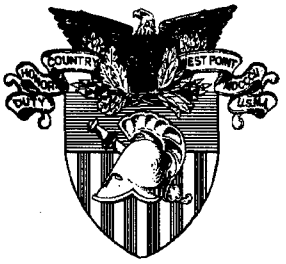

United States Military Academy

West Point, New York 10996

PEO Soldier Simulation Roadmap: Initial Steps in Implementation

OPERATIONS RESEARCH CENTER OF EXCELLENCE
TECHNICAL REPORT #DSE-TR-0501
DTIC #: ADA435707

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The Operations Research Center of Excellence is supported by the Assistant secretary of the Army (Financial Management & Comptroller)

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Abstract

The Army acquisition community requires high-resolution simulations that represent the dismounted infantry soldier in enough detail to conduct an analysis of alternatives (AOA) for individual weapons and equipment. These models must also be capable of assessing future, proposed capabilities and technologies. Previous work proposed coordination among three different models to achieve this capability. In this report, we discuss the implementation of that recommendation. We first will describe the process of approving a Memorandum of Agreement among the parties involved. We then will discuss our procedure used to identify PEO Soldier's analysis needs. Finally, we will detail the procedure we used to translate those analysis needs into specific simulation requirements. We will conclude with a discussion of how effective the technique has been in practice.

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Our mention of these contributors does not imply their approval of our results. The opinions contained herein are the opinions of the authors and do not necessarily reflect those of PEO Soldier, the United States Military Academy, the United States Army, or the Department of Defense.

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Chapter 1: Introduction

1.1 Background

The United States Army relies heavily on modeling and simulation in all aspects of its operations, whether for rehearsing for a tactical mission, training operational staffs in command and control, or proving the value of a new item of equipment. This reliance is especially significant in the case of the equipment becomes more and more technological and expensive. This practice is widely known as simulation-based acquisition. The Army's SMART (Simulation and Modeling for Acquisition, Requirements and Training) program mandates exactly that with the goal of using computer models which "can be saved, altered, deleted, expanded, modified and re-used as the occasion demands, that allows for maximum flexibility to explore alternatives in support of decision processes to modernize the Army."

Unfortunately, the pace of innovation in modeling and simulation has not kept pace with the products themselves. An example of this is the modeling of communication networks. The Army is developing elaborate communication systems, fielding radios further and further down the chain of command. It will not be long before every soldier can have a radio, not to mention an electronic mail capability to almost anyone in their network. However, we are just beginning to fully capture that equipment and the related behaviors in combat simulations. This phenomenon is true for many pieces of equipment carried by soldiers. As a result, there is no single simulation that can provide useful analytical results, the sort used to make expensive acquisition decisions, at that detail.

One organization within the US Army's acquisition community, Program Executive Office (PEO) Soldier, contracted the Operations Research Center (ORCEN) at the United States Military Academy (USMA) to find or develop such a capability. Based on their detailed analysis, the analysis team recommended that PEO Soldier coordinate its analysis needs among three separate simulation programs. The first of those programs is the Infantry Warrior Simulation (IWARS), whose proponents are the Natick Soldier Center (NSC) and Army Material Systems Analysis Activity (AMSAA). The second is One-Semi-Automated Forces (OneSAF) and Objective OneSAF (OOS), whose proponent is PEO Simulation, Training, and

Instrumentation (PEO STRI). The third is the Combined Arms Analysis Tool for the 21st Century (COMBATXXI), whose proponents are the Training and Doctrine Command (TRADOC) Analysis Center at White Sands Missile Range (TRAC-WSMR) and Marine Corps Combat Development Command (MCCDC). The description of the analysis supporting that recommendation can be found in the Defense Technical Information Catalog (DTIC) numbered report ADA-425648.

Over the past 12 months, we have worked closely with PEO Soldier and the three simulation proponents to implement that recommendation. This report will describe that coordination. The work has addressed two separate tasks, both of which have occurred simultaneously. The first task has been drafting and gaining concurrence on a Memorandum of Agreement between the parties. The second has been strictly defining PEO Soldier's modeling needs and translating those needs into specific modeling requirements. We will close this report with a discussion of the future steps, which will be to present a more-refined list of modeling requirements to the modelers, receive and evaluate their proposals for inclusion in the simulation programs. The result will be an acquisition-based simulation capability.

1.2 PEO Soldier

PEO Soldier is the US Army's materiel developer for virtually every item of equipment carried or worn by soldiers around the world. Subordinate to PEO Soldier are three Project Manager Offices: Soldier Warrior, Soldier Equipment and Soldier Weapons. As compared to other Army acquisition organizations with more specific responsibilities, PEO Soldier's activities influence almost every piece of equipment used, carried or fired by any soldier around the world. They are responsible for selecting from among candidate systems those new items of equipment which will enhance a soldier's combat effectiveness. To accomplish that assessment and selection of individual pieces of equipment, they rely on combat modeling. Specifically, it would be necessary to simulate a soldier who was equipped with a particular item, a new helmet for example. Following the required number of runs, the analyst would review the results, then run a similar simulation with a different helmet. With the improved modeling capability and level of detail desired, the changes in performance that would be accrued with the improved helmet will be reflected in the results. However, as mentioned above, advances in combat

modeling technology have not matched the pace of advances in equipment technology, and such a comparison is not realistic.

1.3 The Three Simulations

One-Semi-Automated Force (OneSAF) is a combat simulation developed by the Army's Program Executive Office for Simulation, Training, and Instrumentation. It has two components. The first is OneSAF Testbed Baseline (OTB), which is a "high-resolution entity level simulation that represents combined arms tactical operations up to the battalion level." It will be retired in fiscal year 2006. Objective OneSAF (OOS) is the follow-on version of OTB; it will be at full-operational capability in fiscal year 2006. OOS will be able to represent operations up to the brigade level. It is intended to be used in the Training, Equipment and Military Operations (TEMO), Advanced Concepts and Requirements (ACR), and Research, Development and Acquisition (RDA) domains. It is intended to replace Brigade/Battalion Battle Simulation (BBS), Janus, Aviation Combined Arms Tactical Trainer / Close Combat Tactical Trainer (AVCATT/CCTT) and Joint Conflict and Tactical Simulation (JCATS) for Military Operation in Urban Terrain (MOUT). It will be able to conduct closed-form analysis of equipment, as well as Soldier in the Loop (SITL) operational testing and training.

The Combined-Arms Analysis Tool for 21st Century (COMBATXXI) is a closed-form combat simulation developed by the TRADOC Analysis Center at White Sands Missile Range (TRAC-WSMR) and Marine Corps Combat Development Command (MCCDC). It is an entity-level simulation that models tactical operations at the brigade-level or lower. It has been constructed for use in support of the ACR and RDA domains, and is intended to replace the Combined Arms and Task Force Evaluation Model (CASTFOREM), which is used in selected Analyses of Alternatives. COMBATXXI will release its version 5.0 in the summer of 2005.

The Infantry Warrior Simulation (IWARS) is a closed-form combat simulation developed jointly by the Natick Soldier Center (NSC) and the Army Materiel Systems Analysis Activity (AMSAA). It is designed for use in the RDA and ACR modeling and simulation domains. This model targets "individual and small-unit dismounted combatants and their equipment." Scheduled for release of version 1.0 in September 2005, IWARS will take the place of the Integrated Unit Simulation System (IUSS).

Chapter 2: Implementation

2.1 Overview

Throughout this project with PEO Soldier, analysts from the ORCEN have used the Systems Engineering and Management Process (SEMP) to guide the work. The SEMP is a four-step problem-solving process taught in the Department of Systems Engineering at the United States Military Academy at West Point. The initial portion of the study focused on the selection of a simulation or set of simulations to be used by PEO Soldier. In reaching their recommendation, the analysts followed the first three steps of the SEMP. Those first three steps are Needs Analysis, Modeling and Analysis, and Decision Making. The fourth phase, Implementation, has three sub-steps: Planning for Action, Execution, and Assessment and Control. The focus of this study has been on the Planning for Action step, although we are beginning to execute this coordination. There have been two major tasks within this step, agreeing to and signing a Memorandum of Agreement, and explicitly describing the modeling requirements.

2.2 Road to a Memorandum of Agreement

A memorandum of agreement (MOA) is a formal document between two or more organizations specifying a collaborative relationship. In this case, each organization has agreed to the content of the MOA. However, the formal approval process, culminating with the signature of the director of each agency represented, has yet to be completed.

In our case, the MOA creates the PEO Soldier Modeling and Simulation Community, which is composed of representatives of each simulation proponent. As part of the community, they all agree to participate in coordination meetings as requested by PEO Soldier. PEO Soldier will chair these meetings and use the opportunity to present their modeling requirements to the modelers themselves. The modelers will review the requests and may submit proposals to complete the work. PEO Soldier will then select which modeler should accomplish each task, based on the level of detail offered, the time required to do so, and the cost forecasted. There may also be other factors they consider in their decision.

It is important to note that the MOA does not compel any group to belong to the community. Each of the signatories represents a combat model that has its own direction,

audience and goals – they exist outside of the community. However, membership in the community is evidence of their acknowledgement that greater capability that could be gained from collaboration. Indeed, the goal of the community is to address PEO Soldier's modeling needs, and that is best achieved by capitalizing on the strengths of each separate program. By doing so as part of a coordinated effort, the overall modeling capability is improved for the entire modeling and simulation community.

2.2.1. Approval process

The path to agreeing to the MOA has been largely completed by frequent correspondence and discussion for specific points. PEO Soldier drafted an initial version of the MOA and distributed it to the three agencies, as well as to our analysis team. Each agency then had time to review the document and provide comments back to PEO Soldier. This method of review and feedback worked well for questions that pertained to only an individual agency, and it continued for 2-3 months. However, it was not adequate to address questions that involved more than one agency, specifically the question of identifying a particular agency to become the lead integrator and direct the connections between models. To better explain this, it is necessary to describe the initial recommendation and the work done to identify requirements.

2.2.2. Connecting the models

The ORCEN analysts who made the recommendation that PEO Soldier coordinate its modeling efforts among the three agencies also broadly stated that they should link the three models. That last point has generated a great deal of discussion. By linking the models, is it a goal to have all three models run simultaneously and communicate in real-time? Should all three run simultaneously, or just two? Or is it more appropriate that the three models not necessarily communicate in real-time, but instead are simply compatible with one another, so that outputs from one could be used in another? Each of these alternatives has been discussed at length, and we will describe the arguments for and against each one.

Certainly it could be valuable to have all three models run simultaneously and communicate in real-time. Each model would be able to truly capitalize on its individual strengths, and the combination of the three would offer a greatly-increased capability overall. However, doing so would require a much greater level of coordination than is currently

perceived as necessary. That is, it is true that PEO Soldier needs an improved modeling capability, but at this point, their requirements do not necessarily require that all three models communicate in real-time. However, the interfaces between models would have to be very closely and specifically coordinated, and given the separate directions each model has on their own, that integration would be very time-consuming, costly, and not worth the effort for PEO Soldier's needs.

