three primary questions: (1) What games do Soldiers play in their off-duty time and what devices do they use? (2) What would motivate Soldiers to participate in ESP on their own time? (3) How valuable is their qualitative feedback and game data to concept and capability developers? The results of this test were encouraging and overwhelmingly positive. More than 85% of Soldiers play military-themed games in their off duty hours; more than half of the Soldiers play more than 10 hours of military-themed games each week. Most Soldiers stated they would participate in ESP on their off duty hours and their biggest motivation to participate is knowing they are helping shape the future of their Army. The qualitative feedback indicates Soldiers are able to provide insightful feedback about materiel, organizational, and doctrinal solutions. The results of this study show there is strong potential that ESP will not only be a great way for concept and capability developers to gain meaningful feedback from end users but is also an environment Soldiers relate with and can innovate solutions. This paper describes the test procedure, analysis of the results, lessons learned, and recommendations for future development. Insights are generalizable to understand how to engage service members in their off-duty hours through gaming solutions. The results of this test gained the attention and support of senior leaders in ARCIC and TARDEC. Continued research needs to refine the ESP method and to determine the best way to extract and visualize both qualitative and quantitative data from the composite data collected from thousands of Soldiers.

ABOUT THE AUTHORS

Brian Vogt, LTC USA was commissioned an Armor Officer in 1996. He served as an armor officer in several leadership positions and commanded a tank company and headquarters company in two separate tours in Baghdad. He served as a simulations operations officer since 2006 at Ft. Leavenworth, KS as a simulations analyst for the SE Core program. He is a graduate of the Armor Officer Basic Course and Advanced Course, Combined Arms Services Staff School, Command and General Staff College, and the Naval Postgraduate School where he earned a MS in Modeling, Virtual Environments, and Simulations. He is currently serving as the Early Synthetic Prototyping project leader at the Army Capabilities Integration Center, Ft Eustis, VA.

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INTRODUCTION

The recently published Army Operating Concept (AOC) (2014) states, "...innovation is critical, both for the operational and the institutional Army, and the AOC is a beginning point for the innovation we need to ensure that our Soldiers, leaders, and teams are prepared to win in a complex world." (U.S. Army, 2014) More specifically the AOC states that, "The tenet of innovation challenges us to anticipate changing conditions to ensure that Army forces are manned, trained, and equipped to overmatch enemies in order to seize, retain, and exploit the initiative." (U.S. Army, 2014) The AOC addresses how the Army will facilitate innovation through Force 2025 Maneuvers; "Using the Army Warfighting Challenges as the analytical framework, the Army conducts Force 2025 Maneuvers to develop concepts, operational and organizational plans, DOTMLPF solutions... Force 2025 Maneuvers allows the Army to translate big ideas (such as, logistics demand reduction; integration of robotics and autonomy-enabled systems; and leader, Soldier, and team optimization) into concrete actions to improve the future force." (U.S. Army, 2014) Specifically, Army Warfighting Challenge #20, Develop Capable Formations (How to design Army formations capable of rapidly deploying and operating to achieve missions across the range of military operations) describes the need to harness the creativity and problem solving skills of the current force to shape the future Army through innovation.

Early Synthetic Prototyping (ESP) is envisioned to allow Soldiers to assess future concepts and capabilities in a game environment available to them on and off duty. Soldier assessment from the game environment will be used to inform materiel solution research as well as doctrine and force organization development. ESP will help the Army win in a complex world because it will greatly enhance the communications between engineers and Soldiers. Engineers often lack a deep understanding of how new material may be used and what performance is needed. At the same time, Soldiers gain an early understanding of potential new technologies for the U.S. Army and how a future enemy might exploit the same.

More specifically, ESP is envisioned to link Soldiers to engineers, scientists, and capability developers. First, concept and capability developers, as well as scientists and engineers from across the Army will postulate various doctrine, organization, and materiel solutions. These ideas are then modeled in the game environment with an appropriate amount of detail. Scenarios are created that specifically address what the Army wants to learn about the postulated solutions. For example, the Army may want to explore how future platoons should be equipped and employed in a jungle environment against a near-peer threat. The game is distributed to Soldiers across the Army and they are able to learn how to use and modify the equipment in single-player missions before engaging in multi-player scenarios against other Soldiers. Some Soldiers will play as an opposing force and some will play as the U.S. player. Following each scenario, the players are able to provide feedback about what they liked/disliked and provide recommendations. Additionally, the game server will collect game data for analysis. This process is intended to repeat continuously with changing equipment, scenarios, organization, goals, rules, and objectives.

