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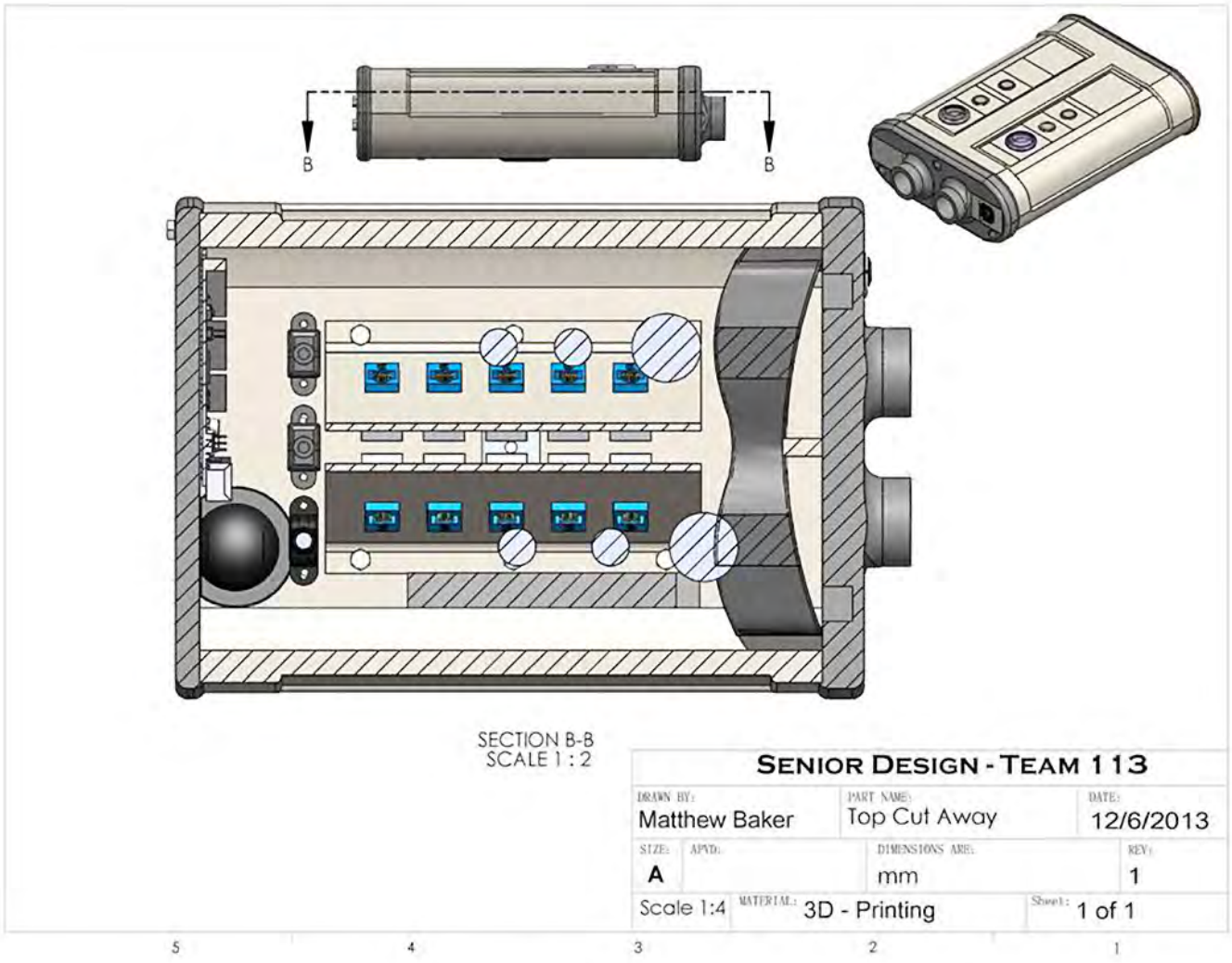
Leveraging students' engineering expertise to bridge the gap between Soldier and system

by COL Michael E. Sloane, MAJ Toby Birdsell and CPT(P) Tom Beyerl

Project Manager Soldier Sensors and Lasers (PM SSL) is in the business of developing the most advanced maneuver and targeting sensors ever fielded. A sometimes unwanted adjunct to advancement, however, is complexity, one of the greatest enemies of usability. Recognizing this critical relationship, the PM SSL team continuously seeks opportunities, in conjunction with the U.S. Army Maneuver and Fires Centers of Excellence, to connect with current and prospective warfighters through "touch points," warfighter juries that enable the PM SSL team to tailor equipment designs to Soldiers' mission needs and exceed their initial expectations. While a PM may be expert in managing programs that provide capabilities to the warfighter, there is often a missing link in the design process that can enhance the user's experience with the system.

Now PM SSL's Product Manager Soldier Precision Targeting Devices (PdM SPTD) team has branched out to obtain a different kind of feedback, through civilian touch points that leverage academia's expertise to identify alternative solutions, save taxpayer dollars and unite the user with the system.