Perhaps a better answer is to have only two of the models operate simultaneously with real-time communication. This proposal improves the level of coordination that would be required, as compared to having all three linked. However, again the question returns to the real needs of PEO Soldier and the original purpose of the study. Each model has its own sort of core competency. OOS has the broadest, able to model individual soldier effects, as well as aggregate those effects to the battalion and brigade level. COMBATXXI can model the individual soldier, but is focused on platoon, company and battalion modeling. IWARS focuses strongly on the individual soldier. Given this scope of modeling, there appears to be room for overlap or coordination, and in fact there is. These facts have led us to recommend that PEO Soldier consider linking two models at a time, or at least ensuring that the inputs, outputs, and algorithms used to run the model are compatible with each other. But there is an important initial step that must be taken.

PEO Soldier is the immediate benefactor of this improved modeling capability, and they will fund these efforts as needed. We have considered that point paramount in our consideration of linking any models. As will be discussed later, we have provided the three agencies with specific modeling requirements and asked for their feedback as to how well they could model those requirements. To address those requirements, it may be useful or even necessary to link two or all three of the models. However, at this point, it is incumbent on the modelers to identify those requirements which will best, or could only be met by linking the models. Only then will the implementation be requirements-based. Initial reports are that such linkage may be valuable in modeling new communication equipment, especially when that communication equipment connects individual soldiers with combat vehicles as well as some sensors or battlefield assets that are not organic to the squad or platoon. Another potential area where linking models could apply would be having soldiers operate in a synthetic environment, but wanting the results to be

used in another model. As the modelers identify those areas, we would recommend PEO Soldier pursue a solution that links two or three models.

Similarly, it will be important in many cases to ensure that the inputs and outputs in a particular model are compatible in other models. This often will require an understanding of the algorithms used in the models themselves. An example of this is the implementation of a target acquisition algorithm. If two models use different algorithms for a soldier attempting to acquire targets, the result of the soldier's search will be different. One model may not account for the effect of blowing dust on a battlefield and result in a successful acquisition, while the other model correctly captures the blinding effect of the dust and the target remains hidden. In those cases, PEO Soldier can use the meetings of the Modeling Community or specific Technical Interchange Meetings (TIM) to discuss these issues in depth. The important point that must be taken away is the realization that any linkage or translation that is needed must be based on one of PEO Soldier's specific requirements.

2.2.3. Continuing the acceptance process

The three modeling agencies and PEO Soldier continued in their revision of the MOA, passing it up chains of command for comment. Having established that the community existed to improve the Army's combat modeling capability, specifically on behalf of PEO Soldier, the agencies could focus on their own responsibilities. This review has continued, and the agencies have agreed to the terms set forth. The MOA is now working its way through administrative approval channels at PEO Soldier. Nonetheless, the discussion among the modelers has continued, and their question for PEO Soldier and our analysis team has been, what exactly are PEO Soldier's modeling requirements?

Chapter 3: Providing the requirements

3.1 Defining the analysis needs

As the MOA acceptance process occurred, we in the ORCEN had focused on defining the requirements for the modelers. We knew that we had to focus our efforts specifically on PEO Soldier products or capabilities, to support acquisition decision-making. Chief among those products has been the development of the Land Warrior System, an integrated, very

technologically-advanced ensemble of equipment. Land Warrior represents the next step in the evolution of equipment used by the US Army soldier. For that reason, our initial efforts were targeted at that system. Since then, we have taken a broader approach, attempting to widen our field of view and capture the vast array of potential analysis needs of PEO Soldier. Nonetheless, this initial approach was useful, because it allowed us to "try out" methods of requirement definition using the Land Warrior equipment and capabilities. To broaden the scope of our study, we relied upon a four-step process, shown below.

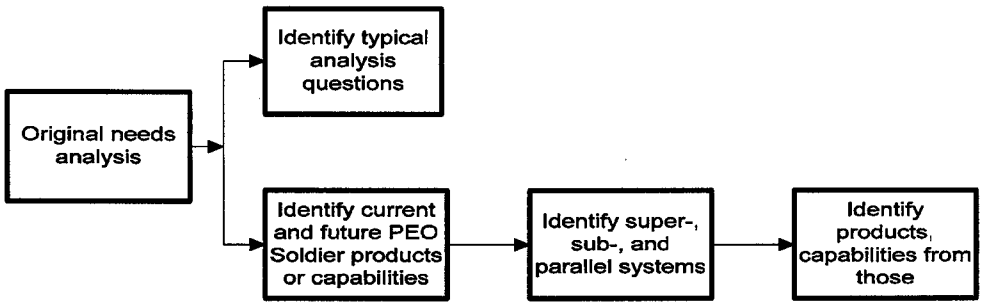

Figure 1: Method to identify analysis needs

The ORCEN analysts who initiated this project twelve months ago provided the basis for the original needs analysis. They identified that the original goal of the project was to analytically support acquisition decision-making for PEO Soldier and choose between candidate Soldier Tactical Mission Systems (STMS), such as radios or weapons. This restricted our scope of potential modeling topics to those which would be used or carried by an individual soldier in a combat situation. That point is significant, since it allowed us to prioritize our original list of over 450 products to about 65 products in 7 broad "families."

Based on the realization that this coordinated set of models would be used in the acquisition process, it was important for us to remember that to support any decision, any item of equipment would have to prove its worth by answering certain analysis questions. Further, the modelers stated that knowing these questions would assist them in understanding the modeling detail needed. Those two facts led us try to identify typical analysis questions. Therefore, we began to collect several examples of analysis questions used for similar items of equipment. However, as we continued in this process, we have changed our perspective toward these questions. While we will provide them to modelers, we have not highlighted them in the requirements for three reasons. First, given the nature of technological innovation, it is impossible for us to claim to capture a representative set of analysis questions for equipment.

The questions will change for every new item of equipment, as well as for different studies. Second, although it has been our experience that the modelers are completely conscientious, if we provide a question, it could be possible to provide enough detail in the model to answer only a particular question, without regard to a broader set of possible questions. Finally, we originally envisioned that we would provide the questions early in the process, using them as a guide. Instead, we will provide them later, as that will allow us to prioritize the groups of products and therefore have a more specific set of questions. For those three reasons, we have decreased the importance placed on this step in the process.

Our next step was to identify current and future PEO Soldier products or capabilities. PEO Soldier is the client and the direct recipient of this modeling improvement. Further, by taking this product-based approach, we focus the modelers' effort, as compared to the result had we broadly attempted to improve modeling of lethality or situational awareness. A by-product of capturing the effects of the products themselves is the improved representation of those general terms. We have started with current products -- those that are already fielded – so that we can ensure that the models capture the necessary detail to use as comparative or baseline data. This is important because we also have provided requirements that are based on future capabilities. As mentioned earlier, PEO Soldier will want to compare some future product to a current item they are considering replacing. We began the study with over 450 products. The original list of all PEO Soldier products can be found at Appendix B. The refined list of approximately 65 products that we used to define requirements, can be found at Appendix C.

We are also considering, as part of a parallel system, the new technologies under development as part of the Future Force Warrior (FFW) program. FFW is the next step past Land Warrior in the evolution of soldier equipment and includes very technologically-advanced products. Using both current and future products as our starting point, we will capture the necessary types of equipment and capabilities that PEO Soldier must analyze as part of their acquisition process.

3.2 Translating needs into simulation requirements – Alternative approaches

Once we had identified the analysis needs – specific products or capabilities, either current or future – we had to translate those needs into a specific modeling requirement. Doing so

provided the connection between the PEO Soldier organization, their products, and the model developers who have to write the code to perform the simulation. We wrestled with three alternative methods for making this translation, eventually settling on a method that combines the best of the three.

3.2.1. Effects-based approach

Our first attempt to provide these requirements was solely based on PEO Soldier products and their individual effects. Since this was our initial concept, we used the Land Warrior systems as our examples. For each of those products, we could define the first and second order effects of the product. By passing along that information to the modelers, they would have a "plain English" understanding of what capabilities a new piece of equipment offered. We often used new developments in body armor as an example of how this would be done.

Product: Improved body armor

1st order effects (1): Improved protection for soldiers from direct fire, shrapnel, debris on the battlefield, as compared to current body armor systems.

1st order effects (2): Increased mobility of the soldier due to lighter material, better design, as compared to current body armor systems.

2nd order effects (1): Decreased caloric usage of the soldier, again due to lighter material, as compared to current body armor systems.

2nd order effects (2): Decreased range of motion, due to increased size of the armor, as compared to current body armor systems.

Listing these first and second, or more, effects was a fairly simple task, and it would allow the modelers a non-technical description of a potentially very technical object. In effect, it would allow a programmer to see and understand how a soldier would use an item on the battlefield. In fact, the modelers appreciated that aspect of this method. Unfortunately, it is truly too simple a process and misses the characteristics and specifications of a piece of equipment. Further, it overlooks the interaction of pieces of equipment.

3.2.2. Analysis-based approach

Our second candidate for translating these needs into requirements had its roots in the Army acquisition process. That process requires a detailed analysis of alternatives (AoA), which

is to prove the worth of any new item of equipment and uses specific questions about a product to do so. Our method would have us define those analysis questions which would be used in such an AoA. Any new or proposed item must have some "advertised value." For example, a new weapon would need to offer some improvement against the current weapon, whether that is increased range, decreased weight, or a new caliber of round, in order to be considered to replace the current weapon. For each product, we would attempt to determine a good set of analysis questions that would prove that value. We could then define a level of representation detail that would be required to answer the question. That specification of the detail would become the modeling requirement, delivered to the developers for their action. Again, body armor was a simple example to define and use.

Product: Improved body armor

Advertised value: Increased protection to soldiers against direct fire, shrapnel and debris, as compared to current body armor systems. This system covers a greater surface area of the soldier.

Question to prove: What are the friendly losses (wounded and killed) due to direct fire, shrapnel and debris for soldiers equipped with the current and proposed body armor?

To answer that question: Model must represent direct fire engagements, effects of shrapnel and debris on the battlefield. It must also represent the location of impact of any of those against a soldier. It must also consider the angle of the impact, to account for the increased surface area of the new body armor. It must also represent different levels of injury, based on the impact experienced, as well as the protection provided by the armor.

While that process would have retained the focus on acquisition decision-making, as well as the emphasis on PEO Soldier products, it would have been too reliant on the analysis question involved. For reasons given above, we are reluctant to tie ourselves to any current idea of what the analysis question could be. Further, that detail needed to answer a particular question may not capture the interactions of various pieces of equipment. That point is clear above, since the example did not consider the weight or bulkiness of the body armor, or any other aspect than its protection. Those other effects and interactions are critical to the overall soldier representation.

3.2.3. Universal Modeling Language approach

We considered a third alternative for providing these modeling requirements, one that would have been based largely on a Universal Modeling Language (UML) construct. We would begin by considering soldiers as objects, with attributes (physical, mental, etc) and methods (move, sense, decide). Each new piece of equipment would become either an attribute of the soldier or of some other object, or an object itself. This would lead to a comprehensive listing of the equipment to be modeled, as well as its attributes. Based on that, we would define a soldier's method using each of the other objects' attributes. This would capture the interrelatedness of many of the items, and the programmers would be familiar with the format delivered. Additionally, the work completed in the initial part of the study, especially the hierarchy of soldier functions, would lend itself to this quite well. Body armor is still useful as a simple example of this approach.

Object:	Soldier
Attributes:	Physical strength
	Mental ability
Function:	Move
	Communicate
	Engage
	Decide
Object:	Body armor
Attributes:	Physical dimensions
	Composition

Table 1: UML Description of Body Armor

The soldier's function of move is affected by the body armor object, which has specified attributes (physical dimensions). The soldier's function of engage is also affected by body armor, which has specified attributes of composition (stronger body armor should lead to increased likelihood of engagement).