There are several perceived advantages of incorporating ESP into the concept and capability development process. First, ESP allows Soldier feedback early in the development process where design changes are significantly less expensive in terms of resources, time, and money. Second, ESP allows orders of magnitude more design options to be explored in a crowd-source game environment because Soldiers could make changes in model performance in a game environment in a short period of time whereas physical prototyping could take weeks, months, or years to change a physical prototype's characteristics. Third, the ESP process enables the Army to develop a greater understanding of the problem while developing a greater understanding of potential solutions that span materiel (capabilities), doctrine (force employment), and organization (force organization) considerations.

While the perceived advantages of ESP are encouraging, there are three fundamental questions that need to be addressed before ESP is integrated into the concept and capability development process. First, what games do Soldiers play in their off-duty time and what devices do they use? Second, what would motivate Soldiers to participate in ESP on their own time? Third, how valuable is their qualitative feedback and game data to concept and capability developers?

METHOD

An ESP operational test was conducted at the Brigade Modernization Command (BMC) in December 2014. This test included 76 Soldiers. Figures 1 and 2 show the breakdown of Soldier rank (pay grade) and years in service. The median rank was Specialist (E4) with 2.3 years of service. The participants also included females (14%) at roughly the same percentage as the Army as a whole.

The parent unit leadership selected the participants. Therefore, there is some question whether the participants were a representative sample of the Army as a whole. Regardless, the participants represented multiple military occupational specialties (MOS) typically found in Army brigade combat teams. The represented MOS's included intelligence analysts, cavalry scouts, infantrymen, medics, artillerymen, mechanics, armor crewmen, combat engineers, and communication specialists.

The pilot study focused on four technologies from various RDECOM partners, Class 1A Next Generation Close Combat Vehicle (NGCCV), Virtual Pointer, Autonomous Areal Resupply, and Counter Unmanned Aerial System (UAS). These four systems were selected for the test because they represent capabilities that are undergoing research and development at some level from multiple RDECOM organizations. Additionally, the participants did not have any previous experience with these specific capabilities that would influence their feedback during the test.

Testing was conducted December 8-11 (Mon-Thurs) but the NGCCV was the primary focus of Monday and Tuesday. Wednesday and Thursday morning focused on the Virtual Pointer, Autonomous Areal Resupply, and Counter UAV. While the NGCCV was shown briefly Wednesday and Thursday afternoon, it was not the focus. A brief description of the battle rhythm was as follows.

Monday – Tuesday: NGCCV Focus (0900-1600)
 ~24 Soldiers each day

- ESP Overview (~30 minutes)
- VBS3 Training (~30 minutes)
 - Basic Movement
 - Weapons and Vehicles
- NGCCV Overview
- NGCCV Training
 - How to drive and Shoot with NGCCV
- NGCCV Airfield Seizure scenario (2-3 run-throughs)
 - 12 BLUFOR / 12 OPFOR switching sides after each run

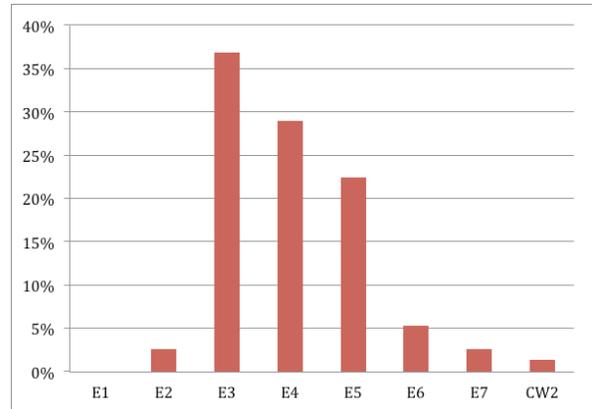


Figure 1. Rank (Pay Grade) of Participants.

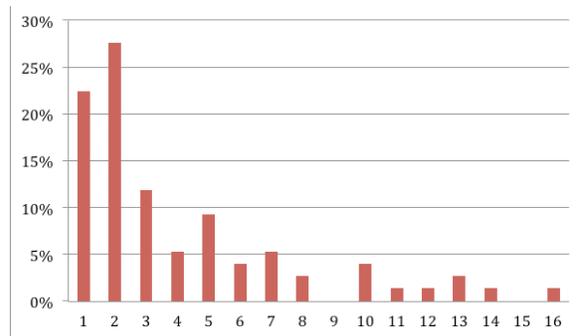


Figure 2. Years of Service of the Participants.



