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System Integration Lessons Learned: Results of Soldier Testing Trials on Integrated Survivability Demonstrator Vehicle

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ABSTRACT

Advanced Survivability Systems will be fully utilized by the Soldiers in the battlefield when the spatial, power and data integration issues are effectively managed during the vehicle integration process. Challenges faced during the integration process range from the packaging of oversized legacy equipment to the environmental requirements of advanced sensory systems. This paper discusses such integration efforts and the lessons accumulated during this resource intensive process. The utility of this complex integrated system was tested and validated by the Soldiers recently returning from the theater. Some surprising aspects of the testing resulted in questioning our traditional view of information presentation to the Soldier.

Introduction

History of Human Factors for Military Vehicles

Historically, pre World War I, human machine compatibility, was determined by the machine. If the human was not compatible, he was rejected. This approach changed drastically during World War II with more sophisticated equipment being used. It was recognized that technology had to be designed with the user in mind [1].

The Research and Development (R&D) community within the current Army has continued with this strategy. Designing the vehicle, in TARDEC's case, around the soldier has become a primary focus, because it makes sense. In order to achieve this, the science of human factors, the dedication of making humans efficient within their environment [1], is being applied. Scientists and engineers within the Army R&D community are focusing on many different aspects of technology to allow for a stronger, smarter, faster, safer and more lethal soldier. The path to accomplishing this requires the participation of the soldier in the design and integration of these technologies.

Importance of Human Factors in Military Missions

Military missions have little room for mistakes. Lost lives can/may be the result of inefficiencies. Providing the most effective environment for the soldier to perform in drastically improves his/her chance of survival when performing these life threatening missions. The application of a human factors approach within the engineering evaluation of these technologies allows for the development of an effective, efficient work environment for the soldier.

The TWVS ATO main mission was to improve the survivability of the soldier while performing in-vehicle missions. A large portion of this program was dedicated to matching the best technology to a specific threat. This process will not be discussed in this paper. What will be discussed is how well the soldiers were able to utilize the technologies that were incorporated into the test bed platform for evaluation.

Design considerations

Spatial Location

Aviation psychology evolved from being focused on the aviator themselves, to the design and placement of controls and displays during World War II. This was the beginning of the human factors focus in spatial location importance of controls. The same principles apply to any space. Vehicle cab design takes into account the ability of the user to be able to maneuver efficiently and effectively. This poses quite a challenge as the army vehicles continue to require more technologies within them.

War Fighter Machine Interface

As mentioned earlier, many survivability technologies were added to the test bed platform for evaluation of ease of use, sensibility, and perceived effectiveness[3]. Because of the amount of information the soldier is subjected to while maneuvering through the use of these technologies, a War Machine Interface (WMI) was designed. This WMI is built upon existing Smart Display technology [Figure 1]. The WMI was a main area of focus for this study. It is important that this WMI provides the most appropriate ease of use for the soldier. It needs to make sense.

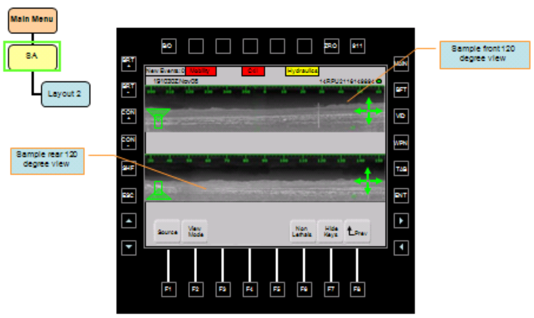

Figure 1: Example of the WMI - IR Video Interface

Information Layering

The Tactical Wheeled Vehicle Survivability (TWVS) Army Technology Objective (ATO) team applied the most basic principle of a human factors approach in this study (the TWVS Limited User Test (LUT)). By subjecting the soldier to a simulated environment with a mocked up cab, the engineers were able to conduct exit interviews which provided invaluable information regarding the soldier's impression of the proposed survivability technologies. The test design, test execution and test results will be discussed in this publication.

ISSIL User Testing

ISSIL Scenario Development Environment

An important part of the user test planning was the development testing scenarios reflective of actual vehicle operation. The following chart (Figure 2) describes a typical scenario developed to demonstrate the capability of the TWVS active protection systems. Additional scenarios followed similar sequences (but under different conditions) to activate the various functions/subsystems. In addition to the measuring the user feedback with the activated scenarios, the power and network data was also collected and analyzed

Figure 2: Typical Scenario to Test Threat Engagement

to determine if the system met performance specifications required for battle field operation.

ISSIL Testing Environment

In order to program and execute these scenarios, the ISSIL was equipped with the environment to script and play the scenarios. In Case1 (Figure 3) the mission scenario is fully scripted ahead of time and are played back to test and monitor the behavior of the system. During execution, the ENTITY SIMULATION process will read the script and generate the corresponding simulated data traffic (i.e. populate the DIS network) in the network to excite the necessary software/hardware/load/communication to replay the scripted scenario.