Unfortunately, this process would be quite tedious and be more detailed than would probably be needed. Also, each of the three simulations has their own UML chart. Creating a

fourth could produce confusion as we move forward, not to mention that there would likely have to be a considerable effort to ensure each object in each chart was similarly represented.

In the end, none of these methods by itself seemed to provide the necessary detail while still allowing a modeler to understand the larger environment of the battlefield and how a soldier would employ an item. It was therefore necessary for us to create another process to provide these requirements.

3.3 Our approach to defining requirements

After considering each of these candidate methods of translating needs into requirements, we developed a fourth technique. This four step sequence combines several of the steps seen in our candidate methods. We applied these steps to our list of products to define the requirements for PEO Soldier. A flow diagram of the process is shown below. I will first describe the process used to break the products into groups, then describe the four step process, then describe an example of its use.

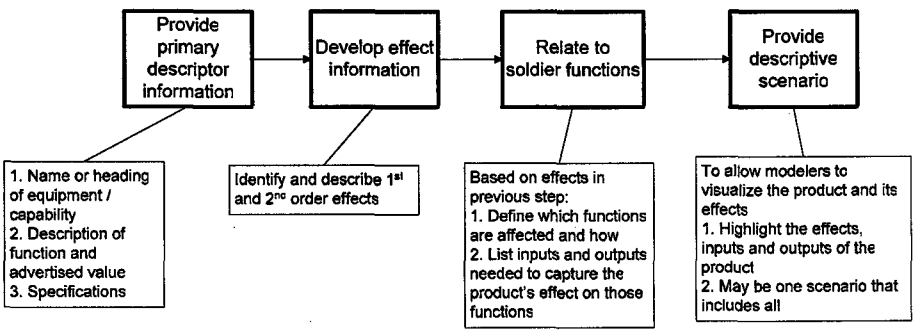

Figure 2: Method to translate analysis needs into simulation requirements

3.3.1. Separating the products

We began this process with over 450 different products or new technologies provided or being considered by PEO Soldier. These ranged from a soldier's belt buckle to the combat helmet to night vision devices. Recognizing that we were providing this simulation capability for representation of close infantry combat, we were able to cull out those items not used in such an activity. Once we had a list of the equipment used in close combat, we grouped the items into families. Doing this allowed us to broadly define the basic descriptive information or effects of an item. Each of these lists of products and families are listed in the appendices.

For a family of products, we specified which items are in the family and capture the representative facts that are common to the family. For each family of products, we have also prioritized the products and attributes based on their sequence in the fielding process and their contribution to its performance. The general idea is that the highest priority is attached to basic representations. This simple method is described in the table and example below.

1st Modeling Priority	2nd Modeling Priority	3rd Modeling Priority
Basic representation of currently-fielded products	More advanced representation of currently-fielded products	More advanced representation of future products
	Basic representation of future products	

Table 2: Description of method to prioritize modeling requirements

PEO Soldier has a number of products that aid a soldier's vision. We can describe this prioritization process by using those products. We created an "optics" family which includes viewing, range-finding, and target designation devices. The highest priority products in this family are those that are currently-fielded: PVS-7 Night Vision Devices, as an example. For the PVS-7, the highest priority attributes to model are its field of view, image intensified detection ranges, and any magnification that it possesses – its basic attributes. Including those in a combat model provides an accurate, simple representation of the device. That is the first modeling priority.

For a more detailed representation, it would be useful for the model to represent its weight, power usage and reflection (to enemy observation). Those advanced topics are the second priority. Also in the second priority are products such as the Small Tactical Optical Rifle Mounted (STORM) Micro-Laser Rangefinder (MLRF), which is still in the acquisition process. It has the added attribute of being a rangefinder. In this way, we grouped and prioritized all the PEO Soldier equipment that related to close combat.

3.3.2. Primary Descriptor Information

The process begins with a family of similar products or capabilities. The first step in the sequence is to specify the basic descriptive information about a product or family of products. This is meant as a simple list of the functions and technical specifications of an item. It could include such facts as the dimensions of a weapon, its range, its muzzle velocity, and so on. Recalling the example of the PVS-7 Night Vision Devices above, these attributes would be its field of view, image intensified detection ranges, and any magnification that it possesses. Once these attributes have been defined, it becomes the basis for an accounting for the battlefield effects of an item, which is the second step.

3.3.3. Battlefield Effects

This second step, which is identical to the first candidate method described above, is quite simple. It is to provide a non-technical, two- to three-sentence description of the first and second order effects of the product. Although simple, this has continued to be significant because of discussions with the modelers themselves. They have maintained that while it is important that they know the engineering-level details of an item of equipment, it is perhaps more important that they understand how a soldier would employ it. We expect it will be necessary to provide more than one of these descriptions for most products, especially those that encompass many functions or related items of equipment.

Returning to the example of the products in the optics family, this requires providing a description of the device's effects on a soldier. PVS-7 Night Vision Devices allow soldiers to see and operate at night or in obscured environments. They also enable more accurate target engagement and allow soldiers to control fires or target with infrared targeting devices. Finally, it also reduces the peripheral vision of the soldier. Providing these simple descriptions gives the modeler an idea of the effect of an item. It is significant to note that these effects may not always be positive effects. Using PVS-7s is a simple example; this description becomes more important as the equipment becomes more technologically-advanced or difficult to visualize.

3.3.4. Input and Output Description

While that second step will provide the opportunity for the modeler to visualize the piece of equipment on the battlefield, it does not give the required detail to completely and accurately

model it. This occurs in the third step, and is very reliant on the work that was done in the initial part of the study. As mentioned earlier, the ORCEN analysts charged with choosing a simulation program developed a detailed hierarchy of functions that a soldier performs on the battlefield. They also identified an initial list of interacting inputs and outputs which would affect or be affected by each of those functions. We use these results in the third step of our process. Specifically, we relate the 1st and 2nd order effects of an item to the soldier function or functions it affects. Doing so also allows us to list the inputs and outputs, and more importantly, to explicitly detail the effect of the equipment on them. By modeling those inputs and outputs and how they interact with the equipment, it is possible to specify the modeling detail needed.

For the example of PVS-7s, it is necessary to first identify the soldier functions that are affected by the equipment – in this case, sense, engage and move. The original hierarchy deconstructed those functions further, leading to the specific inputs and outputs. For the sensing function, a sub-function is to search – manipulate equipment, orient and observe. Clearly the PVS-7 has a great effect on how a soldier performs that function. To correctly model the contribution offered by the device, it therefore is necessary to model the following inputs: a soldier's decision to search, a soldier's METT-TC assessment, the terrain and weather conditions, the symmetric and asymmetric lines-of-sight, the field of view of the device, and the optical contrast of the environment or target. As an output, the model should capture a change in equipment status, reduced ability to focus on other tasks, a change in the equipment orientation, as well as the visual information sensed through the device.

The final step of the process is to provide a descriptive scenario of how a soldier or squad of soldiers would actually employ the equipment. This complements the description completed in step two, but provides an operational vignette of the effect of an item. It also will be tailored to include examples of many of the inputs and outputs noted in step three. This portion of the translation process is a product of discussions with the model developers. They use a similar tool when modeling operational techniques or tactics, with which they are not generally familiar. We do expect to combine several pieces of equipment into the same vignette, so there will not necessarily be exactly one for each item. Further, while we began with 65 products, we will provide these vignettes for those products which are highest priority and show the most promise for modeling. Finally, it may not be necessary to provide this vignette for all pieces of equipment, especially those that have similar characteristics to already-fielded products.

3.4 Result and Reception

Each of these steps produces a result for a product or family of products, and we captured that information in several workbooks in an Excel spreadsheet. We distributed the spreadsheet to the modelers and asked them to provide feedback for each of the product effects, inputs and outputs. Specifically, we asked them to classify each effect, input and output as either one that was already included in their model, would be included in the next version of their model, could be included in a future version, or was believed to be too hard to accomplish in the near future. For those that could be included in a future version, we also asked which they perceived would be relatively easy or relatively difficult to include. We have accomplished that and received their responses. In general though, the modelers were able to understand the format of the requirements and gave very valuable feedback. It was necessary in some cases to clarify the input or output requested. This was often because the factor listed was affected by a secondary characteristic of the item. For example, most people think of the gained sensing advantage from a weapon sight, but they overlook that the sight may reduce a soldier's ability to be aware of his immediate surroundings.

One area that still needs attention is developing a more robust method of reporting how well a model represents a particular effect, input or output. It is possible for a modeler to correctly report that they model something, but that answer by itself does not provide all the detail needed – it merely leads to a next question. This problem is most easily illustrated by considering whether a model represents the weather. Using our Excel spreadsheet, it is possible for a modeler to report that they capture the effects of the weather. However, it then falls to the analyst to determine exactly how that is done, and what elements of the weather are included. This will depend on the purpose of the study, as well as the equipment being considered. A computer simulation that represents temperature and rain does in fact represent the weather. But if the item of equipment being studied is a magnified weapon sight, the model must represent those elements, as well as the effect of wind, blowing dust, and humidity, all of which could diminish the effectiveness of the sight. The Excel spreadsheet in its current form answers the first level question, which is a valuable function; it is left to the analyst to understand the true capabilities that are to be modeled and ask the requisite follow-up questions.

As discussed above, the modeling agencies provided very useful feedback using this system of defining the requirements. The overall result has been that PEO Soldier now has a

very clear understanding of the modelers' abilities and focus. The spreadsheet allows them to know which of those items are feasible in the near term for relatively little investment, and which will either take a longer amount of time or a larger investment. Armed with that knowledge, PEO Soldier will be able to move into the execution phase of this project and choose the most critical pieces of equipment to propose for modeling.

Chapter 4: Current Progress and Conclusion

This process has been a work in progress for several months. The next steps for PEO Soldier are to provide the modelers with that list of critical products or technologies that it would like included in any one of the models. The Excel spreadsheet described above is a useful starting point for describing those pieces of equipment. The modelers will need to respond to that list of products with a form of proposal to actually complete the modeling. Critical to that proposal are three elements: the time required, the investment required, and the level of detail or method they envision using to represent a particular item. That third item is essential, but it is possible by linking their method to the effects, inputs and outputs listed in the spreadsheet to ensure that the level of detail proposed truly meets the acquisition community's need. After receiving these proposals, PEO Soldier must decide which model offers the best capability and detail for the investment and time. After that decision is made, they will enter the supervision phase of the process, ensuring the simulation is correctly representing each of the items and associated behaviors as desired. They will also be able to expand their list of products to be modeled, for the next round of proposals to be discussed in the PEO Soldier M&S Community.

It is possible that a similar method of identifying requirements be used for other acquisition organizations. Computer simulation is a very powerful tool, especially when the items to be modeled are potentially expensive or the actual testing would be dangerous or inefficient. An acquisition organization, or potentially any organization, could use a similar technique of identifying the effects, inputs and outputs that would need to be included in a model as a way to describe their simulation requirements. This method requires a functional decomposition of the items of concern, but the result is a very-detailed description of the entities or attributes to be modeled. In this study, we have found that working with such a method provides a helpful description of the item for the modelers, as well as the detail required for a

high-resolution simulation. Equally important, it keeps the model from overlooking secondary or interrelated effects of a piece of equipment.