Figure 3. Pictures taken during the test at Ft. Bliss, TX.

- Brief Discussion on NGCCV
- Lunch
- NGCCV Airfield Seizure scenario (3-4 run-throughs)
 - Mission planning time
 - 12 BLUFOR / 12 OPFOR switching sides after each run
- Out brief and question answer discussion

Wednesday-Thursday

- Morning focused on Virtual Pointer, Autonomous Areal Resupply, and Counter UAS
- NGCCV was evaluated in afternoon
- Out brief, survey question/answer and a video recorded discussion

DISCUSSION

Overall, Soldiers enjoyed the opportunity to share their opinion on a future technology and saw the value of presenting future systems in a game environment. Though the focus of the effort was largely geared toward the ESP concept rather than exclusively focusing on the technologies, useful feedback on the technologies was provided.

What Games Do Soldiers Play In Their Off-Duty Time And What Devices Do They Use?

The following information was collected in written surveys that the Soldiers answered before the ESP overview briefing. This was done to ensure that the ESP introductory briefing would not influence the Soldiers’ answers on the surveys.

Participants were asked how many hours per week they played video games, which included PC, Mac, Console, and Tablet games. The question was further refined to differentiate between military-themed games (such as Call of Duty, Battlefield, and ARMA series games) and other-themed games (such as Assassin’s Creed, World of Warcraft, Grand Theft Auto, and sports-themed games). Figure 4 shows over 50% of the participants play more than 10 hours of military-themed games per week and over 76% of the participants reported that they play video games at least occasionally. Additionally, more than 15% of the participants reported that they play more than 30 hours of military-themed video games per week.

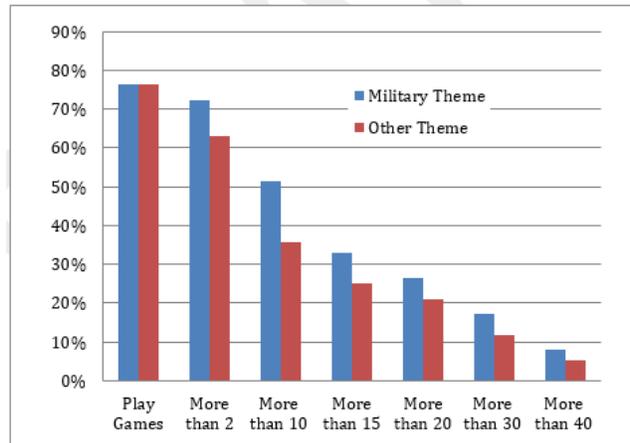


Figure 4. Number of Hours Per Week That The Participants Played Military and Other Themed Video Games.

The participants stated they play first person shooter (FPS) games the most (68%) followed by sports games (17%), fantasy games (12%) and real-time strategy (RTS) games. Table 1 shows the specific games they played. The Call of Duty game series was clearly the most popular video game that the participants played in their off duty time. During the discussion at the end of the testing day, several participants indicated there are several less popular games they played through web browsers and similar web-based games. The participants stated they are drawn to these titles because they were unique and had an engaging internet following of players. Table 2 shows the devices the participants used to play video games during their off duty hours. Large portions of participants use consoles to play games while only 42% reported they used either PC desktop or laptop to play video games. The participants also indicated 73% of the participants used voice chat during multiplayer games. Last, 17% of the participants participate in game blogs and/or forums.

Table 1. The percentage of the participants that played specific game titles on their own time.

Call of Duty	59.20%	Final Fantasy	13.20%
Battlefield	46.10%	World of Tanks	11.80%
Assassins Creed	38.20%	Civilization	9.20%
GTA	38.20%	World of Warcraft	9.20%
Halo	31.60%	SOCOM	7.90%
Madden	22.40%	Counter Strike	6.60%
Skyrim	18.40%	Arma 3	5.30%
Medal of Honor	15.80%	Company of Heroes	3.90%

In summary, if the Soldiers that participated in the test were a representative sample of the active, National Guard, and Reserve components of the U.S. Army, then there is strong potential to leverage Soldier off-duty hours to support concept and capability development. Additionally, many of the Soldiers either own or have regular access to many game platforms and game tools, such as microphones and game pads. The next section addressed what would motivate Soldiers to participate in ESP on their own time.

What Would Motivate Soldiers To Participate In ESP On Their Own Time?