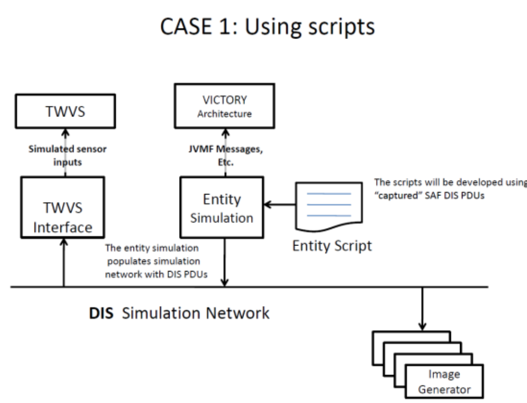

Figure 3: ISSIL Testing Using Scripts

In Case 2 (Figure 4), the testing is based on dynamic generation of events using the Semi Automated Forces (SAF) mission simulation software. It generated events in real-time, which are then interpreted by the required processes (entity simulation and/or TWVS interface) to excite the necessary software/hardware/load/communication and to react accordingly.

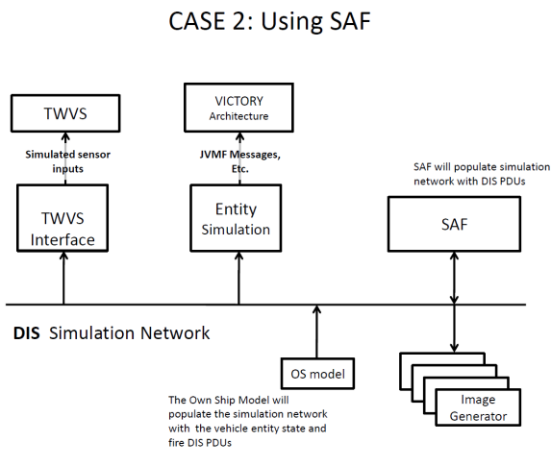

Figure 4: ISSIL Testing Using Dynamic SAF Environment

Testing and Evaluation

Based on the framework and methodology described above, a comprehensive suite of tests was generated and conducted. In September 2010, Soldiers were brought in for testing on the ISSIL. Over two weeks, four teams of three (gunner, driver, commander) participated in the 3-day testing. The first day of testing was given over to training and acclimating Soldiers to the ISSIL testing environment (Figure 4). During the second day, the teams went through three scenarios:

Major Ambush — The convoy came under fire from shoulder-mounted, rocket-propelled grenades (RPGs) and multiple sources of small-arms fire, initiating an external vehicle fire. Test participants were expected to use the vehicle weapon system and other on-board capabilities to suppress the multiple-source threat.

Small Ambush — The vehicle came under attack from sniper fire. Participants were expected to use the vehicle weapon system and other on-board capabilities to suppress the single-source threat.

Crowd Control — The convoy encountered an unruly crowd at dusk in an urban setting. Participants were expected to use non-lethal methods to disperse the crowd, including a spotlight, audio from a loudspeaker, rubber bullet canisters and tear gas.

Each scenario was conducted three times with participants rotating among the vehicle's driver, gunner and truck commander (TC) positions.

Lessons Learned

The feedback from the Soldier-in-the-Loop Testing was used to gain Measurable and Actionable data from that will be for addressing and recommending immediate enhancements to the fielded vehicles as well as for future program planning. The major outcomes (qualitative results) of the TWVS system are laid out in Table 1 by the functional area and the major sub-systems that contribute to the functionality.

Functional Area	Sub-Systems	Qualitative Outcomes
Survivability Systems	IED Protection, Active Protection Systems, Non-Lethal System	- Protection Systems were fully utilized - Additional Non-Lethal counter measures were suggested.
Situational Awareness	C4ISR SA 360 Peripheral Cameras	- Automated messaging screens are desirable - SA 360 is a highly desirable enhancement during all operations – convoy, night watch, ambush. - Out the window visibility improvement required
Human Factors	WMI Component placement Human Factors	- WMI was easy of use – suggested enhancements for Mission Prep, planning & routing, SITREPS. - Limited maneuverable space - Despite constraining movement, full collaboration between driver, Gunner & TC
Vehicle Systems	Vehicle safety systems	- Vehicle safety systems were not greatly utilized as they are more of a distraction in close quarter driving.
System Characteristics	Power management & usage Network utilization & quality Simulation environment	- Sub-system power control, health & diagnostics were appreciated and utilized fully. - Suggested many improvements to the realism of the simulated scenarios based on the current field environment

Conclusion

Feedback from the warfighter testing will play a crucial role in determining how the TWVS ATO's survivability capabilities are integrated onto platforms and into convoys. Results from the study also will be examined by a human factors specialist to help determine what adjustments may be needed for the WMI, and information will be shared with Program Managers and Program Executive Offices to keep them abreast of the TWVS ATO's progress. Soldier testing will continue to be a vital tool across the Army to validate new technologies and develop new capabilities for keeping warfighters safe.

REFERENCES

[1] Human factors, Wikipedia, http://en.wikipedia.org/wiki/Human_factors

[2] "Soldiers Provide Key Perspective to Survivability in TWVS Research" by, Stacy Budzik

[3] Matthew Sablan, "Encounter Avoidance – Protecting and Sustaining the Tactical Wheeled Vehicle [TWV] Fleet", Accelerate, TARDEC, Warren, MI, Summer 2010 Edition.