The US Army will and should continue to rely on modeling and simulation to support their acquisition decision-processes. For many items of equipment, it is critical that the acquisition community is able to translate their needs into descriptive, detailed simulation requirements. We have applied the Systems Engineering and Management Process to this need and developed a method of addressing it for PEO Soldier. More broadly, it is possible to use the same analysis method to develop modeling requirements for any acquisition organization. By linking the simulation capability to the needs of the acquisition community, it ensures that the model captures the necessary detail to provide useful analysis for a decision maker. This detail will only increase the realism and effectiveness of any simulation conducted for any other purpose as well. The end result will be an improved modeling capability, valuable for decision-making and training for the next generation of soldiers.

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Appendix A: List of Abbreviations

ACR	Advanced Concepts and Requirements
AMSAA	U.S. Army Materiel Systems Analysis Activity
AOA	Analysis of Alternatives
AVCATT	Aviation Combined Arms Tactical Trainer
BBS	Brigade / Battalion Battle Simulation
CASTFOREM	Combined Arms and Task Force Evaluation Model
CCTT	Close-Combat Tactical Trainer
COMBATXXI or CXXI	Combined Arms Analysis Tool for the 21st Century (affiliated with TRAC-WSMR and MCCDC)
DTIC	Defense Technical Information Center
FFW	Future Force Warrior Program
IUSS	Integrated Unit Simulation System
IWARS	Infantry Warrior Simulation (affiliated with AMSAA and NSC)
JCATS	Joint Conflict and Tactical Simulation
LW	Land Warrior System
MCCDC	Marine Corps Combat Development Command
METT-TC	Mission, Enemy, Time, Terrain, Troops, Civilian
MOA	Memorandum of Agreement
MOUT	Military Operations in Urban Terrain
NSC	Natick Soldier Center
OAKOC	Observation, Avenues of approach, Key terrain, Obstacles, Cover and concealment
OneSAF	One-Semi-Automated Force (affiliated with PEO-STRI)
OOS	Objective One-SAF
ORCEN	Operations Research Center
OTB	OneSAF Testbed Baseline
PEO	Program Executive Office
PEO-STRI	PEO Simulation, Training and Instrumentation
Ph / Pk	Probability of Hit / Probability of Kill
PM	Project Managers (subordinate to PEOs)
RDA	Research, Development and Acquisition
SMART	Simulation and Modeling for Acquisition, Requirements and Training
SEMP	Systems Engineering and Management Process
SITL	Soldier-in-the-loop
STMS	Soldier Tactical Mission System
TEMO	Training, Equipment and Military Operations
TIM	Technical Interchange Meeting
TRAC	TRADOC Analysis Center
TRAC-WSMR	TRAC at White Sands Missile Range
TRADOC	Training and Doctrine Command
UML	Universal Modeling Language
USMA	United States Military Academy

Appendix B: Original list of all PEO Soldier products.

PEO Soldier Products to model

Air Warrior (AW) Block 1
Air Warrior (AW) Block 2
Air Warrior (AW) Block 3
Aircraft Modular Survival System (AMSS)
Aircrew Integrated Helmet Systems (AIHS), HGU-56/P Helmet
Cockpit Air Bags System (CABS)
Communication Ear Plugs (CEP)
Electronic Data Manger (EDM), AW Block 2
Helicopter Oxygen System (HOS)
Laser Eye Protection (AW-LEP)
Retinal Scanning Display (AW-RSD)
SRU-37/P One Man Life Raft
Advanced Army Combat Cold Weather Clothing System
Advanced Bomb Suit
Advanced Combat Helmet
Advanced Communications Aural Protection System (ACAPS)
Advanced Tactical Parachute System (ATPS)
Aircrew Battle Dress Uniform
Aircrew Cold Weather Clothing System Jacket
Aircrew Cold Weather Clothing System Liner (Coat and Trousers)
Aircrew Survival/Egress Knife
Aircrew/CVC Cold Weather Clothing System Overalls
All Purpose Weapons and Equipment Container System
Anchor, Snow, Wired
Anodized Buckle
Army Combat Uniform
Ascenders, Cam Action
Axe, Ice
Bag, Duffel
Ballistic Laser Protective Spectacles (BLPS)
Ballistic Shin Guards
Ballistic-Non-Ballistic Face and Body Shields
Band, Helmet, Camouflage
Belt & Buckle, Trouser, Black, Webbing
Belt, Individual Equipment (All-Purpose Lightweight Individual Carrying Equipment (ALICE) - Fighting Load)
Beret
Bindings, Ski, Alpine and Cross Country
Blast Protective Footwear System (BPFS)
Body Armor Set, Individual Countermine (BASIC)
Body Armor Set, Individual Countermine (BASIC)(Legacy)
Body Armor System for Explosive Ordnance Dsposal (EOD)
Body Armor, Aircrew Integrated Recovery Survival Armor Vest & Equipment (AIRSAVE) (PM AW)

Body Armor, Combat Vehicle Crewmen's, Fragmentation Protective Undergarment
Body Armor, Concealable
Body Armor, Concealable Stab Protective
Body Armor, Fragmentation Protective Vest, Personnel Armor System for Ground Troops (PASGT)
Body Armor, Interceptor (PM-CIE/USMC)
Body Armor, Small Arms (Hand Gun) Protective, Undergarment, MP-1
Body Armor, Small Arms Protective, Aircrewman With Survival Vest SRU-21P
Body Armor, Woman's Small Arms (Hand Gun) Protective, Undergarment
Boot Gaiters
Boot, Combat, Desert
Boot, Combat, Mildew and Water Resistant, Direct Molded Sole
Boot, Extreme Cold Weather, Insulated, Black
Boot, Extreme Cold Weather, Insulated, White
Boot, Hot Weather
Boot, Intermediate Cold/Wet (ICWB)
Boot, Modular
Boot, Mounted Crewman
Boot, Ski, Mountain
Boot, Ski-Mountain, Plastic Shell
Camouflage Uniform System for Soldiers (Individual Camouflage)
Canteen, Collapsible, 2-Quart Capacity with Cover
Canteen, Water, 1-Quart Capacity with Cover
Canteen, Water, Insulated, Corrosion Resisting Steel, with Cup and Cover
Cap, Cold Weather, Insulating, Helmet Liner
Cap, Combat, Temperate Camouflage, Type 1 and Neckerchief
Cap, Garrison Male
Cap, Woodland Camouflage, Temperate BDU
Cardigan Sweater, White (Optional)
Case, Field, First Aid Dressing-Unmounted Magnetic Compass
Case, Small Arms, Ammunition, 30-Round Magazine
Chemical Protective Socks and Gloves
Chemical/Biological Protective Equipment Bag
Climbers, Ski
Coat, All-Weather, Men's and Women's
Coat, and Trousers, Cold Weather, Field, Woodland Camouflage Pattern
Coat, Cold Weather
Cold Weather Canteen System
Cold Wet Parka P31
Combat Patrol Pack
Combined Camouflage Face Paint (Medical Research and Material Command/PM-CIE)
Compression Sack
Cook's Shoes
Cover, Desert Camouflage Pattern for Fragmentation Protective Vest, Personnel Armor System for Ground Troops (PASGT)
Cover, Field Pack, Camouflage
Cover, Helmet, Chemical Protective

Cover, Helmet, Ground Troops and Parachutists, Camouflage Pattern
Cover, Individual, Camouflage (ICC)
Coveralls, Combat Vehicle Crewman
Coveralls, Flyer's, Fire Restraint, CWU-27P
Crampons, Hinged
Descender, Figure-8
Disposable Restraint System
Drawers/Undershirt, Cotton, Brown 436
Enhanced Hot Weather BDU Cap
Entrenching Tool, Lightweight
Equipment Belt Extender
Equipment Set, Mountaineering, Special Operational Forces (SOFME)
Extended Cold Weather Clothing System (ECWCS), Woodland Camouflage
Face Paint, Camouflage Compact
Family of Batons and Nightsticks
Family of Restraint System (FORS)
Female Sized BDUs
Field Pack, Combat, Nylon, Medium
Field Pack, Large with Internal Frame
Fighting Position Overhead Cover
Filter, Flashlight, ANVIS Compatible
Fingerlight, ANVIS Compatible
Frame, Field Pack and Shelf, LC-1 with Straps, Waist and Shoulder
Gaiters, Snow and Ice Traversing Equipment
Ghille Suit Accessory Kit (GSAK)
Glove Inserts, Cold Weather
Glove Set, Chemical Protective (Butyl Rubber Gloves)
Gloves, Barbed Wire Handler's
Gloves, Flyers, Summer, Type GS/FRP-2
Gloves, Leather, Black
Gloves, Men's and Women's, Anticontact
Gloves, Men's and Women's, Heavy Duty
Gloves, Men's and Women's, Light Duty
Gloves, Mounted Crewman's
Gloves, POL Handler's
Goggles, Sun, Wind and Dust; 1974
Grappling Hook, Collapsible
Hammer, Hand, Piton, Mountain
Hammer, Rock and Ice
Harness, Climbing, Full-Body
Harness, Single Point Release
Hat and Insect Net, Hot Weather
Hat, Desert Camouflage, and Neckerchief, Man's Cotton, Knitted
Helmet Integrated Ballistic Shell, Combat Vehicle Crewmen, DH-132B
Helmet, Fire Fighter's
Helmet, Flyer's, Protective, SPH-4B
Helmet, Ground Troops and Parachutists

Helmet, Parachutist's, Rough Terrain System
Hood, Anti-Flash
Hood, Balaclava, Extended Cold Weather
Hood, Combat Vehicle Crewman's Coveralls (Lightweight Balaclava)
Hood, Extreme Cold Weather/Synthetic Fur Ruff
Hot Weather BDU Cap
ICWB w/Removeable Liners
Improved Aircrew Battle Dress Uniform (PM AW)
Improved Combat Butt Pack (IBP)
Improved Combat Shelter
Improved Insulating Liners for ECWCS
Improved Mechanics Coveralls
Improved Personal Flotation Device
Improved Physical Fitness Uniform
Improved Rainsuit
Improved Suspension System, Helmet, Ground Troops and Parachutists
Improved Toxicological Agent Protective (ITAP) Ensemble
Individual Ration Heater System
Individual Riot Control Agent Disperser
Infantry Combat Boot
Interim Small Arms Protective Vest (ISAPO)
Intermediate Cold/Wet Glove System
Jacket, Cold Weather, High Temperature Resistant
Jacket, Flyer's, Lightweight (Expandable Wrists and Waist)
Joint Firefighter's Integrated Response Ensemble (JFIRE)/FIS-C
Joint Protective Air Crew Ensemble (JPACE) (Joint)
Joint Protective Air Crew Ensemble Interim (JPACE-I) (Joint)
Joint Service Lightweight Integrated Suit Technology (JSLIST) Overgarment (Joint)
Joint Service Lightweight Integrated Suit Technology (JSLIST) Source Qualification (Joint)
JSLIST Block 1 Glove Upgrade (USMC/PM-CIE)
Knee and Elbow Pads
Law Enforcement and Special Reaction/Civil Disturbance Team Equipment Bag
Lightweight Cold Weather Underwear System (LWCWUS)
Liner, Coveralls, Combat Vehicle Crewman's
Liners, Cold Weather, Coat and Trousers
Liners, Extreme Cold Weather, Parka and Trousers
Liplight, ANVIS Compatible
Low Profile Flotation Collar, LPU-34/P
M37 Mid-Size Riot Control Disperser
Mask, Cold Weather, OG_207
Mask, Extreme Cold Weather
Mat, Sleeping
Maternity Cardigan Sweater
Mattox
MC1-1B/C Parachute
Men's Class A/B Service Uniform