The current operational tempo of the U.S. Army today makes it difficult to add any new requirements that require extensive planning, preparation, or execution for operational units. Using ESP to explore concepts and capabilities in established simulation centers, battle labs, and engineering centers has great potential. However, ESP could tap into a tremendous opportunity if it could engage Soldiers in their off-duty time. The ESP test found more than 76% of Soldiers played video game and 50% of Soldiers played more than 10 hours of video games per week.

Table 2. Platform and devices that the participants reported they used to play video games.

XBox	59.20%
PlayStation	43.40%
Android Phone	22.40%
PC Desktop	21.10%
PC Laptop	21.10%
Headset with Microphone	14.50%
iOS Phone	10.50%
Tablet	9.20%
iPad	9.20%
Joystick	5.30%
Apple Laptop	3.90%
Game Steering Wheel	3.90%
Gamepad (desktop or laptop)	3.90%
Apple Desktop	0.00%

The following information was collected from Soldiers at the end of the day of testing but before the group discussion. This was done to ensure individual responses would not be influenced by the group discussion that included some leaders.

Figures 5 to 7 provided indicators about participant motivation and level of engagement. Additionally, the group discussion at the end of the day provided qualitative feedback indicating Soldiers were enthusiastic to participate in Early Synthetic Prototyping. One participant indicated that he did not have time to play games for entertainment during the week, but would find time to participate in ESP if he knew it was influencing and shaping the future Army. The structure of the test did not allow Soldiers to determine their own pace in the familiarization scenarios and did not allow the Soldiers to determine how they would to participate. These factors likely negatively influenced their overall opinion because one of the attractions to video games is the players are able to determine their own pace through scenarios and determine how they participate in competitive scenarios online. There were some participants that indicated they did not see the utility of the ESP game environment and strongly preferred live training and similar activities.

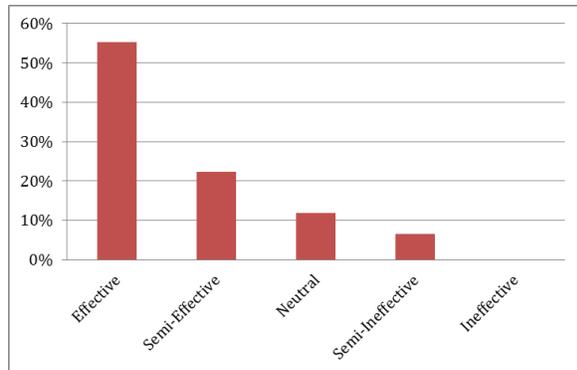


Figure 5. Knowing that your participation contributes to the Early Synthetic Prototyping concept and the Future Army, do you feel that your time was spent effectively today?

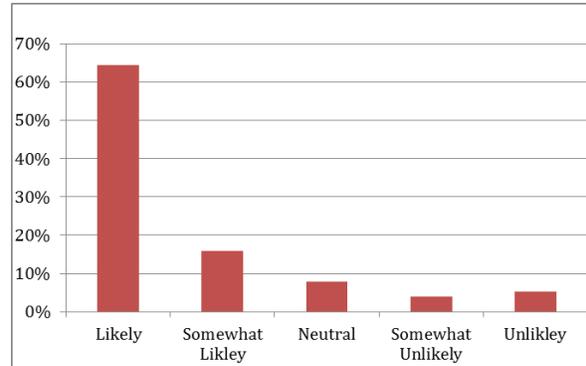


Figure 6. Would you contribute to future efforts to develop or test ideas in a game environment?

Figure 7 indicates the most important factor to engage Soldiers with ESP on their off duty time is to make sure the game is fun. The group discussion at the end of the test indicated that Soldiers wanted the game to be easy to use, easy to learn, and provided a good game experience. The participants explicitly stated the game didn't have to be unrealistic to be engaging, but it needs to be easier to use and learn than VBS3. The second highest rated motivation

to participate in ESP is significant – knowing the player is shaping the future of the Army. This is especially encouraging since this motivational factor is much higher than recognition from Army senior leaders, which indicates a certain level of selfless service and intrinsic motivation on the part of the Soldiers.