EMULATOR DESIGN
A computer-aided design drawing of the LTLM GUI emulator which, using embedded virtual reality goggles and configurable controls, will enable the PM SPTD product team to model, test and demonstrate key aspects of the user interface, both through development with Soldiers and in communications with industry. (SOURCE: HF/E Lab, OSU School of Mechanical, Industrial, and Manufacturing Engineering)

While the most valuable feedback still comes from Soldiers, academia—specifically college-age engineers and their advisers—can provide a unique perspective on system attributes. To harness this perspective, the PdM SPTD team recruited the Human Factors/Ergonomics (HF/E) Laboratory of the School of Mechanical, Industrial, and Manufacturing Engineering at Oregon State University (OSU), which is on the leading edge of applying interface design principles to improve real-world systems. Together, they conducted a detailed analysis of the human-machine interface as it applies to precision targeting. The university has worked with the Navy, the Federal Aviation Administration, NASA and multiple private organizations to analyze and recommend user interface solutions.

Spearheading these efforts has been Dr. Ken Funk, associate professor and director of the HF/E Lab, whose primary research addresses human performance in complex, high-risk systems. PM SSL, assigned to Program Executive Office (PEO) Soldier, develops complex systems for use in high-risk combat environments, so it made sense for OSU to join the Army development teams that are

DESIGN TEAM
Professor Ken Funk, left, with MAJ Toby Birdsell, Katie Morowsky, Sarah McCrea and Daniel Gilruth of OSU's Department of Mechanical, Industrial, and Manufacturing Engineering Department. Morowsky, McCrea and Gilruth, OSU engineering graduate students, helped assess design and usability during development of the Family of Weapon Sights. (Photos courtesy of PEO Soldier)

building the next generation of targeting devices and maneuver sensors.

THREE LINES OF EFFORT

The initial project, begun in fall 2011, encompassed three parallel lines of effort: a better, lighter tripod; a new graphical user interface (GUI); and a GUI emulator for developing and demonstrating the final products.

Soldiers need a stabilization device or tripod to locate targets accurately at distance and enable a steady aim on target. The tripods currently fielded create consternation at user juries because of their inflexible and bulky design.

While not specifying a tripod, PM SSL asked OSU to improve stabilization. OSU undergraduate engineering students designed, built and tested five different tripod prototypes, with guidance and supervision from Dr. John Parmigiani, research assistant professor. Then, based on Army feedback, graduate research assistants Anthony Nix, Josef Hortnagl and Patrick Dailey integrated the best ideas from the undergraduate designs to develop a vastly improved tripod. Improvements included a more ridged structure, a fine-adjustment mechanism for azimuth and elevation, greater deployability and much more rugged overall design, as well as changes to reduce size and weight, reflecting feedback from users.

CHEST TEST
James Haskell, a graduate research assistant, demonstrates one of the freestanding stabilization devices developed to aid a forward observer while operating the Vector 21 Laser Target Locator System, during a preliminary design review in spring 2013 at OSU.

RESEARCH ASSISTANCE
Soldiers from 4th Brigade Combat Team, 82nd Airborne Division operate the Mark VIIE LTLM at Fort Benning, GA, in September 2013 while conducting PdM SPTD's Advanced Targeting and System Integration class. At right is Raschelle Barkume, a graduate research assistant from OSU who attended the class to gather data on current operating models and doctrinal employment of the systems.

A similar process, starting with a design by graduate student Clint Clow in 2011, created a stabilizer bar that integrates with the Modular Lightweight Load-carrying Equipment. The stabilizer bar gives the user something to lock the elbows into, thus reducing jitter in the device. It eschews the weight and bulk of a tripod while providing significantly improved stability over the traditional handheld operation.

This effort led the PdM SPTD team to draft specifications for the Laser Target Locator Module II (LTLM II) tripod, representing improvements in size, weight and power over LTLM I while sharing the same requirements. PdM SPTD pursued the tripod procurement separately, which will provide increased capability at potentially half the cost of currently fielded equipment. This contributed greatly to an expected 20 percent cost avoidance in the overall system procurement.

PdM SPTD fields a suite of targeting devices that provide a broad spectrum of capability to forward observers, infantrymen and scouts. As technology and requirements matured, each manufacturer developed operating models and GUIs that best suited their interpretation of the requirements and specifications. Involving the OSU students as technical consultants early in the development of specifications eliminates the previous challenges of diverse interfaces across manufacturers and will significantly reduce the volume and complexity of institutional and unit training. It will also allow Soldiers to gain proficiency on the LTLM II system much more easily, with fewer dedicated resources.