Micro Rappel System
Microclimatic Conditioning Air Vest and Connector
Military Eye Protection System
Mitten Inserts, Cold Weather, Trigger-Finger
Mitten Set, Extreme Cold Weather (ECW)
Mitten Set, Extreme Cold Weather for POL Handlers
Mitten Shells, Cold Weather, Trigger-finger M-1965
Mitten Shells, Snow Camouflage, White
Modified Improved Reserve Parachute System
Modular Glove System
Modular Lightweight Load-carrying Equipment (MOLLE) (PM CIE/USMC)
Modular Sleeping Bag System (MSBS P31 Bivy Cover)
Mounted Crewman Compartmented Equipment Bag
MP Combat/Law Enforcement Ensemble
NBC Compatible Drinking System
Neck Gaiter
Neck Shield
Overall, Bib, Cold Weather, Fiberpile
Overcoat, Men's & Women's
Overshoes, Men's and Women's Boot, Combat (for Chemical Protection)
Pad, Comfort
Pad, Parachutist's Helmet
Parachute Reserve Automatic Opening Capability (ATPS P3I)
Parachutist Ankle Brace
Parachutist Drop Bag
Parachutists Rough Terrain System (PRTS)
Parka and Trousers, Extreme Cold Weather (Arctic)
Parka and Trousers, Wet Weather
Parka w/Liner and Trousers, Desert Nighttime Camouflage
Parka, Snow Camouflage, and Trousers, Snow Camouflage, White
Penlight Flashlight
Peremethrin Treated Battle Dress Uniform
Physical Fitness Uniform (PFU)
Piton, Ice
Piton, Mountain, Angle
Piton, Mountain, Cliffhanger
Piton, Mountain, Flat
Piton, Mountain, Knifeblade Offset
Pitons, Mountain
Pocket, Ammunition Magazine, 9mm
Poles, Ski, Aluminum Shaft Adjustable
Poncho, Wet Weather, Camouflage
Poromeric Shoe
Protective Gloves
Protector, Crampon
Pulley, Moutain Rescue
Repair Kit, Ski

Rope, Kernmantle
Ruff, Parka, Extended Cold Weather
Safety Restraint Tether
Search Mirrors
Self-Contained Toxic Environmental Protective Outfit (STEPO)
Service Uniform Modernization, Class A/B
Sheath, Knife
Sheath, Machete
Shelter Half, Tent
Shirt, Cold Weather, Field, Wool/Nylon, Olive Green 108
Shirt, Sleeping, Heat Retentive and Moisture Resistant w/Liner, Wet-weather Poncho
Shirts, Polyester, Fiberpile, Extended Cold Weather
Ski, Military, All-Terrain
Sleeping Bag System, Extreme Cold Weather
Sleeping Bag, Intermediate Cold Weather
Sleeping Mat, Self Inflating
Small Unit Health and Comfort Pack
Snap Link, Mountain Piton
Snap Link, Mountain Piton, Locking and Nonlocking
Snowshoes, Trail, Magnesium w/Bindings
Sock System Evaluation
Socks, Men's, Wool, Cushion Sole, Stretch Type
Socks, Men's, Wool, Winter
Soldier Ground Insulator
Soldier Intercom
Special Protective Eyewear, Cylindrical (SPEC)
Special Protective Eyewear, Cylindrical (SPEC) (Ballistic/Pers Protection)
Stopper, Hexagon, Irregular
Stopper, Wired, Wedged
Strap, Retention, Parachutist's Helmet
Straps, Crampon
Suit, Chemical Protective (Overgarment) (BDO)
Suit, Contamination Avoidance, Liquid Protective (SCALP)
Survival Armor Recovery Vest, Inserts & Packets (SARVIP) Body Armor
Survival Armor Recovery Vest, Inserts & Packets (SARVIP) Vest
Survival Egress Air (SEA) MK2 Device
Suspension System, Helmet, Ground Troops and Parachutist's (Improved Version)
Sweater, Olive Drab
T-10 Parachute
T-10 Reserve Parachute
Tactical Assault Ladder System
Tactical Thigh Holster
Towel, Bath, Brown
Toxicological Agent Protective (TAP) Outfit (Coveralls, Hood, Footwear Cover)
Trousers, Cold Weather, Field, Woodland Camouflage Pattern

Trousers, Cold Weather, Field, Wool, M-1951
Underwear, Chemical Protective, Two Piece (CPU)
Underwear, Cold Weather
Underwear, Extended Cold Weather, Polypropylene
Uniform, Battle Dress, Desert
Uniform, Battle Dress, Hot Weather
Uniform, Battle Dress, Temperate Zone
Uniform, Cold-Dry
Uniform, Cold-Wet
Universal Static Line (USL)
Utility Glove
Vest, 40 mm Grenade
Vest, Aircrew Integrated Recovery Survival Armor Vest & Equipment (AIRSAVE)
Vest, Combat Medic
Vest, Individual, Tactical Load Bearing
Watch Cap, Black or White
Water Purification Pen
Webbing, Tubular Nylon
Women's Class A/B Service Uniform
Women's Dress Mess Uniform
Wrinkle Free BDUs
7.62 Medium Machinegun, M240B (with mod line)
Barrel Life Extension for the M249
Bipod/Handguard/Heatshield for the M249 MG
Collapsible buttstock for M249 Machine Gun
Combat Ammo Pack (CAP) for the M240B
Common Remotely Operated Weapon System (CROWS) Station/Remote Mount
DUD Reducing 40MM M430A1 (FCT)
M100, Grenade, Rifle, Entry Munition (GREM)
M1001, 40mm Canister Round
M1030, 12 Gauge Breaching Cartridge
M107, Semi Automatic Long Range Sniper Rifle
M145, Machinegun Optics Program
M240H 7.62 MG Aviation
M249 Squad Automatic Weapon (SAW) (with mod line)
M249 Squad Automatic Weapon (SAW) 200 Round Soft Pack
M25, Stabilized Binoculars
M973/M974 7.62 Short Range Training Ammo
MK19 Grenade Machine Gun (GMG) (with mod line)
MK243 Mod 0 9MM, Jacketed Hollow Point Cartridge
MK281 Target Practice 40MM Cartridge
Sniper Accessory Kit/ECP (for M24)
Weight Reduction Program for M240B
XM102, Reloadable Fuze for M84
XM1037, Short Range Non-Lethal Cartridge - M249
XM1041/XM1042, Close Combat Mission Capability Kit
XM1060 40mm Multipurpose Cartridge

XM192, Light Weight Ground Mount for MG
XM307 Machine Gun, 25mm, Objective Crew Served
XM312 Machine Gun, .50 cal (XM307 variant)
XM320, Grenade Launcher
XM992 Infrared Parachute Cartridge
9mm pistol rail system for M9
M16A4 Rifle/M16A4 (with mod line)
M4 Carbine/M4 (with mod line)
XM110, 7.62MM Semi-Automatic Sniper System (SASS)
XM116, Sight, Computerized, Small Arms Fire Control
XM25, Air Burst Weapon
XM26, 12 Gauge, Modular Accessory Shotgun System (MASS)
XM8 Carbine, 5.56mm Lightweight
Artillery Warrior Demonstration
Commander's Digital Assistant (CDA)
Dismounted - Combat ID Marking System (D-CIMS)
Land Warrior (LW)
Military Police (MP) Warrior
Mounted Warrior
Soldier Radio Multiband Inter/Intra Team Radio (MBITR)
AN/PAQ-4C & AN/PEQ-2A Aiming Lights
AN/PAS-13 Thermal Weapon Sights
Aviator Night Vision Imaging System (ANVIS) [AN/AVS-6 & AN/AVS-7]
Enhanced Night Vision Goggle (ENVG)
Integrated Laser White Light Pointer
Laser Borelight System
Lightweight Laser Designator Rangefinder (LLDR), AN/PED-1
Lightweight Video Recon System (LVRS)
Mark VII (Laser Target Locator)
Multi-Function Laser System (MFLS)
Night Sight - Enhanced Sniper Spotting Scope (NS-ESSS)
Night Sight - Semi-Automatic Sniper System (NS-SASS)
Sense Thru The Wall (STTW)
Sniper Night Sights (AN/PVS-10 & Long Range SNS)
Soldier Night Vision Devices (AN/PVS-7 NVG & AN/PVS-14 MNVD)
STORM Micro-Laser Ranger Finder (MLRF)
Target Acquisition Laser Observation Night (TALON)
VIPER Target Location System
XM8 Red-dot Sight (RDS)
XM8 Thermal Sight (CQX)
Advanced Combat Helmet with accessories (ACH)
Knee and Elbow Pads
MOLLE Accessories
Ballistic Protection Goggles
Hydration system
Glove System
Cold Weather Cap

AF Desert Flyers Boot (OEF)
Standard Army Desert Boot (OIF)
COTS Socks (4 Per)
Moisture Wicking T-Shirts
Combat Belt
Moisture Wicking Sports Bra
USSOCOM Silk Weight Underwear
Black Fleece Jacket
Emergency Bandage (Israeli Pressure Dressing)
Modular Sleeping System
MBITR
Close Combat Optic (M68)
TA 31F ACOG
Machinegun Optic M145
MICH Communication Systems
M249 Ammo Soft pack
M240B Combat Ammo Pack
Weapon Light
VIPER (VECTOR 21)/Mark VII
249 Rail
240B Rails
Flex Cuff
Helmet Repair Kit
Small Binoculars (M24) (Reduce BOI)
IR Strobe/Glint Tape
Visual/Language Translator Card
One Handed Tourniquet
Chitosan Dressing
Back-up Iron Sight
M249 Short Barrel
M249 Collapsible Buttstock
M240B Spare Barrel Bag
M122A1 Lightweight Tripod
3 Point Sling
Modular Weapon Sys Kit (Ind Rails for M16)
Modular Accessory Shotgun System (MASS)
Day/Night Sight (M203)
Night Vision (PVS-14) Mono lock
Improved Spotting Scope with Tripod
Improved Cleaning Kit
Improved Buttstock, M4
Modular M9 Holster
Fwd Grip Bipod
Haligan Tool
Grappling Hooks
Door Ram
Fiber Optic Viewer