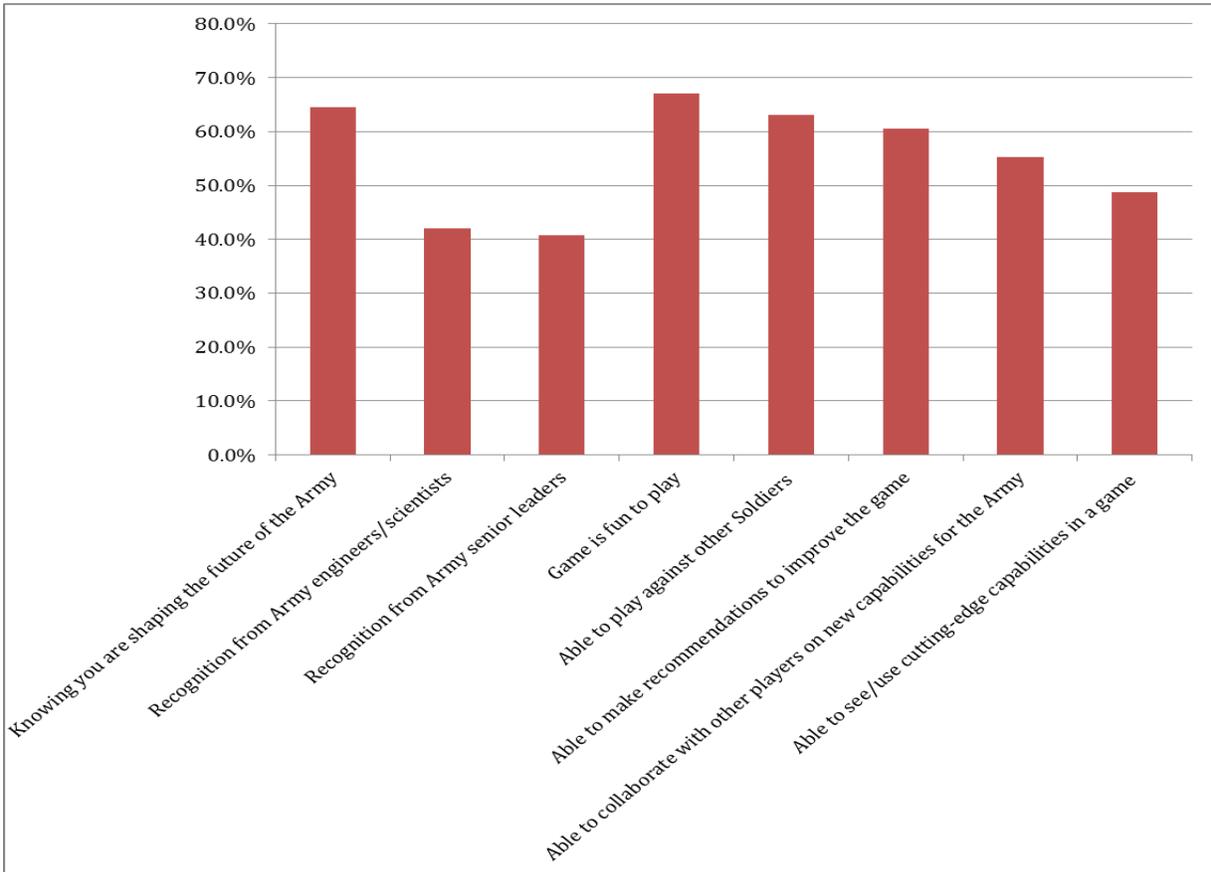


Figure 7. What would motivate you to participate in your off-duty time? (Check all that apply)

Table 3 outlines the feedback from participants about their perceived utility of the game environment to support concept and capability development. The discussion at the end of the test day did not indicate Soldiers with combat experience had a significantly different opinion than Soldiers without combat experience about the appropriateness and utility of game environments to support concept and capability development. However, participants with combat experience did state there is more to combat than directly engaging the enemy. The participants with combat experience stated direct human interaction (within the Army and with civilians) was a significant part of combat operations was not portrayed in the game environment.

Table 3. Summary of questions indicating participant perceived utility of the game environment

	YES	NO
Do you think you could innovate using a game environment to come up with better equipment, tactics, and/or organizations for the future Army?	89%	11%
Do you feel using the technology in the game environment allowed you to gain understanding on how you would use the real technology on the battlefield?	87%	13%
Do you feel the game immersed you enough in the simulation that results would correlate to the real world?	75%	25%

Figures 8 to 13 describe the participants' likelihood to participate in various aspects of ESP. Most participants indicated they would prefer to participate in multi-player mode over single player mode. The end of day discussion indicated participants found fighting against a thinking human opponent was more satisfying and engaging than

fighting against an artificial intelligence opponent. However, participants also indicated value in single player modes to allow them to become familiar with the equipment in the game before attempting to play against another opponent. This is consistent with the participants experience with commercial games they play on their own time.