GUI development is the area of greatest payoff for PdM SPTD in its partnership with OSU. The perennial challenge for any PM developing complex hardware is how to trade off performance and design specifications while being mindful of the customer and inherent operational challenges. Previous generations of precision targeting equipment relied heavily on performance specifications,

USER REQUIREMENTS
Barkume engages targets with the M110 Semi-Automatic Sniper System while training at the U.S. Army Sniper School, Fort Benning. Her purpose was to gather data on user requirements, in conjunction with the Maneuver Center of Excellence, while demonstrating prototype products.

which enabled manufacturers to innovate and compete in a more open arena. The downside to this approach is a lack of commonality in operation and training between generations and families of equipment. This results in unaffordable upgrades and inefficient training.

GUI design concepts developed in 2013 by student teams in HF/E courses, then refined and elaborated by graduate research assistant Raschelle Barkume, provided an opportunity to blend performance and design specifications into a portable, adaptable document dubbed the Laser System Operating Paradigm (LSOP). This document clearly communicates to prospective vendors both the "what" and "why" of GUI design as it applies to the diverse group of Soldier specialties using the equipment. Based on sound principles of human factors engineering, the LSOP incorporates current joint fires and maneuver doctrine into a common menu structure, layout and nomenclature without overly specifying the design.

This more standardized design ensures that the training required for future generations of systems will be less demanding. Cues from contemporary consumer electronic designs, such as circular menu navigation like that on video game controllers, and the use of selectable soft keys make for a shallow learning curve with a reduction of almost 50 percent in operator training hours.

SETTING THEIR SIGHTS

The relationship established between PdM SPTD and OSU also paved the way for PM SSL's Product Manager Soldier Maneuver Sensors (PdM SMS) to leverage the expertise and lessons learned in OSU's HF/E Lab. PdM SMS is responsible for developing mobility and targeting sensors that enable the Soldier to dominate the

battlefield, namely limited-visibility enablers that are mounted to a Soldier's weapon in addition to an array of night vision devices. The technologies associated with these systems are complex, and it is critical that PdM SMS make them as intuitive as possible for the Soldier to operate, especially in a high-stress combat environment.

For PdM SMS, the perfect opportunity to enlist the OSU's HF/E Lab to gain engineering insight and optimize the user interface was during development of the Family of Weapon Sights (FWS) over the past few years. FWS is the next generation of long-wave infrared thermal weapon sights that mount to a Soldier's weapon. It enables the Soldier to recognize and engage the enemy in limited visibility and through obscurants, such as fog, smoke and haze.

FWS is the latest capability whereby PdM SMS leverages emerging technologies and addresses the warfighter's needs as represented by the Maneuver Center of Excellence.

The FWS program is in the technology maturation risk reduction (TMRR) phase, approaching Milestone B. It includes three variants that use the latest thermal weapon sight technologies—including wireless chipsets, rapid target acquisition algorithms and the ability to mount in-line with the day view optic, so that the Soldier need not remove it—to enable the Soldier to acquire and engage the enemy faster and more decisively.

Throughout the TMRR phase from Milestone A to Milestone B, the FWS team conducted multiple Soldier touch-point events with early FWS-I prototypes, both on live-fire ranges and in the modeling and simulation environment. While accumulating this feedback, PdM SMS quickly discovered that the non-optimized user interface did not enable Soldiers to execute the key feature of FWS-I—rapid target acquisition (RTA) of the enemy. For example, while on short-range marksmanship lanes, the Soldier would switch inadvertently into different modes that distracted, and at best delayed, rapid target engagement.

Enter Funk and his team of engineers. Funk incorporated FWS-I's user interface challenge into a student project in his HF/E graduate course, culminating in a critical design review and FWS-I mock-up presentation to the PM's FWS team.

OSU engineering graduate students Katie Morowsky, Sarah McCrea and Daniel Gilruth conducted task analysis of a Soldier using the FWS-I. They also conducted an exhaustive review of user interface research relevant to the design and a usability assessment. Their subsequent recommendations to the FWS team included a menu structure that prevented obstruction of the display, and a redesigned, tethered remote that quickly enables RTA functionality.

The next step for PdM SMS, having developed a 1-to-n list of interface design improvements based on OSU recommendations and Soldier input during testing, is to incorporate the changes into a prototype during FWS-I's engineering and manufacturing development phase for Soldiers to validate or for the team to refine further.

CONCLUSION

The primary lesson learned from this effort is that academia can, and will, economically support system development, especially in the technology development phase, when the final design is not yet complete. Involving academia can add significant value in terms of inventiveness and fresh insight, benefiting design and usability, without adding to cost. PM SSL's user interface design is just one example of many disciplines in which academia can contribute to a program. In their continuous search for solutions to real-world problems, colleges and universities are an inherent source of knowledge. Whether the goal is to improve power consumption, explore the future of nanotechnology or develop more intuitive sensor interfaces and improved mechanical systems, identifying opportunities for civilian touch points is a valuable step in developing the best available technology for the warfighter.

*For more information on PEO Soldier, go to **https://peosoldier.army.mil**. You can also follow PEO Soldier on social media: Facebook, at **www.facebook.com/PEOSoldier**; Twitter, **@PEOSoldier**; and YouTube at **www.youtube.com/user/usarmypeosoldier**.*

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