Tactical Assault Ladder
Modular Entry Tool Kit

Proposed technologies to model

Land Warrior Computer System Weight and Power Consumption, Land Warrior Dead Reckoning/SAASM GPS Device, and JTRS Cluster 5 Soldier Radio System
Improved Soldier Worn Antenna System
Hands Free Voice Communications
Dismounted Soldier Multi-Level Security (MLS)
Individual Soldier Knowledge Management
Soldier Micro-climate Control
Accurate Three Dimensional Soldier Position Location
Advanced Image Processing
Soldier System Electronic Warfare Detection System
Soldier System Advanced Video / Audio Cueing System
Flexible Displays
Integrated Head, Neck, Face Protection
Flexible Body Armor
Soldier Micro-climate Control
Combat Identification
Miniature Non-magnetic Direction Finding System
Digital, Inexpensive Low Light Level Vision
High Power Long Life Mini-battery
Lightweight Direct View Optics
Miniature Producible IR Focal Plane Arrays
Multifunctional (Tunable?) Laser
Wireless Weapon Interface
Ecubed Shielding
Advanced Explosive Trains
Miniaturization of Electronic Components
High Brightness, Miniature Video Display
Mini-Setback Power Generator
Low Power Drain Electronics & Sensors
Miniaturized Wireless Signal Transmission for Fuze Applications
Increased Lethality 5.56mm Ammunition
Insensitive Explosive for 25-40mm HE/HEAB Ammo
Lightweight 5.56mm Ammunition
Breach Metal Doors
Tag/Mark Personnel/ Materiel
Increased Lethality in Support of Future Handgun Ammunition
Engage Targets with Non-Lethal Ammunition
Nano Explosives (Includes Thermobarics)
Maneuverable Small Arms Projectiles
Suppress Targets to 3,000m with Crew Served Weapons
Nano Propellants
Weapon Signature
Lightweight, High Strength Materials
Wear Resistant Coatings for Weapon Mechanisms (Tribology)
Increased Probability of Recognition (Pr)
Accurate Range Determination

Appendix C: Refined list of products

Model as a weapon

Modeling Priority 1	M16A4, M4, M249, M240
Modeling Priority 2	XM8 MAWS, M240 Weight Reduction, Reduced visual, acoustic, IR, RF firing signatures, XM307 ACSM, XM320 GL, XM29 IAWS, XM25 AWS, M249 w/new bipod, Lighter, stronger gun barrels, mechanisms and mounts, EM Weapon, XM26 Shotgun; M249 w/collapsible buttstock; M2, MK19; XM31 .50 Caliber
Modeling Priority 3	Multifunctional (Tunable?) Laser: Need a single laser that can not only accurately range find, but also act as an IR and visible pointer, IR illuminator, combat ID interrogator, and MILES trainer for individual weapon fire control systems.

Model as a type of ammunition

Modeling Priority 1	5.56, 7.62, 40mm (all common)
Modeling Priority 2	M995 5.56 AP; M993 7.62 AP; Increased lethality 5.56; Lightweight 5.56; M100 Rifle Grenade; XM430 40mm; XM992 40mm IR
Modeling Priority 3	M1030 Shotgun breaching; Insensitive 25-40mm; M1012 Shotgun crowd control; M1006 Non-lethal (NL) 40mm; M1029 NL 40mm; Nano-eplosives and thermobarics; Maneuverable projectiles; Nano-propellants; M1001 40mm Canister; SLAP

Model as a type of firing configuration

Modeling Priority 1	Reduced exposure firing platform (REFP), w/HMD; M192 LMG Mount
Modeling Priority 2	Common Remotely Operated Weapon Station (CROWS)

Model as a type of optic or visual aid

Modeling priority 1	Unaided, PVS-7D, PVS-14, TWS, PEQ-2A, PAQ-4C, Head Mounted Display (used with other devices), ENVG, ILWLP, LLDR
Modeling priority 2	STORM Rangefinder, MKVII Target Locator, Viper Target Locator, LVRS
Modeling priority 3	Fiber optic viewer; Sense Through The Wall (STTW)

Model as a communications system

Voice; hand and arm signals; SINCGARS system; MBIT Radio, EPLRS Radio; CDA

Modeled as an advanced attribute of various types of equipment

Land Warrior Computer System Weight and Power Consumption, Land Warrior Dead Reckoning/SAASM GPS Device, and JTRS Cluster 5 Soldier Radio System
Improved Soldier Worn Antenna System.
Low Power Drain Electronics & Sensors
Miniaturization of Electronic Components
Increased Probability of Recognition (Pr)
Dismounted Soldier Multi-Level Security (MLS)
Advanced Image Processing
Accurate Three Dimensional Soldier Position Location
Lightweight Direct View Optics
Digital, Inexpensive Low Light Level Vision
Flexible Displays
Individual Soldier Knowledge Management
Soldier System Advanced Video / Audio Cueing System
High Brightness, Miniature Video Display

Modeled as attributes of a soldier

Camouflage paint, uniforms
Dismounted - Combat ID Marking System (D-CIMS)
Helmet, Ground Troops and Parachutists

Advanced Combat Helmet, with accessories

Body Armor, Concealable

Ballistic Laser Protective Spectacles (BLPS)

Ballistic-Non-Ballistic Face and Body Shields

Body Armor, Interceptor (PM-CIE/USMC)

Integrated Head, Neck, Face Protection

Combat Identification

Flexible Body Armor

MOPP Gear

Basic cold weather gear, rain gear, combat boots, knee and elbow pads, Sun, Wind, Dust Goggles

Ballistic Shin Guards

Microclimatic Conditioning Air Vest and Connector

Soldier Micro-climate Control

Appendix D: Modeling Requirements

These are listed in the order they appear in Appendix C. This is the format that was delivered to the modelers. In general, these matrices list four things: items of PEO Soldier equipment (or families); the soldier methods that are affected by a particular piece of equipment or family of equipment; the attributes of that equipment; the specific modeling inputs and outputs required for accurate representation of that piece of equipment.

Modeled as a weapon

	Modeling Weapons 1	Modeling Weapons 2	Modeling Weapons 3
Equipment	M16A4, M4, M249, M240	XM8 MAWS, M240 Weight Reduction, Reduced visual, acoustic, IR, RF firing signatures, XM307 ACSM, XM320 GL, XM29 IAWS, XM25 AWS, M249 w/new bipod, Lighter, stronger gun barrels, mechanisms and mounts, EM Weapon, XM26 Shotgun; M249 w/collapsible buttstock; M2, MK19; XM31 .50 Cal	Multifunctional (Tunable?) Laser: Need a single laser that can not only accurately range find, but also act as an IR and visible pointer, IR illuminator, combat ID interrogator, and MILES trainer for individual weapon fire control systems.
Key Attributes	Munition (see below), muzzle velocity, rate of fire, bias, dispersion, Pk, Ph, Rounds per trigger pull, Rounds in magazine, firing modes	Supporting optics (see below), firing signature (audio, visual, olfactory), weight, firing configuration (see below), reliability, length	
Key Effects	Kill, incapacitate, suppress enemy from long range; expend ammunition	Engage more accurately (optics); employ airburst ammunition; expend soldier energy; alert to firer's position; effect on firer (recoil, muzzle flash); fight in close quarters; illuminate an area	

Soldier methods, sub-methods, and inputs and outputs required

	All Inputs and Outputs to Soldier Methods	Modeling Weapons 1	Modeling Weapons 2	Modeling Weapons 3
ENGAGE				
	Assessment of METT-TC, perceived target location, identification (friend, foe, neutral), threat, range, attributes; perceived proximity of target to structures, other entities and other objects; desired effects on target; visual, auditory, olfactory, tactile and taste sensed information; weapons available, mission requirements, rules of engagement	Not needed (the weapon itself does not do these things)	Not needed	Not needed
Make engagement decisions	Decision to engage, choice of weapon, choice of optic, choice of posture			
Engage (fire weapon)	Engagement decision, actual target location, range, weather and terrain conditions, weapon status, equipment configuration, device orientation, firer posture, target posture, laser designation, attentional resources, Ph, Pk, muzzle velocity, bias, dispersion, rounds per trigger pull	Engagement decision, actual target location, range, weather and terrain conditions, weapon status, equipment configuration, Ph, Pk, muzzle velocity, bias, dispersion, rounds per trigger pull	Same and device orientation, firer posture, target posture, laser designation, attentional resources	Same

	Ballistic trajectory, EM wave, thermal effect, smoke, audio signature, olfactory signature, EM trajectory, terminal effects on target, suppressive effects on target and vicinity, entity reaction, effect on environment, effect on firer, firer reaction, change in weapon status, reduction of available ammunition, elapsed time,adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments, reacquisition decision, reengagement decision	Terminal effects on target, target reaction, change in weapon status, reduction of available ammunition, elapsed time, reacquisition decision, reengagement decision	Same and ballistic trajectory, smoke, audio signature, suppressive effects on target and vicinity, effect on environment, effect on firer, firer reaction, adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments	Same and EM wave, thermal effect, olfactory signature, EM trajectory
MOVE				
Make navigational decisions	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC); information from navigational aids, perception of terrain, perceived location	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)
	Perceived location, perceived distance to objective, perception of time required	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)
Make general movement decisions	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC), and time remaining to complete mission; information from navigational aids, perception of terrain, perceived location	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)
	Choice of movement technique, formation, method, timing and pace	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)	Not needed (the weapon itself does not do these things)

	General movement and navigational decisions listed above; actual terrain, weather, light conditions, soldier physiological attributes (esp. energy level and physical fitness), equipment attributes (esp. weight, dimensions, bulkiness), availability of equipment to assist in this function (ladder)	Not needed at this detail	Soldier physiological attributes (esp. energy level and physical fitness), equipment attributes (esp. weight, dimensions, bulkiness)	Same and availability of equipment to assist in this function (ladder)
Change physical location	Change in soldier location, change in soldier posture, change in soldier exposure, audio waves, physiological effects, change in equipment status, change in equipment configuration, reduced attentional resources	Not needed at this detail	Change in soldier exposure, audio waves, physiological effects	Same and change in equipment configuration, reduced attentional resources
	Assessment of METT-TC, especially enemy and terrain; knowledge of directives, SOPs, availability of cover and concealment, equipment configuration	Equipment configuration and availability of cover and concealment	No additional effects	No additional effects
Choose posture	Choice of posture, choice of timing to change posture	Choice of posture, choice of timing to change posture	No additional effects	No additional effects
	Decision to change posture and timing to change, equipment configuration, soldier physiological status	Decision to change posture and timing to change, equipment configuration	Same and soldier physiological status	Same
Change posture	Change in posture, changed exposure, physiological effects, changes in firing and throwing ability, audio waves, visual cues, change in equipment state	Change in equipment state	Same and change in posture, changed exposure, physiological effects, changes in firing and throwing ability, audio waves, visual cues	Same

Modeled as ammunition

	Modeling Ammunition 1	Modeling Ammunition 2	Modeling Ammunition 3
Equipment	5.56, 7.62, 40mm (all common)	M995 5.56 AP; M993 7.62 AP; Increased lethality 5.56; Lightweight 5.56; M100 Rifle Grenade; XM430 40mm; XM992 40mm IR	M1030 Shotgun breaching; Insensitive 25-40mm; M1012 Shotgun crowd control; M1006 Non-lethal (NL) 40mm; M1029 NL 40mm; Nano-eplosives and thermobarics; Maneuverable projectiles; Nano-propellants; M1001 40mm Canister; SLAP
Key Attributes	Caliber, impact effect (penetrate, explode, illuminate)	Weight, number linked, dud rate	
Key Effects	Kill, incapacitate, suppress enemy from long range; impact effect	Adds weight to soldier load; affects the firing soldier (esp. riot control); requires reload	

Soldier methods, sub-methods, and inputs and outputs required

ENGAGE	All Inputs and Outputs to Soldier Methods	Modeling Ammunition 1	Modeling Ammunition 2	Modeling Ammunition 3
Make engagement decisions	Assessment of METT-TC, perceived target location, identification (friend, foe, neutral), threat, range, attributes; perceived proximity of target to structures, other entities and other objects; desired effects on target; visual, auditory, olfactory, tactile and taste sensed information; weapons available, mission requirements, rules of engagement	Perceived target location, identification (friend, foe, neutral), threat, range, attributes; desired effects on target; weapons (and ammunition) available, mission requirements	Same and perceived proximity of target to structures, other entities and other objects; rules of engagement	Same
	Decision to engage, choice of weapon, choice of optic, choice of posture	Decision to engage, choice of weapon and ammunition	Same and choice of posture	Same