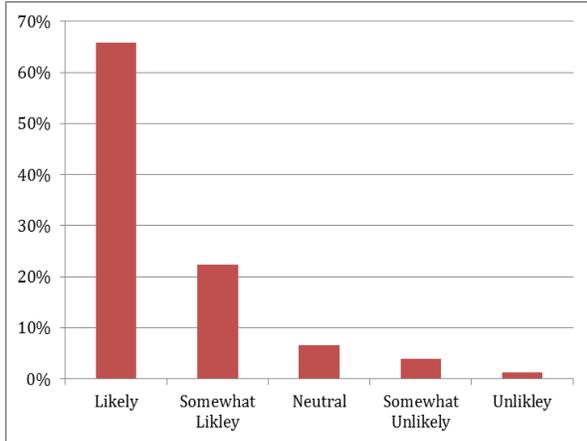


Figure 8. Play the ESP game in multiplayer mode.

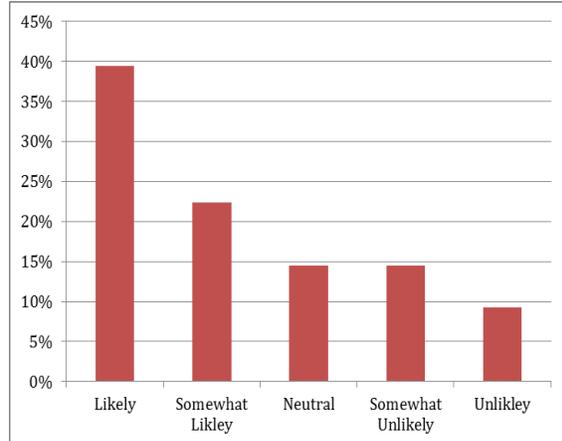


Figure 9. Play the ESP game in single-player mode

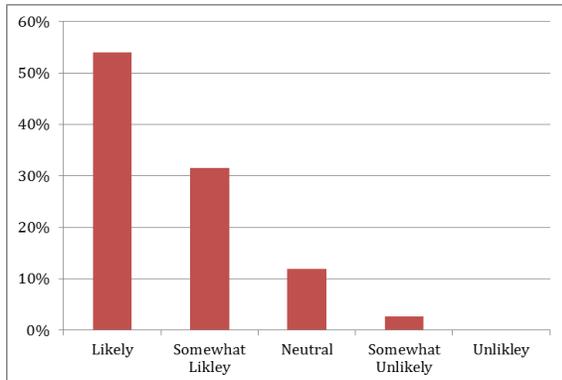


Figure 10. Provide feedback at end of game surveys

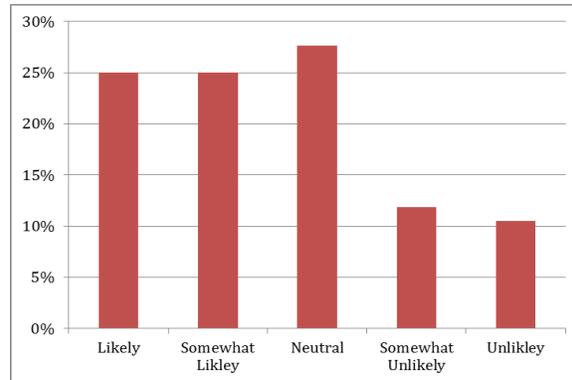


Figure 11. Participate in player blogs with Army scientists and engineers

Figure 11 indicates the participants have mixed feelings about interacting with Army scientists and engineers. Perhaps this identifies one of the greatest needs of ESP for the Army. In order for the Army to rapidly innovate and win in a complex world, we need to breakdown the real and perceived barriers between Soldiers, capability developers, scientists and engineers. During the ESP test, participants indicated they wanted to make sure their ideas were heard by capability developers, scientists, and engineers, but they indicated that could be intimidating. The ESP environment needs to ensure there is free exchange of ideas and feedback between Soldiers and capability developers, scientists, and engineers. Game blogs and forums could be one of the direct means to achieve this environment.

Figures 12 and 13 highlights another need for the ESP game environment. The ESP game environment needs to be easy to learn, easy to play and must have a good game experience to engage Soldiers. The participants indicated difficulty learning the right key strokes and hotkeys to do certain things in the game environment. This mild frustration was evident from participant comments throughout the test each day. Figure 13 clearly indicates the ESP game environment must be more engaging and easier to learn/use than VBS3, which was used for this test.