	Engagement decision, actual target location, range, weather and terrain conditions, weapon status, equipment configuration, device orientation, firer posture, target posture, laser designation, attentional resources, Ph, Pk	Engagement decision, actual target location, range, weapon status, attentional resources, Ph, Pk	Same and weather and terrain conditions, equipment configuration, device orientation, firer posture, target posture, laser designation,	Same
Engage (fire weapon)	Ballistic trajectory, EM wave, thermal effect, smoke, audio signature, olfactory signature, EM trajectory, terminal effects on target, suppressive effects on target and vicinity, entity reaction, effect on environment, effect on firer, firer reaction, change in weapon status, reduction of available ammunition, elapsed time,adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments, reacquisition decision, reengagement decision	Ballistic trajectory, terminal effects on target, suppressive effects on target and vicinity, entity reaction, change in weapon status, elapsed time, reacquisition decision, reengagement decision	Same and ballistic trajectory, smoke, audio signature, olfactory signature, effect on environment, effect on firer, firer reaction, adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments	Same and EM wave, thermal effect, EM trajectory

Modeled as a type of firing configuration

	Modeling Firing Configurations 1	Modeling Firing Configurations 2
Equipment	Reduced exposure firing platform (REFP), w/HMD; M192 LMG Mount	Common Remotely Operated Weapon Station (CROWS)
Key Attributes	Weight, supported weapon system, remaining soldier exposure	Same
Key Effects	Increase stability of weapon and firer while firing (bias, dispersion); reduces exposed portion of firer	Same

Soldier methods, sub-methods, and inputs and outputs required

ENGAGE	All Inputs and Outputs to Soldier Methods	Modeling Firing Configurations 1	Modeling Firing Configurations 2
Make engagement decisions	Assessment of METT-TC, perceived target location, identification (friend, foe, neutral), threat, range, attributes; perceived proximity of target to structures, other entities and other objects; desired effects on target; visual, auditory, olfactory, tactile and taste sensed information; weapons available, mission requirements, rules of engagement	Perceived target location, identification (friend, foe, neutral), threat, range, attributes; desired effects on target; visual information; mission requirements, rules of engagement	Same and perceived proximity of target to structures, other entities and other objects; desired effects on target; auditory information
	Decision to engage, choice of weapon, choice of optic, choice of posture	Decision to engage, choice of optic	Same
Engage (fire weapon)	Engagement decision, actual target location, range, weather and terrain conditions, weapon status, equipment configuration, device orientation, firer posture, target posture, laser designation, attentional resources, Ph, Pk	Engagement decision, actual target location, range, weapon status, equipment configuration, device orientation, firer posture, Ph, Pk	Same and weather and terrain conditions, target posture, laser designation, attentional resources

	Ballistic trajectory, EM wave, thermal effect, smoke, audio signature, olfactory signature, EM trajectory, terminal effects on target, suppressive effects on target and vicinity, entity reaction, effect on environment, effect on firer, firer reaction, change in weapon status, reduction of available ammunition, elapsed time,adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments, reacquisition decision, reengagement decision	Ballistic trajectory, effect on firer, firer reaction, targeting adjustments, reacquisition decision, reengagement decision	Same and adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments, reacquisition decision, reengagement decision
MOVE			
Make navigational decisions	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC); information from navigational aids, perception of terrain, perceived location	Assessment of METT-TC, especially enemy location and threat	Same
	Perceived location, perceived distance to objective, perception of time required, perceived enemy location, choice of direction or route	Perceived enemy location, subsequent navigational decision	Same
Make general movement decisions	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC), and time remaining to complete mission; information from navigational aids, perception of terrain, perceived location	Assessment of METT-TC, especially enemy location and threat	Same
	Choice of movement technique, formation, method, timing and pace	Choice of movement formation, timing and pace	Choice of movement technique and method

	General movement and navigational decisions listed above; actual terrain, weather, light conditions, soldier physiological attributes (esp. energy level and physical fitness), equipment attributes (esp. weight, dimensions, bulkiness), availability of equipment to assist in this function (ladder)	General movement and navigational decisions listed above	Same and equipment attributes (esp. weight, dimensions, bulkiness); availability of equipment to assist in this function (ladder)
Change physical location	Change in soldier location, change in soldier posture, change in soldier exposure, audio waves, physiological effects, change in equipment status, change in equipment configuration, reduced attentional resources	Change in equipment configuration	Physiological effects
	Assessment of METT-TC, especially enemy and terrain; knowledge of directives, SOPs, availability of cover and concealment	Assessment of METT-TC, especially enemy and terrain; knowledge of directives, SOPs, availability of cover and concealment (esp. that afforded by the equipment)	Same
Choose posture	Choice of posture, choice of timing to change posture	Choice of posture, choice of timing to change posture	Same
Change posture	Decision to change posture and timing to change, equipment configuration, soldier physiological status	Decision to change posture and timing to change, equipment configuration	Same and soldier physiological status

	Change in posture, changed exposure, physiological effects, changes in firing and throwing ability, audio waves, visual cues, change in equipment state	Changed exposure; changes in firing ability; change in equipment state	Same and change in posture, physiological effects, changes in throwing ability, audio waves, visual cues, change in equipment state
SENSE			
	Assessment of METT-TC, equipment capabilities, sensory cues (EM, audio waves, vibrations, heat, odors), battlefield experience, assigned sectors, standard operating procedures	Equipment capabilities	Same
Make search decisions	Decision to search	Decision to search	Same
	Decision to search, METT-TC assessment, terrain, weather conditions, equipment configuration; equipment characteristics, field of view, scan time and technique; symmetric and asymmetric lines of sight (LOS), battlefield obscurants, EM waves, audio waves, vibrations, heat, odors, material properties, device capabilities, physiological capabilities, optical contrast, target detectability	Decision to search, equipment configuration; equipment characteristics, field of view; symmetric and asymmetric lines of sight (LOS), device capabilities, optical contrast, target detectability	Same and terrain, weather conditions, scan time and technique; battlefield obscurants, EM waves, audio waves, physiological capabilities
Search - Manipulate equipment, Orient, Observe	Change in equipment status, reduced attentional resources, elapsed time, audio signature; change in equipment orientation, change in soldier orientation; visual, auditory, olfactory, tactile, taste sensed information, reduced power, recognized need for another observation point, recognized need for more information	Change in equipment status, elapsed time, change in equipment orientation, change in soldier orientation; visual, sensed information	Same and reduced attentional resources, audio signature; change in equipment orientation, change in soldier orientation; auditory, olfactory, tactile, taste sensed information, reduced power, recognized need for another observation point, recognized need for more information
Make acquisition decisions	Observed visual, auditory, olfactory, tactile and taste information, assessment of METT-TC	Observed visual information, assessment of METT-TC	Same and observed auditory, olfactory, tactile and taste information

	Acquisition decision: which target to focus on	Acquisition decision: which target to focus on	Same
Acquire	Acquisition decisions, combat identification / IFF devices, weather and terrain conditions, actual target characteristics, signature, location, activity, assessment of those	Acquisition decisions, weather and terrain conditions, actual target characteristics, signature, location, activity, assessment of those	Same and combat identification / IFF devices
	Perceived target location, identification (friend, neutral, foe), threat, reduced attentional resources, reduced equipment power, combined effects of multiple systems being used	Perceived target location, identification (friend, neutral, foe), threat, reduced attentional resources	Same and reduced equipment power, combined effects of multiple systems being used
Make tracking / designation decisions	Assessment of METT-TC, acquisition decision, perception of target location, identification and threat, target choice	Assessment of METT-TC, acquisition decision, perception of target location, identification and threat, target choice	Same
	Tracking decision: which target to track	Tracking decision: which target to track	Same
Track / designate	Tracking / designation decision, environmental and weather conditions, target characteristics, location and activity	Tracking decision, environmental and weather conditions, target characteristics, location and activity	Same
	Target being tracked, target being designated, reduced attentional resources, reduced equipment power	Target being tracked, reduced attentional resources, reduced equipment power	Same

Modeled as an optic or visual aid

	Optics Priority 1	Optics Priority 2	Optics Priority 3
	Unaided, PVS-7D, PVS-14, TWS, PEQ-2A, PAQ-4C, Head Mounted Display (used with other devices), ENVG, ILWLP, LLDR	STORM Rangefinder, MKVII Tgt. Locator, Viper Tgt. Locator, LVRS	Fiber optic viewer; Sense Through The Wall (STTW)
Equipment	Unaided, PVS-7D, PVS-14, TWS, PEQ-2A, PAQ-4C, Head Mounted Display (used with other devices)	STORM Rangefinder, MKVII Tgt. Locator, Viper Tgt. Locator, LVRS	
Key Attributes	Field of view; I2 detect range; thermal detect range; magnification	Same and how mounted, effect on bias; effect on dispersion; reflection; reliability; weight; power usage	
Key Effects	Allow soldiers to see and operate at night or in obscured environments; enable more accurate target engagement; reduce peripheral vision; allow soldiers to control fires or target with aiming devices	Add weight to soldier load; Allow soldiers to designate targets; provide a reflection for enemy detection, expend battery life; sensitivity to sudden light	

Soldier methods, sub-methods, and inputs and outputs required

SENSE	All Inputs and Outputs to Soldier Methods	Optics Priority 1	Optics Priority 2	Optics Priority 3
Make search decisions	Assessment of METT-TC, soldier's equipment capabilities, sensory cues (EM, audio waves, vibrations, heat, odors), battlefield experience, assigned sectors, standard operating procedures	Assessment of METT-TC, equipment capabilities; soldier's knowledge of equipment capabilities	Same	
	Decision to search	Decision to search	Same	

Search - Manipulate equipment, Orient, Observe	Decision to search, METT-TC assessment, terrain, weather conditions, equipment configuration; equipment characteristics, field of view, scan time and technique; symmetric and asymmetric lines of sight (LOS), battlefield obscurants, EM waves, audio waves, vibrations, heat, odors, material properties, device capabilities, physiological capabilities, optical contrast, target detectability	Decision to search, METT-TC assessment, terrain, weather conditions, equipment configuration; equipment characteristics, field of view; symmetric and asymmetric lines of sight (LOS); device capabilities; optical contrast, target detectability	Same and scan time and technique; battlefield obscurants, EM waves, audio waves, vibrations, heat, odors, material properties; physiological capabilities	
	Change in equipment status, reduced attentional resources, elapsed time, audio signature; change in equipment orientation, change in soldier orientation; visual, auditory, olfactory, tactile, taste sensed information, reduced attentional resources, reduced power, recognized need for another observation point, recognized need for more information	Change in equipment status, reduced attentional resources, elapsed time; change in equipment orientation, change in soldier orientation; visual, auditory sensed information	Same and audio signature; change in equipment orientation, change in soldier orientation; olfactory, tactile, taste sensed information; reduced power, recognized need for another observation point, recognized need for more information	
Make acquisition decisions	Observed visual, auditory, olfactory, tactile and taste information, assessment of METT-TC	Observed visual, auditory information, assessment of METT-TC	Same and olfactory, tactile and taste information	
	Acquisition decision: which target to focus on	Acquisition decision: which target to focus on	Same	
Acquire	Acquisition decisions, combat identification / IFF devices, weather and terrain conditions, actual target characteristics, signature, location, activity, assessment of those	Acquisition decisions, weather and terrain conditions, actual target characteristics, signature, location, activity, assessment of those	Same and combat identification / IFF devices	

	Perceived target location, identification (friend, neutral, foe), threat, reduced attentional resources, reduced equipment power, combined effects of multiple systems being used	Perceived target location, identification (friend, neutral, foe), threat, reduced attentional resources	Same and reduced equipment power, combined effects of multiple systems being used	
Make tracking / designation decisions	Assessment of METT-TC, acquisition decision, perception of target location, identification and threat	Assessment of METT-TC, acquisition decision, perception of target location, identification and threat	Same	
	Tracking decision: which target to track	Tracking decision: which target to track	Same	
Track / designate	Tracking / designation decision, environmental and weather conditions, target characteristics, location and activity	Tracking / designation decision, environmental and weather conditions, target characteristics, location and activity	Tracking / designation decision, environmental and weather conditions, target characteristics, location and activity	
	Target being tracked, target being designated, reduced attentional resources, reduced equipment power, visible/IR signature designating target	Target being tracked or designated; visible/IR signature designating target	Same and reduced attentional resources; reduced equipment power	
ENGAGE				
Make engagement decisions	Assessment of METT-TC, perceived target location, identification (friend, foe, neutral), threat, range, attributes; perceived proximity of target to structures, other entities and other objects; desired effects on target; visual, auditory, olfactory, tactile and taste sensed information; weapons available, mission requirements, rules of engagement	Identification of target (by pointing device)	Same	
	Decision to engage, choice of weapon, choice of optic, choice of posture	Decision to engage	Same	

	Engagement decision, actual target location, range, weather and terrain conditions, weapon status, equipment configuration, device orientation, firer posture, target posture, laser designation, attentional resources, Ph, Pk	Engagement decision; device orientation; laser designation	Same	
Engage (fire weapon)	Ballistic trajectory, EM wave, thermal effect, smoke, audio signature, olfactory signature, EM trajectory, terminal effects on target, suppressive effects on target and vicinity, entity reaction, effect on environment, effect on firer, firer reaction, change in weapon status, reduction of available ammunition, elapsed time,adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments, reacquisition decision, reengagement decision	Ballistic trajectory	Same and adjusted Ph given a sensed miss, adjusted Ph given a miss not sensed, targeting adjustments	
MOVE				
	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC); information from navigational aids, perception of terrain, perceived location	No effects		
Make navigational decisions	Perceived location, perceived distance to objective, perception of time required, choice of route/direction	None		

Make general movement decisions	Assessment of METT-TC, especially of mission, enemy, terrain (OAKOC), and time remaining to complete mission; information from navigational aids, perception of terrain, perceived location	Perception of enemy, terrain	Same	
	Choice of movement technique, formation, method, timing and pace	Choice of movement formation, timing, pace	Same and choice of movement technique, method	
Change physical location	General movement and navigational decisions listed above; actual terrain, weather, light conditions, soldier physiological attributes (esp. energy level and physical fitness), equipment attributes (esp. weight, dimensions, bulkiness), availability of equipment to assist in this function (ladder)	General movement and navigational decisions listed above; actual terrain, weather, light conditions, equipment attributes (esp. FOV, magnification)	Same and soldier physiological attributes (esp. energy level, physical fitness, visual acuity)	
	Change in soldier location, change in soldier posture, change in soldier exposure, audio waves, physiological effects, change in equipment status, change in equipment configuration, reduced attentional resources	Change in equipment status, reduced attentional resources	Same and change in equipment configuration	
Choose posture	Assessment of METT-TC, especially enemy and terrain; knowledge of directives, SOPs, availability of cover and concealment	Equipment configuration	Same	
	Choice of posture, choice of timing to change posture	Choice of posture, choice of timing to change posture	Same	
Change posture	Decision to change posture and timing to change, equipment configuration, soldier physiological status	Decision to change posture and timing to change, equipment configuration	Same and soldier physiological status	

	Change in posture, changed exposure, physiological effects, changes in firing and throwing ability, audio waves, visual cues, change in equipment state	Change in equipment state	Same and physiological effects	

Modeled as a type of communication

	Modeling Communication 1	Modeling Communication 2	Modeling Communication 3
Equipment	Voice; hand and arm signals; SINCGARS system; MBIT Radio, EPLRS Radio; CDA	Same	Same
Key Attributes	Audio, visual signature; transmission range; wavelength; weight; dimensions; transmission type (data, voice); security	Same and electronic signature; power usage	Hands Free Voice Communications; wireless weapon interface (feed high-resolution video to HUD)
Key Effects	Allow communication between team/squad members; allow communication between individual soldiers and platoon/company/battalion; allow communication between individual soldiers and supporting assets (vehicles, artillery); exposes friendly forces to enemy (noise); transmits soldier positions to higher echelons (PLT/CO/BN); presents interactive map display for soldiers for planning and navigation; allows changes to plan enroute	Requires sorting, prioritization and selection of messages; expends battery life; requires frequency update	Wireless Weapon Interface: Need a wireless streaming video interface for transmitting high resolution no latency color video from a Soldier's weapon-mounted camera to the Soldier's head's up display and communicating bi-directional control data between the soldier's weapon and body-mounted computer. Wireless interface signals must be non-detectable by the enemy and jam-proof.

Soldier methods, sub-methods, and inputs and outputs required

COMMUNICATE	All Inputs and Outputs to Soldier Methods	Modeling Commo 1	Modeling Commo 2	Modeling Commo 3

	Assessment of METT-TC, (esp. comm. equipment, supporting units available) perception of terrain, perception of enemy situation, visual, auditory, olfactory, tactile and taste sensed information, recent battlefield experience, entity attentional resources due to current activity, SOP, communication received requiring response	Assessment of METT-TC, perception of terrain, perception of enemy situation, visual, auditory, entity attentional resources due to current activity, SOP, communication received requiring response	Same and olfactory, tactile and taste sensed information, recent battlefield experience	
Make transmission decisions	Choice of when, what, how and to whom to transmit	Choice of when, what, how and to whom to transmit	Same	
	Decision to transmit, entity attentional resources due to current activity, equipment configuration, equipment status (esp. power), bandwidth load, bandwidth capacity, light, weather and terrain conditions (esp. LOS), soldier clothing and equipment effects, length of message, background noise, interference	Decision to transmit, entity attentional resources due to current activity, equipment configuration, equipment status (esp. power), light, weather and terrain conditions (esp. LOS), length of message, background noise, interference	Same and equipment status (esp. battery usage), bandwidth load, bandwidth capacity, soldier clothing and equipment effects	
Transmit	Verbal, typed, written and signaled communications, change in equipment status, reduced attentional resources, elapsed time, audio and visual signature, additional load to bandwidth, reduced equipment power, pyrotechnic effects on the environment, transmission success or failure, accuracy of transmitted	Verbal, typed, written and signaled communications, change in equipment status, reduced attentional resources, elapsed time, audio and visual signature, transmission success or failure, accuracy of transmitted information, transmission quality	Same and additional load to bandwidth, reduced equipment power, pyrotechnic effects on the environment	

	information, transmission quality			
	Assessment of METT-TC, perception of the terrain, enemy situation, visual, auditory, olfactory, tactile and taste sensed information, recent battlefield experience, SOP, communication received	Assessment of METT-TC, perception of the terrain, enemy situation, visual, auditory, SOP, communication received	Same and olfactory, tactile and taste sensed information, recent battlefield experience	
Make reception decisions	Decision to receive, decision of how to receive	Decision to receive, decision of how to receive	Same	
	Decision to receive and how to receive, equipment configuration, equipment status, bandwidth load, light, weather and terrain conditions	Decision to receive and how to receive, equipment status, light, weather and terrain conditions	Same and equipment configuration, bandwidth load	
Receive	Change in equipment status, reduced attentional resources, elapsed time, reduced equipment power, visual, auditory and tactile sensed information, perceived information	Change in equipment status, reduced attentional resources, elapsed time, visual, auditory and perceived information; MAY TRIGGER other functions	Same and reduced equipment power; tactile sensed information	
	Transmission and reception decisions listed above, METT-TC assesment, terrain and weather conditions, equipment configuration, equipment characteristics	Transmission and reception decisions listed above, METT-TC assesment, terrain and weather conditions, equipment configuration, equipment characteristics	Same	
Manipulate communications equipment	Change in equipment status, reduced attentional resources, elapsed time, audio signature	Change in equipment status, reduced attentional resources, elapsed time, audio signature	Same	

	Visual, auditory, olfactory, tactile and taste sensed cues, environmental conditions, physiological and psychological conditions, sorted or unsorted communications data	Visual, auditory sensed cues, environmental conditions, physiological	Same and olfactory, tactile and taste sensed cues; psychological conditions, sorted or unsorted communication s data	
Process communication information	Information, changed cognitive bandwidth, physiological conditions, trigger other decision or action cycles (move, engage, sense)	Information, changed cognitive bandwidth, physiological conditions, trigger other decision or action cycles (move, engage, sense)	Same, but consider cognitive bandwidth more taxed (unsorted email, for example)	

Modeled as an attribute of a soldier

	Optical, thermal and audio detectability	Ballistic protection	EM Wave protection	Chemical protection	Environmental protection
Baseline equipment	Camouflage paint, uniforms	Helmet, Ground Troops and Parachutists	None	MOPP Gear	Basic cold weather gear, rain gear, combat boots, knee and elbow pads, Sun, Wind, Dust Goggles
Next steps	Dismounted - Combat ID Marking System (D-CIMS)	Advanced Combat Helmet, with accessories			Ballistic Shin Guards
		Body Armor, Concealable			Microclimatic Conditioning Air Vest and Connector
		Ballistic Laser Protective Spectacles (BLPS)			Soldier Micro-climate Control: Cooling and heating; low power, low weight capability.
		Ballistic-Non-Ballistic Face and Body Shields			Soldier Micro-climate Control: Use of reactive fibers for passive heating and cooling through exploitation of nanotechnology.
		Body Armor, Interceptor (PM-CIE/USMC)			
		Integrated Head, Neck, Face Protection			
		Combat Identification: Passive and tunable (on/off) combat identification marking system that can be embedded into the Advanced Combat Uniform and detected at 1.5 times the max effective range of Army small arms through use			

		of a weapon mounted low signature active illuminator.			
		Flexible Body Armor: Use of reactive fibers for ballistic protection through exploitation of nanotechnology.			

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14. ABSTRACT
The Army acquisition community requires high-resolution simulations that represent the dismounted infantry soldier in enough detail to conduct an analysis of alternatives (AOA) for individual weapons and equipment. These models must also be capable of assessing future, proposed capabilities and technologies. Previous work proposed coordination among three different models to achieve this capability. In this report, we discuss the implementation of that recommendation. We first will describe the process of approving a Memorandum of Agreement among the parties involved. We then will discuss our procedure used to identify PEO Soldier's analysis needs. Finally, we will detail the procedure we used to translate those analysis needs into specific simulation requirements. We will conclude with a discussion of how effective the technique has been in practice.

15. SUBJECT TERMS
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