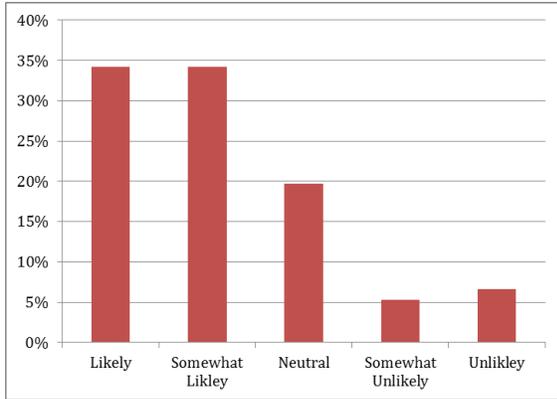


Figure 12. Play the game off-duty.

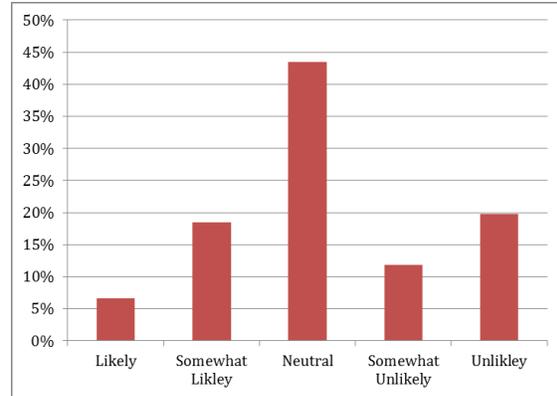


Figure 13. Choose the ESP game over other popular games you own

How Valuable Is Soldier Qualitative Feedback and Game Data To Concept And Capability Development?

The current process of developing a capability from concept to product is a largely linear process that seldom gets continuous feedback from Soldiers. When Soldier feedback is captured, it is typically from small focus groups of Soldiers. The ESP process enables continuous feedback among all stakeholders as illustrated in Figure 14. From a materiel development standpoint, the Army needs to invest in and develop the right technologies based on good requirements while developing the training and doctrine for the technology so when it is fielded, it is a utilized capability. As General David Perkins stated when introducing the new Army Operating Concept *Win in a Complex World* (Perkins, 2014), “A CONEX full of electronic gear is not a capability...that is a property accountability nightmare...a capability is technology in the hands of Soldiers, who are trained to use it, and can apply it on the battlefield.”

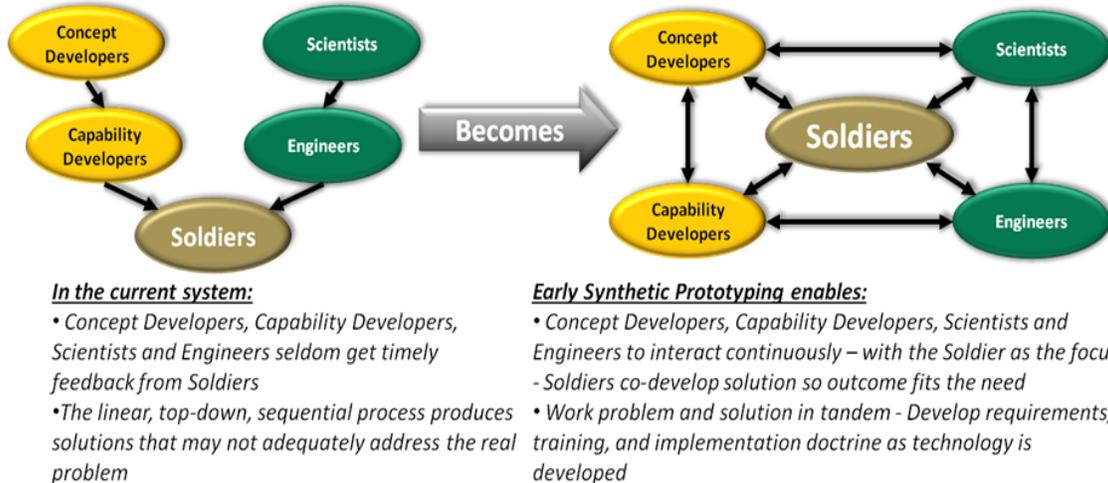


Figure 14. Putting Soldiers at the Center of Capability Development leveraging 21st Century Tools

The Tank Automotive Research Development and Engineering Center (TARDEC) supported the ESP operational test by providing a Next Generation Close Combat Vehicle (NGCCV) model and scenario. This concept is designed to be a representative conceptual expeditionary force ground vehicle platforms with associated technologies based on emerging combat developer operational needs for far term (2028-2038), close combat vehicles with a range of missions and payloads. The Class 1 chassis is a lightweight, air deployable/ droppable ground vehicle concept with high tactical mobility, scalable force protection, and tailorable lethality.

The Class 1A NGCCV has several unique features which proved extremely challenging to model in VBS3, especially an adjustable ride height. The ride height can be changed on the fly to three different ride heights. The low ride height

has high stability at the cost of ground clearance and comparatively, the high ride mode which offers a high ground clearance and IED standoff at the cost of stability. Dynamically changing the ride height allows the vehicle to peek over an obstacle then quickly regain cover.

To provide users with exposure to the unique features of the Class 1A NGCCV, a training scenario was developed. The scenario trained users how to drive the vehicle, change the height of the suspension, engage the check 6 camera, aim, zoom, change weapon, lock on, and fire the weapon. The test scenario was an airfield seizure wherein an airborne unit would jump in with NGCCVs to capture the airfield which could then be utilized to land in heavier assets. The scenario was framed in a way that made it feel more like a game to participants.

Feedback was informally obtained via discussions with Soldiers. Players really liked the speed and quickness of the vehicle. They also commented they appreciated the ability to change the ride height on the fly to adapt to how they were driving. For instance, if they were driving fast over smoother terrain they would switch to low ride for the added stability. They also liked being able to raise the vehicle to see over obstacles. One struggle some Soldiers had was with rolling the vehicle when riding off road at high speed. It is likely due to a function of game engine physics and players inability to judge speed. Soldiers commented they would have liked more armor on the NGCCV even if it meant it would be slower or carry less firepower and it may increase the likelihood of rollover. They stated they would be interested in playing a trade-off analysis where they could decide what combination of mobility, lethality, and survivability they needed for a particular mission.

After-action-reviews (AARs) of selected missions were shown to TARDEC Advanced Concepts and leadership. The video replays of individual runs proved to be an effective communications means. Immediately questions were asked which could not presently be answered. These questions included: 1) Why are they doing things? 2) Where are they looking? 3) How fast were they going? 4) How did the terrain affect their path choices? 5) When were they communicating and what were they saying? The feedback from the experiment was useful, but work on extracting even more data will make ESP significantly more valuable. ESP expects to collect upwards of 120,000 hours of gameplay telemetry per year and new methods must be developed to harness that level of feedback.

FUTURE WORK

ESP is still in early development and much of the work related to ESP is in the area of research. ESP will conduct a long duration test at the United States Military Academy from September to November 2015 to build on the insights derived from this ESP test. The focus of the long duration test is to examine potential player performance scoring mechanisms, determine techniques to keep players engaged over weeks and months when they are not required to play the game, examine player collaboration tools to allow players to communicate about lessons learned and share equipment modifications in the game. In parallel to this effort, ARCIC is developing another game environment that will allow players to explore operations at a higher level, such as battalion or brigade level that include future force combat multipliers. In the future, it is desired to obtain quantitative metrics from the game telemetry (AARs) directly. The simplest metric would be to collect the percent of mission success versus combinations of various mobility, lethality, and survivability solutions. This may be considered a tactical utility metric for various features (Smith, 2014), (Smith & Vogt, 2014). Future work should include research on how to data mine the gaming telemetry and best visualize the data to answer the questions mentioned above. TARDEC is currently sponsoring a Small Business Innovative Research (SBIR) grant "Tactical Behavior Mining of a Soldier-Based Gaming Environment" to conduct some of the basic research to accomplish this task.

CONCLUSION

Our ESP test sought to better understand the efficacy of using game environments to engage Soldiers across the Army to crowd-source future concepts and capabilities. The ESP test was able to determine that a large portion of Soldiers play video games on their own off duty time; over 50% of Soldiers play more than ten hours of military-themed video games each week and either owned or had easy access to computers and gaming consoles. Following the day long test, Soldiers indicated strong interest in participating in ESP activities on their own time. These activities included playing single-player scenarios to become familiar with the equipment and multi-player games against other human opponents. The participants indicated the game needed to be easy to learn, easy to play, and have a good player experience to keep them motivated. However, knowing they are helping shape the future of their Army is equally motivating factor to get them to participate in ESP activities on their own time. Getting Soldiers to participate in ESP

activities alone does not make this effort a success. Therefore, we evaluated the feedback from Soldiers about the various capabilities to determine the quality of Soldier insights. Even though this was not the focus of the test and Soldier feedback was limited to paper surveys and a structured discussion at the end of the day, the quality of Soldier feedback was encouraging. This unique ability to crowd-source future capabilities exploration with Soldiers across the Army and the nation has the potential to ensure we maintain overmatch well into the future to win in a complex world.

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